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### A British Railroad Gazette.

An international combination publication, in London, of the *Railroad Gazette* together with the best known railroad paper in England will begin in the first week in July. The method of republication of nearly all the reading pages in this British edition makes it desirable and necessary to change the size of the leaf and the form of making-up to which the *Railroad Gazette* readers have been accustomed for a generation. London *Transport*, which is the partner in the edition for Great Britain and other Eastern continents, has maintained a vigorous increase in growth during the past 13 years, both in value and in a great foreign circulation, and it affords the best possible basis for such a railroad publication as the world needs.

For the *Railroad Gazette* there are many advantages. The combined editorial staff and correspondents will get more surely and accurately improvements in railroad engineering and in operating methods in all countries. Correspondents may be assured that their articles will be seen wherever there are railroads and railroad officers, and this is alike true of advertisers in the *Railroad Gazette*. In amplifying the science and in working out the art of transportation, *Transport and Railroad Gazette* has an important mission. It is an inspiring undertaking and its editors and publishers have a deep feeling of responsibility in the serious work which is before them. If it is well done the world will be benefited.

### The Economy of the 50-Ton Box Car.

The 50-ton box car is not a rarity on American railroads. The mere fact that the Pennsylvania has adopted cars of this capacity as standard is a strong argument in their favor as having an earning capacity greater than the 30-ton or 40-ton car. An analysis of their real value must take into consideration two important points: Can the greater loads which they will carry be obtained, and if so what is the money value of their greater carrying capacity during a given period over and above the additional first cost and the cost of hauling the extra dead load due to their weight?

If the necessary facts are at hand, it is not hard to arrive at the actual increase in earning power in a given period of time, of the 100,000 lb. car over the 80,000 lb. car, provided both are loaded to their maximum capacity during that period. A concrete example serves best for such a calculation and the following data have been taken from the report of a railroad which fairly represents average operating conditions in the United States. Such assumptions as have been made are conservative and not far from actual values. The comparison is of two box cars, both having bodies of the dimensions adopted as standard by the American Railway Association (36 x 8½ x 8), one of 80,000 lbs. capacity and the other of 100,000 lbs. capacity. The first will cost $1,100 and weigh 41,400 lbs., the second will cost $1,150 and weigh 43,000 lbs.; a difference of $50 in cost and of 1,600 lbs. in dead weight, due largely to the heavier trucks used. On the road in question, the gross operating expenses chargeable to freight were $13,196,142 which includes an equitable proportion of all charges for maintenance, repairs and improvements to track, bridges and other structures together with charges for enginemen and trainmen, repairs to cars and locomotives, fuel, water, oil and all other charges usually included in operating expenses. The total ton-mileage for the year, including dead weight of cars, estimated at 29,000 lbs. each, was 6,281,032,000. Dividing this figure into the gross operating expenses, makes the average cost of moving one ton one mile, 2.1 mills. The average yearly mileage of cars was 11,300 miles. The excess weight of the 100,000 lb. car over the 80,000 lb. car being 1,600 lbs. or .8 ton, the excess ton miles per car for the year, due to running the larger car, would be .8 x 11,300 or 9,040 ton-miles. At 2.1 mills, the cost of moving this excess dead weight in each car would be $18.98. Add to this the interest at 5 per cent. on the excess first cost of $50 and the total cost per year of the 100,000 lb. car over the 80,000 lb. car is found to be $21.48.

With 10 per cent. overload, the larger car has 11 tons greater capacity than the smaller car. The net earnings per ton-mile on this road were 5.6 mills. The excess net earnings per mile run of the 100,000 lb. car over the 80,000 lb. car, both loaded to their maximum, will therefore be 11 x 5.6 mills or 6.16 cents. The excess cost per year of the 100,000 lb. car is $21.48; hence the large car must travel 2,148 ÷ 6.16, or 349 miles, fully loaded, before it begins to show a saving over the 80,000 lb. car. For every mile traveled over and above 349 miles the larger car when fully loaded earns 6.16 cents per mile in excess of the 80,000 lb. car. If it ran its entire mileage, loaded to its maximum capacity, it would show a gain in earning capacity of $674.50 for the year.

But, unfortunately, the assumption on which the above calculation is based, that both cars are loaded for their entire mileage at their maximum capacity, which includes a 10 per cent. overload above the marked capacity, cannot, as a matter of fact, ever be realized in actual operation. The value of the large car as an earning factor depends solely on the possibility of obtaining loads for it which exceed the capacity of the smaller car. The cubic capacity of the American Railway Association standard box car which measures 36 ft. long, 8 ft. 6 in. wide and 8 ft. high is 2,448 cu. ft. If a 100,000 lb. car of these dimensions is loaded with wheat to its capacity of 110,000 lbs. the load would come to within 6 in. of the roof. On the other hand, a car loaded with 88,000 lbs. of wheat would have a load coming to within 2 ft. of the roof; which approximates much nearer to actual loading and unloading conditions. All of the other grains usually carried in bulk weigh from three to five pounds less per cubic foot than wheat and hence could not be used in fully loading the 100,000 lb. car under any circumstances. The common kinds of lumber weigh from 30 to 45 lbs. per cubic foot, or from 3 to 18 lbs. less than wheat. Only a few articles suitable for bulk shipments can be loaded in sufficient quantities to equal the maximum for the 100,000 lb. car, cotton in round bales, bricks, pig metal, paper in rolls or bundles and a few less common commodities. Under the most favorable circumstances, full carloads cannot always be obtained even for bulk shipments and in the case of miscellaneous merchandise and high-class freight, it is seldom, if ever, that a car can be loaded to anything like its full capacity of 55 tons. On the Missouri Pacific after four years of educating shippers and agents in loading cars to their fullest capacity, the average shipment of general freight per car from 23 of the largest stations, was 11,688 lbs. This is less than one-seventh the capacity of the smaller of the two cars that we have been considering, and yet it is looked upon as a highly creditable accomplishment, and justly so. It is no doubt a much larger average than can be found on any similar road which has not given special attention to loading.

In building 50-ton cars to be used for one or two kinds of lading—as, for example, coal and iron ore—no mistake has been made. Everybody agrees that the economy in wages and in track room far outweighs all disadvantages. If a single commodity—say wheat from Lake Erie to the Atlantic Ocean—could be had in sufficient volume to keep a particular lot of cars well employed, similarly satisfactory results might be had with box cars; but in dealing with general traffic the very large "ifs" in the foregoing calculations must be kept constantly in mind. The proportion of our general traffic which must be moved in loads of moderate weight or bulk, because of the need of promptness or the wishes—either businesslike or whimsical—of shippers and consignees, is very large, and with the increased density of population is increasing. The use of a single standard size of car has an element of wastefulness, at best. In England and other countries where small cars have always been used, the reasons why small sizes are still adhered to are based on numerous hard facts which are by no means uninstructive to Americans. A study of those reasons would very likely show convincing grounds for making our standard no higher than 40 tons.

### Discipline and Improvements.

The fact that lives and property are not so safe as they ought to be, on American railroads, is attributed, in part, to poor discipline or lack of discipline among the men who are put in charge of the lives and property. The question of making these men more careful, vigilant and efficient has been discussed a little, here and there, but definite results do not seem to be accomplished in any adequate degree. This being so it may be well to turn the problem around for a moment and look at the other way. If, instead of asserting that the discipline of trainmen and station men is defective or deficient (which seems to imply that it has deteriorated from some past standard or condition which was higher) we should assume that the trouble is due to changes in the demands that are made on the men, we might simplify our problem, or at least make it simple to more people. To tell a trainmaster or a foreman that his discipline is not so good as it once was, when he is all the time vividly conscious of having put forth just as much and as intelligent effort as ever before, is likely to puzzle and discourage him. This feeling should be taken into account, and if the diminished safety of lives or the increased expense on account of wrecks is due to increased burdens put upon the men, it will be well to be frank with ourselves and state the facts as they are. It is true that increased demands ought to be met by the men them-

selves. An intelligent man ought to grow with his work. Such increases in responsibility as have occurred have not been sudden, and wide-awake men have adapted themselves to new conditions. Nevertheless there is a duty to explain and educate which, it may be, has not been fully met.

Take the simple question of the frequency of trains. Assuming a given standard of intelligence and care, on the part of conductors, enginemen and operators, an increase in the number of trains daily will increase the liability of collision, *unless the degree of intelligence and care is* 100 *per cent.* in all the men. As long as our men are admittedly to be graded at less than 100 per cent. in proficiency and reliability, an increase of chances of collision means an increase in collisions. In the former times, supposed to be "good times" as compared with the recent periods of high casualty records, freedom from disaster was partly due to freedom from opportunity for disaster; it is so now; but there is less freedom because more opportunity. No one can measure this risk, or the change which has or may have occurred in it, but the fact will be acknowledged. Possibly this element, with the elements of overwork due to the great volume of traffic, and of inexperience due to the necessity of promoting men too fast and employing too many new ones, would account for most of the increase in the accident and damage record. Whether it does or does not, the point is one which, if reflected on, should serve as a reminder of the unwisdom of permitting expansion in business without providing for a corresponding expansion of facilities; and, in the matter of provision for safety, the facilities should be increased at least a little more than the demands increase, for our standards have never been high enough.

This using facilities up to their limit and beyond is a characteristic of railroad work in more than one department. The familiar experience with freight cars is an example. If we make stronger and better trucks, axles and wheels we forthwith increase the loads so that damage from broken parts keeps up as before; and with the heavier and more costly cars each damage bill is larger than its counterpart of former years. We introduce the air brake to make it safer to run at speed, and then increase the speed so that safety is perhaps diminished instead of increased. As soon as freight train speed is heightened so as to make it easier for the men to get adequate rest, we lengthen the runs so that irregular hours and overwork are as troublesome as ever. If the telephone is introduced to simplify communication by wire, almost the first thought of the superintendent is to try to save money on operators' wages—to get along with a cheaper grade of men. The need of skilful brakemen having become less pressing, with the almost universal use of the air brake, trains are manned with "trainmen" who not only lack skill in braking but also lack the all-around gumption which experience in braking formerly helped to teach.

Now, if we do the same way with the discipline of conductors, enginemen and operators, in those features of their work which come up for consideration when we study the collision record, we may fairly expect to go on killing people. Whatever may be said about the increase of chances or the proportion of killed to carried or employed, it is admitted that higher vigilance is required. No standard of efficiency is a safe guide except the standard of perfection. If the next Government bulletin—or the records of the next year—should show a diminution of 50 per cent. in the casualties to passengers, that fact by itself would not in the least weaken the grounds for the exhortations that have been made on this subject, or give any evidence that the deaths of the last appalling bulletin were unavoidable and conveyed no lesson. As long as trainmen neglect to identify opposing trains at meeting points, the investigation of their habits in this matter is a crying necessity, whether their neglect kills anybody or not. As long as conductors and enginemen are detected every month in depending on each other—instead of conferring with each other—for the safety of their train, discipline is in need of correction, whatever our death records may show or not show. The need for improving discipline is not to be learned now from the casualty records; but in the light of known deficiencies and known possibilities of improvement. The connection between a defect in discipline and the death of a passenger is often as hard to trace as that between a voter's conscience and an honest Mayor or a strong Congressman; but when everyone knows that the connection exists, the duty in the premises is plain.

## Clearance Limits on American Railroads.

On another page in this issue is a diagram showing the minimum composite clearance of the important railroads in the United States. Several points on the diagram are noteworthy as indicating a really serious condition of affairs brought about by the great increase in the size and capacity of passenger and freight equipment within the last few years. The increase has been gradual and the encroachments on what have been commonly assumed as safe limits of size have been made apparently without a careful study of the physical limitations of all of the railroads collectively.

The first projection shown on the line rising from the rail is 3 ft. 4 in. from the center line and rises 9 in. from the top of rail. Low arch-bar trucks are likely to strike the obstruction indicated, which is on a large railroad system in the middle West. The jagged line rising from 1 ft. above the rail is a composite of several Eastern roads, and comes very close to the bottom corner of the journal boxes on 5½ in. x 10 in. journals. If for any reason the size of wheels is decreased, as in the 120,000-lb. flat-car built for the General Electric Co. last year, and described in the *Railroad Gazette* Nov. 13, 1903, where it was necessary to get a very low floor, this point will strike the projections shown. The minimum width above 4 ft. is shown at 10 ft. While only one road reported this minimum width, several others are only an inch or two outside, and 10 ft. can well be taken as the limiting width. Several recent designs of furniture and other large cars, notably the coke car for the Cambria Steel Co., illustrated elsewhere in this issue, exceed this limit for the full height above the floor line.

The most serious condition, however, is indicated above the 11-ft. line. The irregular line from 11 ft. 6 in. up to 13 ft. 6 in. is the east-bound clearance limit for the Baltimore & Ohio. The diagram which was sent in from this road showed a composite clearance for the entire system plotted for east-bound and west-bound tracks. These clearances were originally obtained from a specially designed car built by the Baltimore & Ohio, which had mounted on it an apparatus for recording any projections within certain limits when the car was run through tunnels, bridges or past other structures to one side. (See the *Railroad Gazette*, May 1, 1903). The following note was appended to the print returned, showing the outline: "These clearances are obtained by subtracting the middle ordinate of a car 60 ft. center to center of trucks from the actual distance from the center line of track to the obstruction." In other words, where the obstruction was on a curve the clearances shown were rectified to provide for a car 60 ft. center to center of trucks passing around the curve where the overhang in the middle would apparently strike the projection. It is doubtful if any of the diagrams sent in were more carefully prepared than this one, which indicates the most serious difficulty. The proposed width at eaves for a standard box car is 9 ft. 7 in. at 12 ft. 6¾ in. above the rail. This width falls outside of the clearance shown. It has not been ascertained whether the clearance at this point is on the main line track or on a branch line, but inasmuch as two or three other roads come within 3 in. or 4 in. of the same point, it seems hardly safe to adopt as standard a dimension which interferes under the most favorable conditions with one great trunk line and so closely approaches the clearances of others. If the car is loaded eccentrically or rocks badly when heavily loaded, interference will result which might damage the car badly. Locomotives, perhaps, which are built to run on a certain division can be built as big as the clearances of that particular division will allow, but when a railroad orders cars which are to be used in interchange traffic, it assumes to a certain extent the responsibility for their safe operation. If the cars are too big to be run over another road, the responsibility rests with the owners of such equipment. It might be urged with equal force that if one railroad chooses to build cars which can be run over its own lines and not over some other line, it can equip such cars with air-brakes and couplers of some design which will not operate in connection with the equipment on foreign cars. The one proposition is as sound as the other, and yet the railroads are doing exactly that thing. Before any definite action is taken toward adopting a standard or maximum size of cars, such as the Master Car Builders' Association proposes to take, a careful and thorough examination of the clearances of all, and not a few, railroads should be made; and unless the minimum points can be changed before some agreed time, no encroachment on a safe limit for all the roads should be sanctioned.

The Secretary of the Board of Trade has issued for the year 1903 the "General Report," which follows the regular statistical report of accidents on the railroads of Great

Britain and Ireland. It is prepared by Herbert Jekyll. The statistical report was summarized in the *Railroad Gazette* of April 15, page 291. The present document contains the comments of the bureau officers on the principal facts of the year. The most noticeable feature this time is that part dealing with the form of the returns and proposing certain changes. Hereafter, each quarterly report will deal exclusively with the accidents of that quarter, as is the case in the American reports. Heretofore the English reports made up in July and October have given the figures for six months and nine months respectively. For 1903 the statistics of passengers, servants and other persons, are subdivided further than formerly and comparisons are drawn between the number of accidents and the corresponding number of persons exposed to accidents. It is proposed in the future to make a distinction between what are classed as preventable and non-preventable. It is also proposed to distinguish severe accidents (to employes) from those which are slight, those which lay a man off 14 days being classed as severe. The report declares that more than half the accidents which occur on railroads, either to passengers or employes, are due to want of common care and caution on the part of the injured persons. The inclusion of suicides and accidents to trespassers has led to much misapprehension and to false conclusions by many persons. Large as the totals have been, in the reports heretofore published, it remains true that, excluding the train accidents which cannot be cured by regulations, and those which are not caused by railway working, the field in which improvement is to be looked for is comparatively small. The number of passengers killed in train accidents in 1903 (25) is equal to one in 48 millions carried, the latter figure not including season ticket holders. The number killed is four times greater than in the preceding year, and the ratio is correspondingly greater, the number of passenger journeys having changed but slightly. The number of employes killed in train accidents (6) is equal to one in 12,106. The number of train accidents inquired into by the inspecting officers in 1903 was 31. Only five of these accidents were attended with fatal results to passengers. The number of accidents at highway grade crossings in 1903 was 100, in which 73 persons were killed and 39 injured. A list is given showing the place where each one of these happened and the circumstances in connection with some of them. The report has the usual condensed accounts of the inspecting officers' reports; these fill 11 pages.

The Railway Commission of Canada is giving the world an entirely new brand of state railroad regulation. After investigating an accident recently the commissioners ordered the suspension of the men whose negligence caused it, one for 30 days and another for 60; and in another case the man who was blamed was ordered dismissed. Just how fully the statute laws of Canada provide for punishment of men who, acting as railroad employees, cause death or personal injury we do not know; but if they deal with the subject at all, the interference of the Railway Commission will be likely, we should think, to introduce confusion. Even if the Commission's decisions are uniformly intelligent and just they will be subject to the grave objection that they relieve the railroad company of its responsibility in a way that must impair discipline and improperly favor the railroad. What right has the Commission to say that suspension is the most suitable punishment for the ordinary offenses? One of the first attributes of government is justice, but suspensions are usually unjust, in that they do not require the employee to pay the cost of repairing the damage that he has caused. They often do harm to the employee by enforcing idleness at an unsuitable time. The idle man often sows seeds of discontent in the minds of other employees. Suspensions have sometimes led to the employment of such a large number of "extra" men as to weaken the morale of the forces. Usually the loss of wages sustained by the suspended man results in no benefit whatever to the company. These considerations have led many railroads to decide that suspensions are wholly wrong and to abolish them; so that if a railroad commission in the United States were to adopt this Canadian practice it would be ignoring the experience and defying the opinions of a large part of the community affected. In the matter of dismissals the authority that gives the order can often go wrong much more easily and surely than in suspensions; and the injustice, if there be any, is more palpable. As an example to the other employees a dismissal may entirely fail of its purpose. A dismissal which is made to take the place of a judicial prosecution impairs the majesty of the law. A railroad officer who dismisses a man to avoid the perplexities of administering exact justice neglects a public duty; and a Government officer who does the same thing is chargeable with the same offense.

The simplification of time-tables (by starting trains on the hour) which was introduced on the Philadelphia & Reading a year ago, with marked success, between New York and Philadelphia, has been applied now to the Washington trains as well as those for Philadelphia, and the same arrangement also appears in the time-table of the express trains of the Baltimore & Ohio between Washington and Baltimore. Express trains from New York for Washington start at 8, 10, 12, 2, 4 and 6; and those from Washington for New York start at 7, 9, 11, 1, 3 and 5. These departures from New York are on the same minute with the departure of expresses for Philadelphia (Reading Terminal), but the trains are in each case separate, leaving Jersey City one or two minutes apart. From Baltimore to Washington, and from Washington to Baltimore, express trains start every hour from 8 a. m. to 8 p. m., in each direction, with parlor cars on all trains. Where the traffic is large enough to justify it, this arrangement is a decided convenience, even though the speeds and the intermediate stops cannot be made entirely uniform, and there are other roads or divisions or short sections where such an improvement might be made. In the meantime the attractive even-hour scheme that was adopted on the New York division of the New York, New Haven & Hartford a dozen or 15 years ago seems to have been weakened a little of late; some trains are started at odd times, like 5:47 and 9:15. The remarkable even-hour scheme adopted on the Eastern Massachusetts lines of the New Haven road a dozen years ago for both through and local trains, and on both double track and single track lines, seems to be still in use, though with more variations than at first. This is not surprising; for it was surprising that such a rigid scheme worked as smoothly as it did.

A coal company owning and operating several hundred cars, most of them steel cars of 100,000 lbs. capacity, has been spending on an average $10 a month per car for wheel and axle renewals. This would seem to indicate that the cast-iron wheel is not altogether economical to use under cars in this kind of service at least. Practically the entire mileage which these cars make is over lines having heavy grades, and undoubtedly most of the trouble arises from the heating effect of the brake shoes. There is still a large proportion of old cars running in this service, and many of them are not equipped with air brakes. Quite a number are not equipped with air pipes. These cars are coupled into trains more or less promiscuously, and the result is that a few of the head end cars, usually steel hoppers, are depended upon to control the train. In descending even a light grade, heavy applications are made on these few cars and the heating at the wheel tread is just as severe as when descending a steep grade with all the air brake cars in the train coupled up. Ten braked cars and the engine will control a forty car train on light grades if the braking pressure is high, but twenty cars coupled up, and lighter applications of the air would control the train with greater safety and less damage to the wheels. It would take a little more time at terminals perhaps and use a little more air, but it would save a good many dollars on the wheel bill.

## NEW PUBLICATIONS.

*American Street Railway Investments.* Issued annually in connection with the *Street Railway Journal.* 362 pages, 9 x 13. Subscription, including the present "Red Book" and the Electric Railway Directory and Buyers' Manual, which is published three times a year, $5. The McGraw Publishing Company, 114 Liberty street, New York.

With this issue of the "Red Book," the publishers commence the second decade of the work, under conditions which, as suggested in the preface, are entirely different from those at the time the first volume was published. In 1894 very few street railway companies realized the importance of issuing annual financial statements, and many of them were opposed to the publication of such figures. At the present time the information given is of a very complete character. The street railway companies are arranged according to the alphabetical order of the cities and towns within the state where they have their headquarters, and the principal physical and corporate facts about the status of each company are given, together with information with regard to gross earnings, expenses, etc., for the majority of the companies, although this information has in some cases been withheld from the publishers. Many of the companies print their maps as well, and these show to great advantage on the large pages. A minor detail of considerable importance, which should be imitated in all statistical publications of this character, is the date of information, which is stated definitely at the end of each report.

## TRADE CATALOGUES.

*The Indianapolis Switch & Frog Company,* Springfield, Ohio, sends out a four-page folder with half-tones of various kinds of frogs, crossings, switches, rail-braces, etc. A leaflet is also issued by the same company describing the "Little Giant" switch stand. The novel feature of this switch stand is that the gear actuating the connecting arm of the target is four times the size of the pinion turning it. This confines the wear and tear to one-fourth of the gear, and, when this section is worn out, by readjusting the gear and pinion the other sections can be brought into use.

*The Chicago, Milwaukee & St. Paul* issues

a folder describing the Rosebud Indian Reservation. Under President Roosevelt's proclamation, United States registry land offices are to be opened on July 5 at Yankton, Chamberlain, Fairfax and Bonesteel, S. Dak., for the registration of applicants for these lands. The folder issued by the C., M. & S. P. gives a description of the various characteristics of the country as regards its climate, soil, products and topographical situation. It also has a map of the C., M. & St. P.'s line from Chicago to Yankton, which is the shortest line between these points. The folder contains a large amount of desirable information for any applicants for the new lands.

*The Nernst Lamp Company*, Pittsburg, Pa., issues a small book describing the value and utility of its lamp in the modern central station. This lamp is so designed that the maximum candle power can be obtained directly beneath the lamp, giving an economy of space and a lessening of the strain on the eyes. The need of reflectors is also obviated.

*F. H. Melville*, 192 Front street, New York, is sending out a circular describing a new kind of anti-rust. The circular announces that samples will be sent to any one who is interested in protecting bright steel from rusting.

*St. Louis Expanded Metal Fireproofing Co.*, St. Louis, Mo., has issued in pamphlet form tables for the design of reinforced concrete beams by Johnson's formulæ, as being more convenient for use than the diagram published by the company last year. Included in the pamphlet are the results of tests made at the Massachusetts Institute of Technology on the adhesion of different kinds of bars imbedded in concrete. This is reprinted from the *Railroad Gazette* of Sept. 18, 1903.

*The Empire Safety Tread Co.*, Brooklyn, N. Y., sends out a small catalogue illustrating and describing the application of carborundum safety treads to railroad and street car steps. The safety tread consists of a steel plate having narrow channels formed on its top surface and every other channel is filled with carborundum which it is practically impossible to wear out and which also gives a rough surface on which the foot will not slip.

*The Joseph Dixon Crucible Company*, Jersey City, N. J., publishes a booklet entitled "Graphite as a Lubricant," which discusses in detail the theory of graphite lubrication and its practical benefits. Of the various classes of machinery on which graphite is now used as a lubricant the more important are: Stationary engines and pumps, marine engines, gas engines, cylinders, ammonia compressors, air compressors, locomotives and air brakes.

*The Rand Drill Co.*, New York, is sending out a mailing card which is a decided novelty. It is in the shape of a new Imperial hammer, the address being written on the barrel and a one cent stamp fitting in the handle.

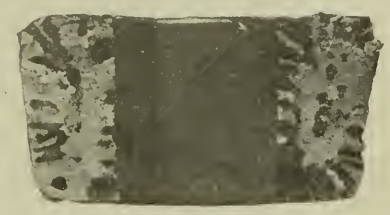
## CONTRIBUTIONS

### A Bad Coupler Casting.

St. Louis, Mo., June 11, 1904.

To the Editor of The Railroad Gazette:

The accompanying photograph of the broken jaw of a coupler may be of interest to your readers. It is the outer half of the upper knuckle pin lug and was found lying alongside of the track. The car from which it came had run loaded to Kansas City and had come back in a long train, but the piece had been broken off by a pull with but one other car behind while switching in the yard after its safe trip of more than 500 miles. Neither the jaw nor the hinge pin of the knuckle are much worn, showing the coupler had not been in service very long. This is an interesting example of the kind of castings that are made and accepted by the railroads as couplers. On one side are 19 blow holes and on the other side are something over 30 holes. The edge next to the pinhole shows 11 perforations, giving an almost perfect "honey-comb" formation. If



A Bad Coupler Casting.

such a thing were not manifestly impossible, one might suppose them to have been bored with a drill. The surface of the casting is pitted with small blow holes and numerous cold-shuts indicating a structure throughout very similar in appearance to the fracture. Not more than 60 per cent. of the area of the fracture is solid metal and that is crystalline. How any conscientious inspector could ever accept a casting which gave such evident surface indications of poor quality is hard to understand. If more care was taken in selecting only sound castings from reputable makers, the railroads would possibly have less trouble from break-in-twos and coupler failures.

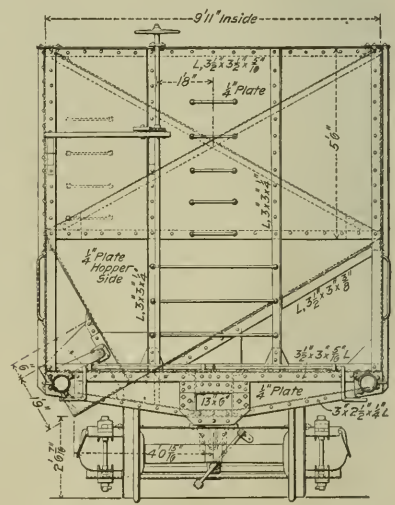
S. D. W.

### Coke Car for the Cambria Steel Company.

The Cambria Steel Company, Johnstown, Pa., has built for its own use a number of steel hopper coke cars of unusual dimensions and design. They are intended to haul coke from the coke ovens near Franklin, Pa., to the new blast furnaces now under erection at the company's plant at that point. The cars have a marked capacity of 100,000 lbs., and a cubic capacity of 3,852 cu. ft., heaped. They are divided by the sloping floor sheets into eight pyramidal hoppers, from each of which a chute leads out to one side of the car only. These side chutes are spaced on centers the same distance apart as the two skip buckets of the furnace elevator. When the car is placed in position opposite the furnace, one chute is opened and the contents of its hopper is discharged into the skip bucket below. As this bucket is raised to the charging platform of the furnace the other bucket descends under the second chute and is loaded and raised. The car is then moved along until the third and fourth chutes are over the skip buckets, and these in turn are allowed to discharge their contents. Four shifts of the car are required to unload it, but as the coke falls directly into the furnace elevators, no handling of the coke at the furnace is necessary.

The cars are 48 ft. long inside, 9 ft. 11 in. wide inside, and 13 ft. 3 in. high from top of rail to top of side. On account of the extreme length and the manner in which the floor and sides are broken up by the hoppers, the design calls for substantial lateral body bracing and longitudinal frame bracing. The center sills are 15 in. 33-lb. channels, spaced 13 in. apart, with the flanges turned out and covered with top and bottom cover plates. The side sill has been omitted on the side carrying the discharge chutes, but on the opposite side a 9-in., 13¼-lb. channel is used between bolsters and a 7-in., 9¾-lb. channel between the bolster and the end sill. The bolsters, end sills and single cross-tie in the middle of the car, are built up of plates and angles. The side stakes on the side opposite the chutes are carried down to the light side sill, but on the side having the chutes, only the stakes at the bolsters and the middle cross-tie are carried down below the vertical plates of the sides. Light angles, 3-in. x 3-in. x ¼-in., are carried across from the center sills to the side sill on the back side of the car, one under the middle of each hopper. A triangular plate, set on edge, rests on top of the center sills under the middle of each hopper, and supports the slope sheet which is further stiffened against sagging by a 3-in x 3-in. x ⅜-in. angle riveted along the under side from the center line of the car up to the top edge of the sheet. The lateral bracing in the upper part of the car consists of cross-diagonals of light angles at every other panel point, and a 4-in. x 4-in. x ½-in. angle tie across the top of the sides. Cross bending strains in the under frame are taken care of by angle braces running back from the side sills on the back side of the car, to the center sills at the bolster and middle cross-tie. A 10-in., 25-lb. channel is used for the end sill diagonal braces between the outer ends of the bolster and the middle of the end sill.

The discharge chutes have an opening at the mouth 2 ft. 6 in. wide, and 2 ft. 3 in. high. The steep slope sheet of the hopper is cut away to this size, and there is no door, the load being held in the open chutes by the prong rakes at the outer end of the chute. These prongs are fastened to a cross-piece at the top, which is pivoted on two

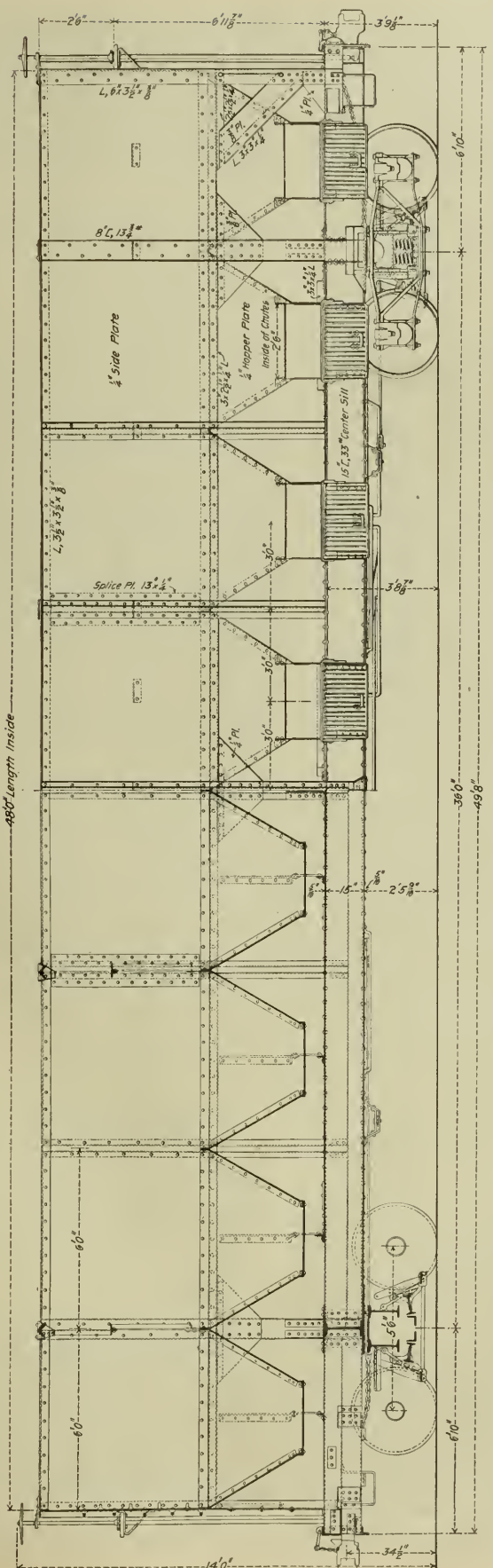


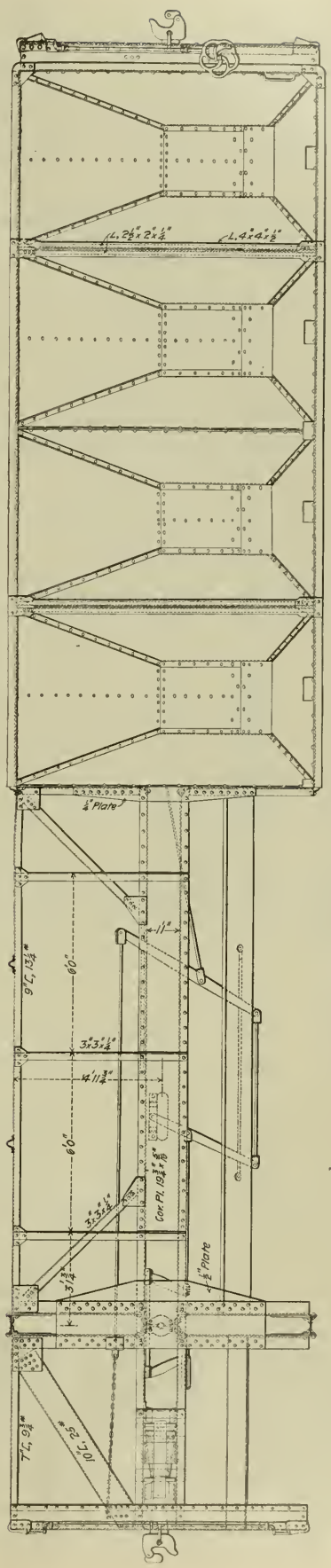

End Elevation of Cambria Coke Car.

arms running back to brackets on the hopper sheet. A handle fastened to the prongs serves to raise the rake up above the chute and allow the load to discharge and to lower it when the discharge is to be stopped. The prongs can be forced down through the stream of coke with less trouble than a solid door could be closed.

These cars are mounted on Cambria arch-bar trucks of 100,000 lbs. capacity, and their light weight is 55,400 lbs.

We are indebted to Mr. H. H. Weaver, assistant to general manager, Cambria Steel Company, for the drawings.

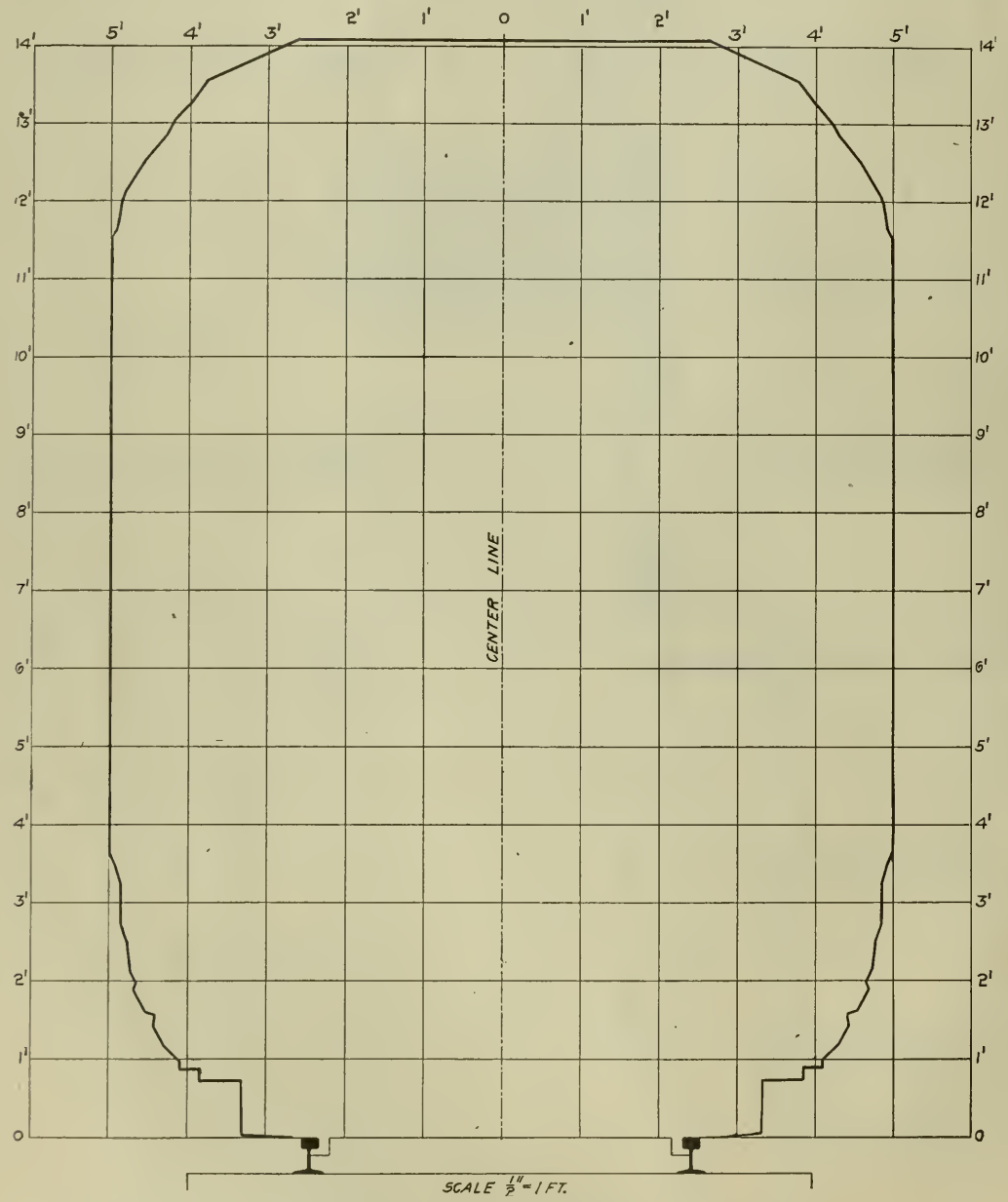



Plan and Side Elevation of Cambria 50-Ton Hopper Bin Coke Car.

## Clearance Limits on American Railroads.

In 1902, a committee of the Master Car Builders' Association recommended certain outside dimensions for box cars to be adopted as standard and again in 1903 these dimensions were recommended but no definite action was taken, the committee being continued for another year to make a complete report on a design of standard box car and its detail construction. The outside dimensions presented in 1902 permitted the use of the standard inside dimensions previously adopted by the American Railway Association, and the committee stated in its report that cars built in accordance with them would be safe to run on any of the larger railroad systems. The width at eaves was fixed at 9 ft. 7 in. for cars with both low and high floors corresponding with a height at eaves from top of rail, of 12 ft. ¾ in. and 12 ft. 6¾ in., respectively. Most of the box cars built since the adoption by the American Railway Association of 8 ft. width and 8 ft. 6 in. height as standard, have conformed to these dimensions and come inside the suggested outside dimensions, but there seems to have been no limit set to the size of furniture, buggy, barrel rack, coke, and other cars for special service. So long as these cars are run in a certain well defined district where the clearance limits are well out, they are just as safe to run as the smaller car but if such a car is loaded to some point on a foreign road and is refused at the interchange point as unsafe to run over the connecting road, expensive delays occur in trans-shipment of the lading to a smaller car. No car which is used in interstate traffic and which may at any time leave the home road should exceed certain outside dimensions limited by the clearances of all the roads of any importance over which there is any likelihood of the car's being routed. Contract car builders are often at a loss to know how far they can exceed certain commonly assumed dimensions in designing cars for special service and still build a car that is safe to run anywhere. A composite clearance diagram compiled from all of the important railroads would be of much value to them in such work and to the railroad mechanical departments as well. With this end in view the accompanying diagram was prepared. A letter was sent to the chief engineers of more than 50 of the largest railroads in the country asking them to indicate on an enclosed blue print the clearance limits of their roads. They were asked, for the sake of uniformity, to indicate only the actual striking contours of the bridges, tunnels, station platforms and other structures and not to show working clearances or outline clearances of equipment running over their roads. Replies were received from more than 40 roads, and




Composite Clearance Limit Diagram of Railroads in the United States.

with the data in hand, each clearance outline was carefully plotted on one sheet, making a composite diagram for all. The inside line was taken as indicating the minimum clearance and this line is shown on the engraving. A number of the replies showed outline clearances for equipment but these were all thrown out and all doubtful points on any of the others were carefully checked or rejected entirely. It is believed that the engraving, which is on a scale of ½ in. to 1 ft., represents as accurately as is possible, the minimum composite clearance for American railroads. Comment will be found in the editorial columns.

## Notes from the Southern Railway Shops at Manchester, Va.

The principal shops for the northern section of the Southern are at Manchester, Va., on the James River, opposite Richmond. They cover 12 acres and give employment to about 700 men. They include both the locomotive and car departments. The shops are not interesting in so far as design and arrangement are concerned. The shops, like Topsy, have "just growed." At one end of the yard is the brick paint shop. When a concrete floor was laid the gutters between the tracks were carried to the end of the building and made to drip into a sewer on the outside at either end. Such an arrangement would be impossible in a cold climate. The shop is heated from a quadruple line of steam pipe sunk into the concrete in the

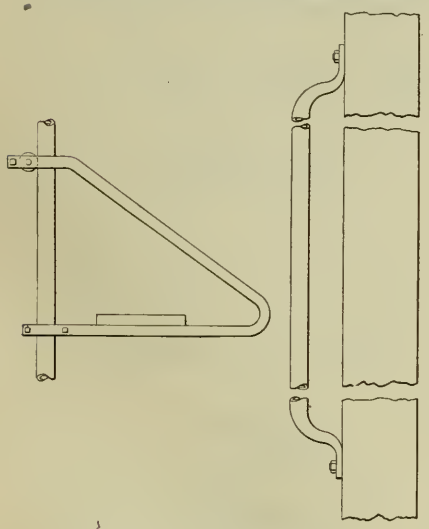


Fig. 1—Paint Shop Scaffolding.

center of each line of track. The object of this is to heat the air beneath the car that is being painted and cause a warm dry stream to flow out and up the sides and thus facilitate the drying.

The paint shop scaffolding is adjustable in height and is carried by swinging brackets like those shown in Fig. 1. These slide up and down gas pipe uprights held to the supporting posts of the roof. The boards are fitted with hooks that lay over the brackets and hold them in position while they are being raised and lowered. The method of working is to raise it for use on the letterboard drop to the proper position for the window posts and then raise it up out of the workman's way when the paneling is being covered. This form of scaffolding has supplanted that previously used, which consisted of a 4½ in. pipe driven into the ground containing a plunger beneath which water under pressure was admitted to raise and hold the scaffolding at any desired height. This form is shown in section in Fig. 2. When these lifts were in use it was considered that they effected a great saving in time in varnishing besides being high enough to be used by the tinners.

The time required to paint a car is about 14 days, although the facilities are such that it can be rushed through in nine days. The sequence followed is first to burn off with a Vulcan torch and scrape. This scraping, which was previously done with a putty knife, is now done with an

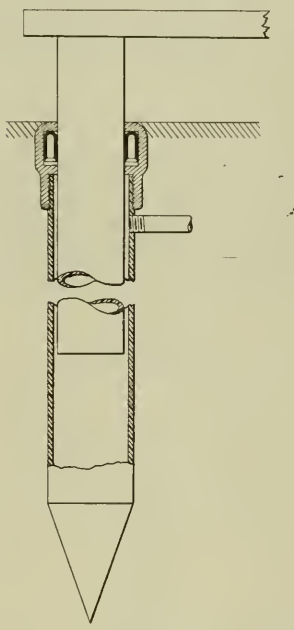


Fig. 2—Hydraulic Lift for Scaffold.

old file bent and sharpened, and the work can be done much more thoroughly and quickly. After burning and scraping the car is sandpapered and given an A coat, then one coat of No. 2, then one coat of glaze after which two coats of No. 3 follow when the car is rubbed down. Then come two coats of color and two coats of finishing varnish. The varnish is allowed to dry for a day and two nights. It is the practice to sand the ends of the baggage, express and postal cars in order to protect them from cinders. This work is done with a sander shown in Fig. 3, which consists of a small tin can fastened to the top of a piece of ½ in. gas pipe, and provided with a broad flat nozzle that has an opening of about $^{2}/_{16}$ in. Compressed air is admitted to the pipe and projects the sand against the car. The sanding can be done in this way in about one-third the time required to do it by hand and with a saving in the amount of sand used. The paints are stirred in their tanks by means of compressed air. This method has been criticised but inquiry at Manchester develops the fact that the paint is not oxidized nor is water deposited.

One of the handy adjuncts of the paint shop is a spraying car used for outside work on freight cars. It is carried on four wheels and between them is a cupboard for the storage of materials and the spraying machine; while, at the ends there is a swinging bracket and shelf so that the total length of the car is equal to that of a box car. It can serve as a traveling scaffold. It moves on a narrow gage track between the main repair or paint tracks and does away with all need of the use of horses and planking. Difficulty has been experienced in getting men to work with the paint sprayer on account of the fine particles which fill the air. Respirators have been used but apparently do little good. The color is well laid, and with the machine a man can paint a box car, including the roof, in 36 minutes.

For many years the road has done all of its own silver and nickel plating and silvering mirrors and etching fancy glass. The silvering of the mirrors is done in the usual manner by pouring a solution of nitrate of silver, Rochelle salts, ammonia and potassium hydrate over the glass that is laid upon a warm cement table, and then draining the water into a gutter at the side. The table has a deep bottom upon which is laid a coil of steam pipe bedded in about 4 in. of sand. The cement top is spread over the sand. This construction insures an even heat beneath the whole surface of the glass. The cement table is also used for chipping glass; that is, for producing the cracked or frosted effect that is worked into deck lights of passenger cars, etc. The glass is first sand blasted to roughen the surface so that glue will adhere. The pattern that it is desired to produce having thus been cut, a coating of glue is spread over it and the glass placed in front of a steam radiator to dry. The rapid drying of the glue draws on the glass and gives the crinkling effect. There is no control over the actual form of the crinkling, but it may be made light or heavy

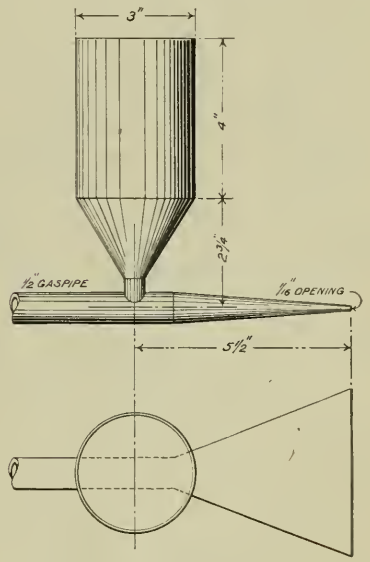



Fig. 3—Sander.

according to the application of the glue. Etching with hydrofluoric acid is also done and produces fine frosted effects. A pattern is drawn or printed on the glass. An ordinary method of doing this printing is to give the glass a coat of paint and while it is still wet, the pattern is placed over it and the glass is set in the sun. The unprotected part soon dries and the pattern is removed and the undried paint readily washed away. This leaves the pattern worked out on the clear glass, which is then covered with acid. An example of this method of etching is shown in Fig. 4, which was obtained by laying the lace on the wet paint. The ordinary patterns that are used for this work are zinc. The water used in the washing-off processes is purified by a small filter and still. The trays used are wood with a thick coating of paraffine on the inside. The zinc patterns are made by coating a sheet of zinc

with a layer of asphaltum or paint, and when this has dried the outline of the pattern or letter is cut through the paint with a scriber. The plate is then given a bath of hydrochloric acid and the metal is eaten through and the stencil finished. The waste hydrochloric acid, which has dissolved some zinc, is then turned over to the tinners for use in soldering so that there is no loss. On all glass decorations there is a material saving. In plating headlight reflectors the price paid to outside parties for the work was $2.50, while the cost under present conditions is 78 cents. An elevator serves the glass decorating room. A horizontal cylinder with its piston attached to a multiplying drum does the hoisting. Power is furnished by compressed air that is admitted to the top of a tank forcing water out through a small pipe into the cylinder. In this way a very steady motion and one

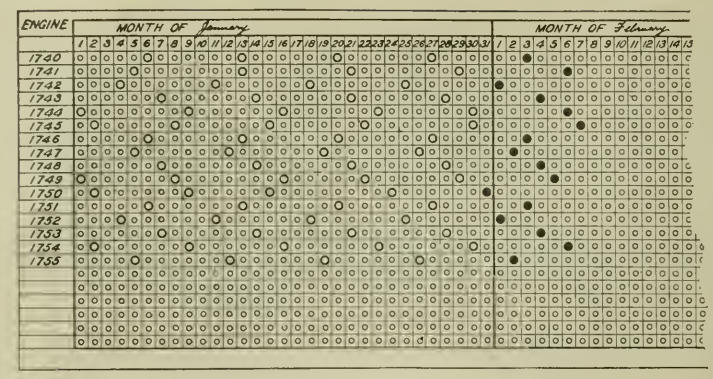



Fig. 5—Record Board for Boiler Washings.

vided with holes in which a button-head pin can be placed. A white head indicates the date on which the boiler was washed and a red head that on which the work is to be done. This gives a record for two months.

Broken engine frames in place are welded in the roundhouse. The methods in use on the New York Central and the Baltimore & Ohio have already been described in the *Railroad Gazette*, Feb. 27 and May 15, 1903. On those roads oil is burned as a fuel. Here a coke fire is used and a filling piece about ¾ in. thick is put in the break which is jacked apart to receive it. The fire is held

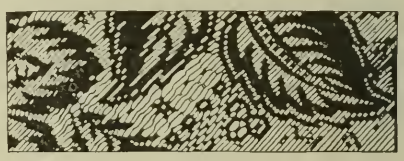


Fig. 4—Lace Etched on Glass.

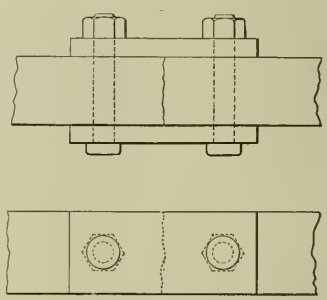


Fig. 6—Engine Frame Splice.

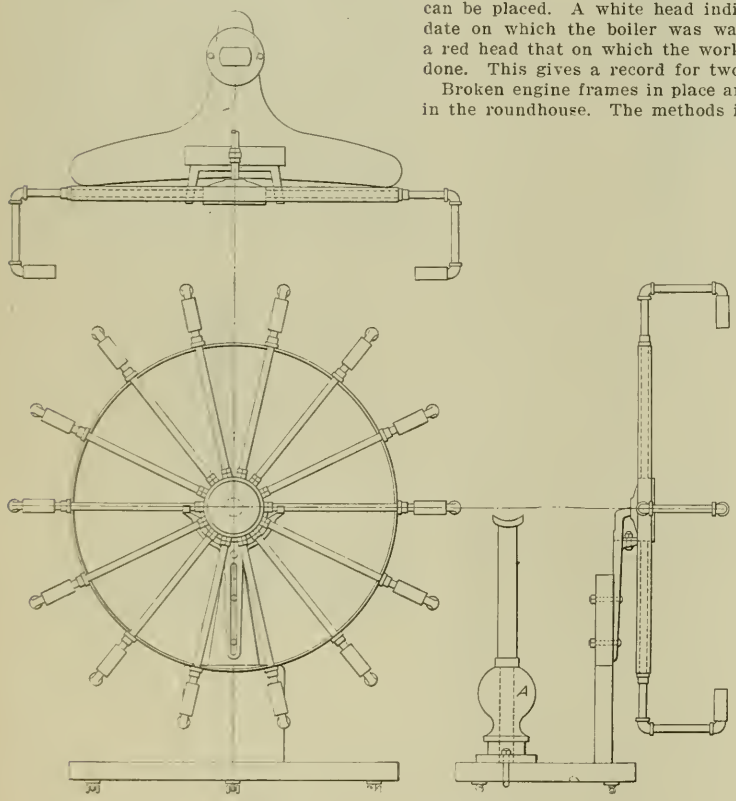



Fig. 7—Gasoline Tire-Heater.

entirely free from jumping or jerking is obtained.

Engines are fired with a Bristol fire kindler using crude oil. This consists of a crude-oil tank, a sprayer and a connection to the supply of compressed air which should be delivered under a pressure of about 90 lbs. per sq. in. It requires from 3½ to 4 cents worth of crude oil to light a fire, and it takes from 35 minutes to 1½ hours to start the fire.

Many of the engines are small for the work required and the exhaust nozzles are small. At the end of each trip the flues are blown out with an air blast. Boilers are washed out about once a week and a record kept in the roundhouse on a board shown in Fig. 5. At the left and permanently fixed is a column in which are the numbers of the engines running into the roundhouse. The remainder of the space is filled by two sliding boards with 31 columns, one for each day of the month. These columns are pro-

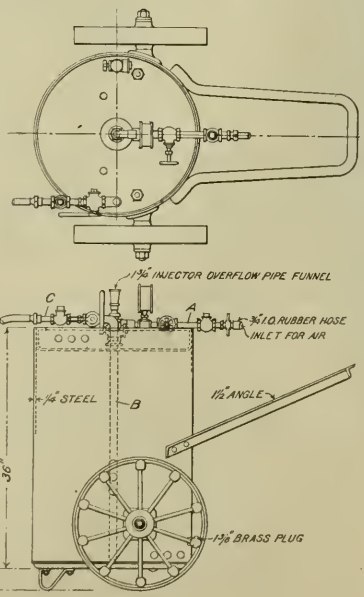



Fig. 8.—Gasoline Tank for Tire-Heater.

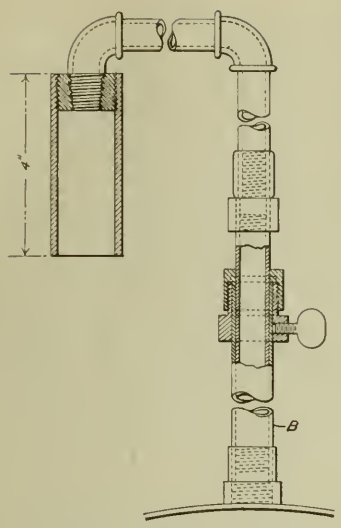



Fig. 9—Tire-Heater Burner.

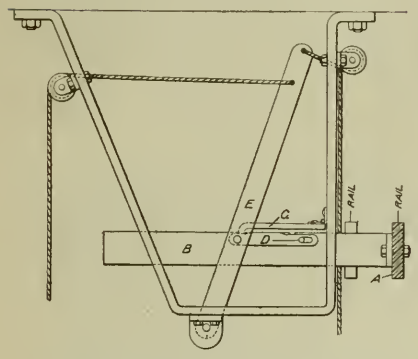



Fig. 11—Overhead Trolley Switch.

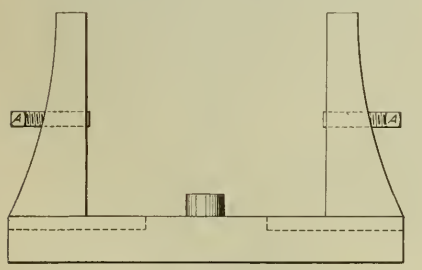



Fig. 14—Jig for Babbitting Crossheads.

in a pan beneath the part to be heated and is blown with a blast of compressed air. Before the heating is commenced all of the fastenings back of the fracture are cast loose, and when the proper temperature has been reached, the parts are driven together by blows with a ram on the back end of the frame. At the same time hammer blows are dealt at the point of the weld. An allowance of about $^{5}/_{16}$ in. more than the proper traming distance between points on either side of the weld is left for contraction or cooling. Broken upper rails are frequently repaired with a splice, as shown in Fig. 6. Two holes each 1⅜ in. diameter in the solid metal are drilled on each side of the crack. Two plates as heavy as can be placed alongside the frame are cut and drilled to fit, the distance between the holes being somewhat less than that between the holes in the frame. These plates are then heated and expanded until the holes come flush with those in the frame. The frames are then secured by bolts. The contraction of the splicing plates draws the frames together.

A tire heater recently made consists of a wheel of gasoline burners at the end of pipes, each of which is furnished with a slip joint. The tire is suspended from a crane and the burners adjusted so that they stand about an inch from it. A gasoline tank with a compressed air pipe leading thereto completes the equipment. The heater is shown in Fig. 7 and the tank in Fig. 8. The former is attached to a bracket supported on a small platform carried by three wheels. The weight at the back marked "A" is to counterbalance the overhang of the burner. The burner is shown in Fig. 9. A piece of brass pipe "B" is screwed into the center casting, shown in detail in Fig. 10, and this pipe is provided with a packing box and collar for a thumb screw to hold the telescope pipe, which is also brass. Beyond the telescope pipe the connection is ½ in. gas pipe ending in a gooseneck and a piece of 1¼ in. iron pipe, with six holes $^{3}/_{32}$ in. in diameter drilled in it to form a Bunsen burner. The gasoline tank is ¼ in. steel, 24 in. inside diameter and 36 in. long over all. It is filled through a funnel opening at the top. When in operation, compressed air is admitted through the pipe "A" and regulated by the pressure gage. The air passes down through the pipe "B" in the interior of the tank to a point near the bottom and then bubbles up. In doing so it becomes charged with gasoline and issues as an inflammable gas.

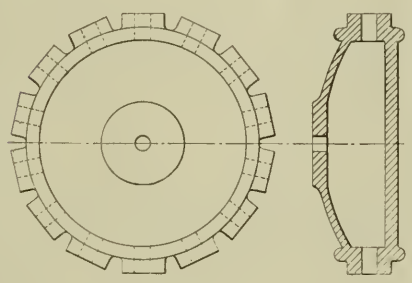


Fig. 10—Center Casting for Tire-Heater.

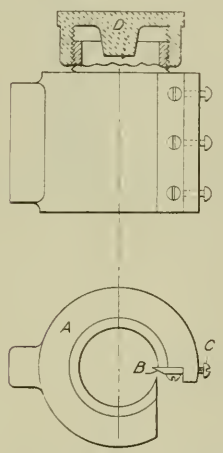



Fig. 13.—Angle-Cock Plug Reamer.

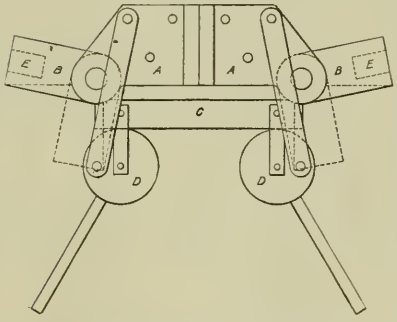



Fig. 15.—Machine for Turning Flat Bar Gibs.

In the car shops there is a traveling air hoist suspended from an overhead trolley. This trolley has a switch (Fig. 11) which locks in any position. The switch rail "A" is held by the bar "B," which has two notches cut in the upper edge to engage the latch "C," by which it is locked at either end. This latch "C" has a width double that of the bar "B" and is raised and lowered by the slide "D" attached to the operating lever "E." This slide has a slot working over a pin "D," so that it can move in either direction to lift the latch before engaging if any further movement carries the switch rail with it. At the end of the throw the latch drops into the other notch and the rail is locked.

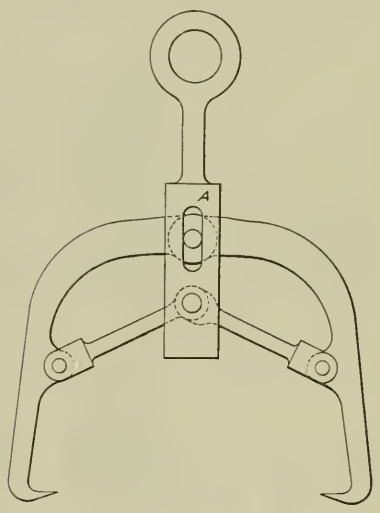



Fig. 12—Lumber Tongs.

Safe and strong lumber tongs is shown in Fig. 12. Instead of lifting direct from the pivotal point of the tongs and trusting to the weight of timber to tighten the jaws, the pivot pin slides in a slot in the lifting stand "A" and the upward pull is transmitted to the legs by connections which thus have a tendency to pinch the stick.

A tool used for reaming angle-cock plugs is shown in Fig. 13. It consists of a cast-iron shell "A," having a lug upon one side for holding in a vise. One-quarter of the case is cut away and to one of the faces thus formed the cutter "B" is fastened by machine screws so that it can be adjusted by the screws "C." The reamer is dropped down into the opening and the cutter "B" is adjusted. The angle cock plug is then dropped down into the opening and while it is turned from below it is forced down by the cap "D," which is screwed down over the upwardly projecting threaded portion of the casing.

A jig for babbitting cross-heads so that they will require no planing is shown in Fig. 14. The cross-head is set down with its piston-rod socket over a boss projecting up from the bottom of the jig. Adjusting screws "AA" are run in from the sides to steady the cross-head and the sides of the jaws are set to the exact distance between the guides. The metal is then poured in a

mould of the same size as the guides. The foundry turns out from 600,000 to 700,000 lbs. of castings monthly which are shipped to the other shops of the company at Alexandria, Columbia, Lawrenceville, Knoxville and Charleston. The cost of the castings is from 1.23 cents to 1.4 cents per pound. The moulders are paid by the piece and a good deal of the work is done on moulding machines. It has been found that a stronger shoe can be cast with less failures if inserts are put in lengthwise instead of across the casting. Burnt foundry sand is sold at 25 cents per ton to brickmakers who use it for facing molds. All brass castings are melted in a cupola having a capacity of about 12,000 lbs. The fuel consumption is 1:9 to 1:10, while that for ordinary crucible work is about 1:7. Coke is used and the cupola is charged the same as an iron cupola. The blast is from 8 oz. to 10 oz. As an example of the economy of the cupola, there was an accumulation of skimmings which were to be sold to a dealer. It occurred to the Master Mechanic to run them through the cupola with the result that 7,000 lbs. of brass was recovered.

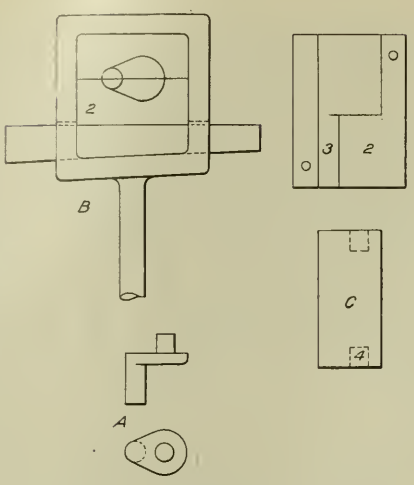



Fig. 16—Die for Forging Clips for Wagner Doors.

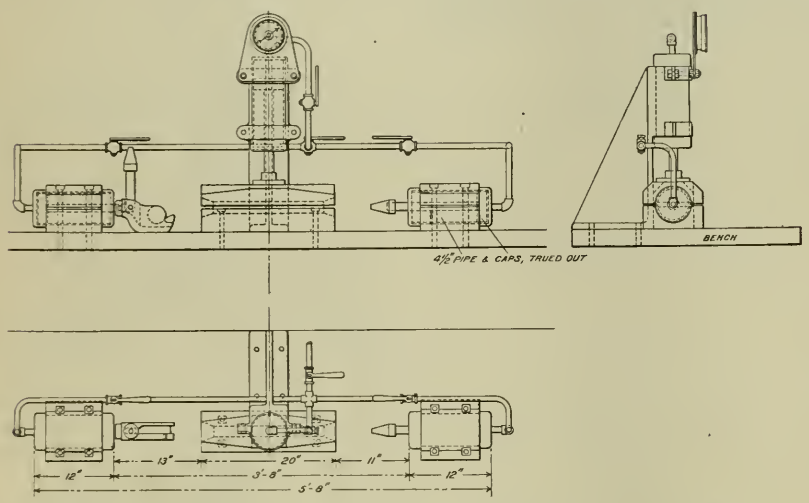



Fig. 17—Machine for Applying Couplings and Nipples to Air Brake Hose.

A blacksmith shop tool used to turn a gib on a bar of flat iron is shown in Fig. 15. It is attached to a heavy flattening table 3 in. thick, its base consisting of two castings "AA" to which the bending dies "BB" are pivoted. The bar to be bent is slipped in between the main casting "AA," and the movable jaw "C" which is brought down and clamps it in position by the eccentrics "DD." When this is done the dies "BB" are turned into the dotted position by the bars thrust into the pockets "EE."

A tool for forging the clips of the Wagner door is shown in Fig. 16. The device accomplishes the work of the drop or forging press with the aid of the ordinary steam or power hammer. The clip is shown at "A," and the die ready for work is shown at "B." It consists of two halves 1 and 2 held in a rectangular frame by an ordinary tapered key. A side elevation of the flat side of the die is shown at the right. A plunger "C" is made to fit in the opening of the dies and is itself fitted with an upward projecting hole, shown by dotted lines to form the small teat on the clip. A piece of round iron to make the clip is heated to a white heat and dropped into the opening in the dies. The plunger "C" is then set in on top of it and driven down by the hammer. In this way the metal is caused to flow down into the hole 3 of the die and up into 4 of the plunger, thus forming the clip, which is taken out by knocking out the key and removing the dies.

The machine used for applying couplings and nipples to hose is shown in Fig. 17. There are three air cylinders attached to the machine, each of which is operated separately. The vertical cylinder operates the upper jaw of the clamp to which its piston rod is directly attached. The right-hand horizontal cylinder is used to carry and push the nipple into place and the left-hand cylinder the coupling. The piston rod is fitted with a dummy for holding the coupling while the work is being done. Air is admitted to each cylinder by a separate plug cock with a leak hole so that when closed the air in the cylinder leaks off. The cylinders are made of 4½ in. gas pipe and are held in position by clamps tightened by bolts. These clamps are wood. The smooth interior surfaces of the air cylinders are obtained by tumbling nuts and scrap in the interior of the pipe.

The standard form of eccentric straps is shown in Fig. 18. The body is an I-section which gives strength, lightness and a surface for radiating heat. The wearing surface is lined with babbitt and the two parts are bolted together with 1¼ in. bolts. Oil cups are cast in the top. The strap is complete in itself and has been found satisfactory.

## Steel Car Design.

BY A. STUCKI.

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While the Master Car Builders' Association has done much towards standardizing certain details of car construction, little has been done along the line of adopting uniform requirements for the strength of the elementary parts, the sills, bolsters and body framing. Car builders differ widely in opinion as to whether in certain cases, concentrated, uniformly distributed or partial loads should be assumed in calculating the strength of members in the framing; whether or not the same percentage for impact should be allowed in all cases; what end shocks should be provided for; the safe working stresses for materials used in car

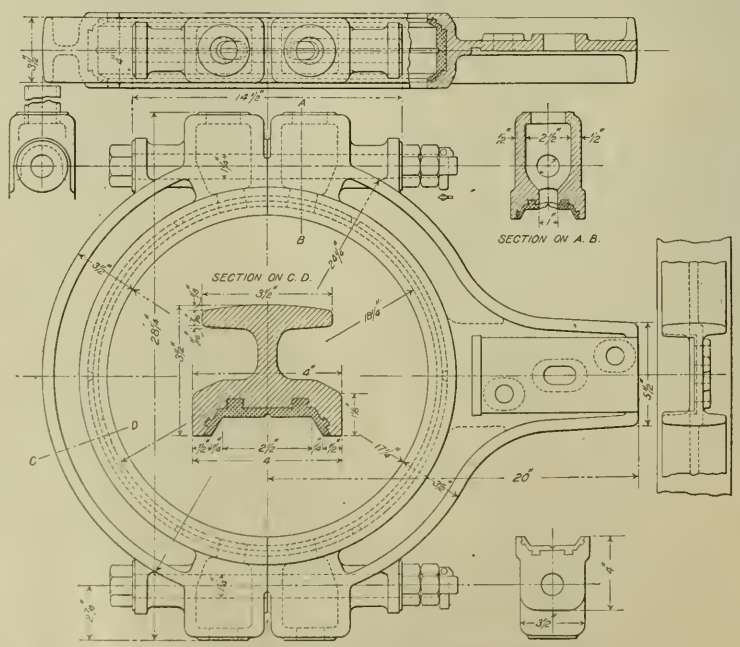



Fig. 18—Standard Eccentric Strap—Southern Railway.

building. The following extracts from the writer's notebook are not intended as a complete and absolutely accurate analysis of the stresses in steel cars. They are the result of several years' work in designing and building cars and are based largely on average conditions as found in service, supplemented with much valuable data from the testing room. Such assumptions as have been made have been verified in practice and are believed to be sufficiently accurate for the purpose of designing.

*The Arch-Bar Truck.*—The four-wheel, arch-bar truck is more generally used under freight equipment in the United States than any other type. A truck should be made strong enough to carry half the marked carrying capacity of the car with 10 per cent. allowed for over load, plus half the weight of the car body. Since the trucks may be interchanged and put under other cars of



Fig. 2.

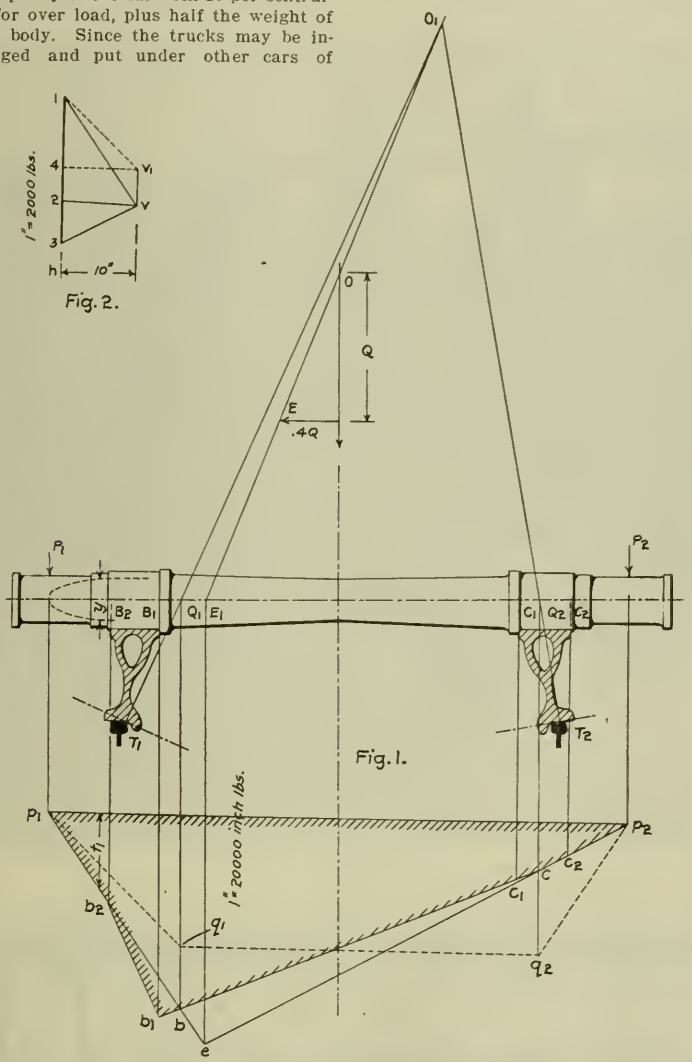


Fig. 1.

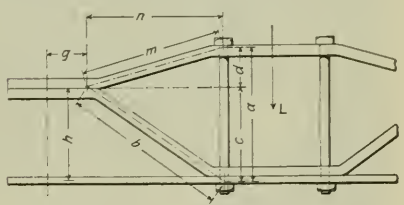
Graphical Analysis of Stresses in Axles.

equal capacity, the heaviest car bodies should always be considered. The weights of car bodies can be taken at 20,000 lbs. for 60,000-lb. cars, 23,000 lbs. for 80,000-lb. cars, 26,000 lbs. for 100,000-lb. cars. The allowable loadings on track, bridges and other structures vary greatly on different railroads, but ordinarily it is safe to assume for the purpose of designing that the weight per running foot of track should not exceed 5,000 lbs. The maximum allowable limit of 45,000 lbs. per pair of wheels is never reached in car construction.

*The Axle.*—The axle may be designed graphically by the following method: (Figs. 1 and 2.) Q being the load coming on one axle, the horizontal force due to centrifugal forces and the swaying of cars on curves can be assumed as .4Q. This includes the benefit derived by elevating the outer rail and is the result of experiments made under ordinary conditions of track at the highest safe speeds. The point O is the center of gravity of the car and load. Draw the resultant OE of the horizontal force .4Q and the vertical force Q and extend it beyond $O_1$. From the rail-head $T_2$, draw $T_2O_1$ at right angles to the coning on the wheel tread and connect $O_1$ with $T_1$, the other rail-head. Drop perpendiculars from $E_1$, $Q_1$ and $Q_2$, the intersections between the center line of the axle and the lines $O_1E$, $O_1T_1$ and $O_1T_2$. Lay off on Fig. 2 the vertical line 1-3 on any convenient scale, preferably 1 in. = 2,000 lbs., of such length that it represents to scale, the vertical load Q. Locate the point v horizontally, 10 in. to the right of the line 1-3 and vertically about ⅓ or ¼ of its height from the bottom. Connect 1 with v. On Fig. 1 drop perpendiculars from $P_1$ and $P_2$, the centers of the journals to $p_1$ and $p_2$. Draw a line from $p_1$, parallel to 1-v (Fig. 2) until it intersects at $e_1$ a perpendicular dropped from $E_1$. Connect 3 with v (Fig. 2) and draw $e_1$-$p_2$ parallel to 3-v. Connect $p_1$ and $p_2$ and draw v-2 (Fig. 2) parallel to it. Line 1-2 now represents to scale the load at $P_1$ and 2-3 represents the load at $P_2$. Drop perpendiculars from the hub faces of the wheels until they intersect the lines $p_1e_1$ and $p_2e_2$ (Fig. 1). Draw cb and extend it to $b_1$. Connect $b_1$ with $b_2$ and connect $c_1$ with $c_2$. The link polygon $p_1b_2b_1c_1c_2p_2$ gives the moment diagram for the assumed loading and the length of any perpendicular included in the shaded portion of the figure corresponds to the moment in inch-pounds of the corresponding section of the axle. The moment diagram is on a scale of 20,000 in.-lbs. = 1 in., since the scale of pounds was assumed at 2,000 lbs. = 1 in. and the point v was taken 10 in. to the right of the line 1-3 (Fig. 2). For example, the line $t_1$ measures 7.75 in. which, multiplied by 20,000 gives 155,000 in.-lbs. as the moment of the section at y.

In order to find the bending moments in the axle if the centrifugal forces are disregarded, move v (Fig. 2) vertically upward to $v_1$, so that a line drawn from 4, half-way between 1 and 3, and parallel to 2-v, will pass through it. Connect 1 with $v_1$ and draw a line parallel to it from $p_1$ (Fig. 1) until it intersects the perpendicular dropped from $Q_1$ at $q_1$. From $q_1$ draw a line parallel to 4-$v_1$ or 2-v until it intersects the perpendicular dropped from $Q_2$ at $q_2$. The vertical distance between the lines $p_1$-$p_2$ and $q_1$-$q_2$ represent the moments for the shank of the axle.

Having determined the bending moments graphically throughout the length of the



Stresses in Arch-Bars.

axle it is not difficult to obtain the diameter at any point.

Let M = bending moment;
S = safe fiber stress, 18,000 lbs. per sq. in. for carbon steel;
Z = section modulus which for a circle is $\frac{\pi d^3}{32}$
d = diameter of the axle.

Then $M = S \times Z$ or $Z = \frac{M}{S}$ from which the section modulus necessary for any bending moment can be obtained. To find the diameter, since $Z = \frac{\pi d^3}{32}$, then $d = \sqrt[3]{\frac{32 Z}{\pi}}$

After a sufficient number of diameters have been obtained at different points, the theoretical shape of the axle can be dotted in. To allow for wear and for imperfections in the material, the diameter of the journals on heavy freight axles is usually made ½ in. larger than the theoretical diameter; the dust-guard seat is made ¼ in. larger; the wheel seat is made ¼ in. larger and the center of the axle ¼ in. larger. Axles should never be allowed to wear below the theoretical sizes determined above. To compensate for lateral wear on the axles and brasses it is well to assume the loads $P_1$ and $P_2$ as being applied ½ in. outside the center of the journal. The center of gravity of the car and load combined should always be kept below 6 ft. from the top of the rail, but at whatever distance it may be below that point, the axle should be designed for the worst case, *i. e.*, 6 ft.

*The Journals.*—To avoid heating, the load per square inch of projected area on the journal should not exceed 350 lbs., cars being on a straight track. The proportions be-

tween the diameter D and the length L should be $\frac{L}{D} = 1.8$.

*Truck Arch-Bars.*—If the bottom tie-bars are reasonably well fitted, the bending strains may be disregarded and the tensile and compressive stresses due to the load can be determined as follows:

Compressive force in top arch-bar $= \frac{Lm}{2a}$;

Tensile force in bottom arch-bar $= \frac{Lb}{2a}$;

Tensile force in column bolt $= \frac{Ld}{2a}$;

Tensile force in tie-bar $= \frac{Lg}{2h}$;

Shear in journal box bolt $= \frac{Ln}{2a}$.

L is the maximum load coming on a set of arch-bars and the other symbols (Fig. 3) indicate the actual dimensions of the truck. The fiber stresses in the respective members of the side frame can be obtained by dividing the forces obtained as above by the effective cross-sectional area of the member. In the tension members the effective cross-sectional area is obtained by subtracting the area of the largest existing bolt or rivet hole from the total cross-sectional area. In the compression members only the maximum bolt hole area is subtracted since the rivets fill up the holes closely enough to be disregarded in compression.

The stresses in the arch-bars as found above should not exceed 6,500 lbs. compression, or 8,000 lbs. of tension per sq. in. for wrought iron or soft open-hearth steel so as to make the parts amply strong to resist other strains coming at times upon them. End shocks cause transverse strains, lateral swaying causes bending strains, uneven track causes torsional strains and unequal length of inner and outer rails on curves causes large bending strains. None of these can be accurately determined, so a large factor of safety is therefore used.

The maximum load L, coming on each set of arch-bars is derived from the load $Q^1$, which is half the load, half the weight of the car body and the weight of one truck bolster. For 60,000-lb. cars this new value of Q or $Q^1$ is 44,000 lbs. per truck; for 80,000-lb. cars is 56,500 lbs. per truck, and for 100,000-lb. cars is 69,000 lbs. per truck. Since the maximum horizontal force is $.4Q^1$ with the center of gravity 6 ft. above the rails, the maximum values of L are: 29,300 lbs. per set of arch-bars for 60,000-lb. cars; 37,000 lbs. per set of arch-bars for 80,000-lb. cars; 45,700 lbs. per set of arch-bars for 100,000-lb. cars.

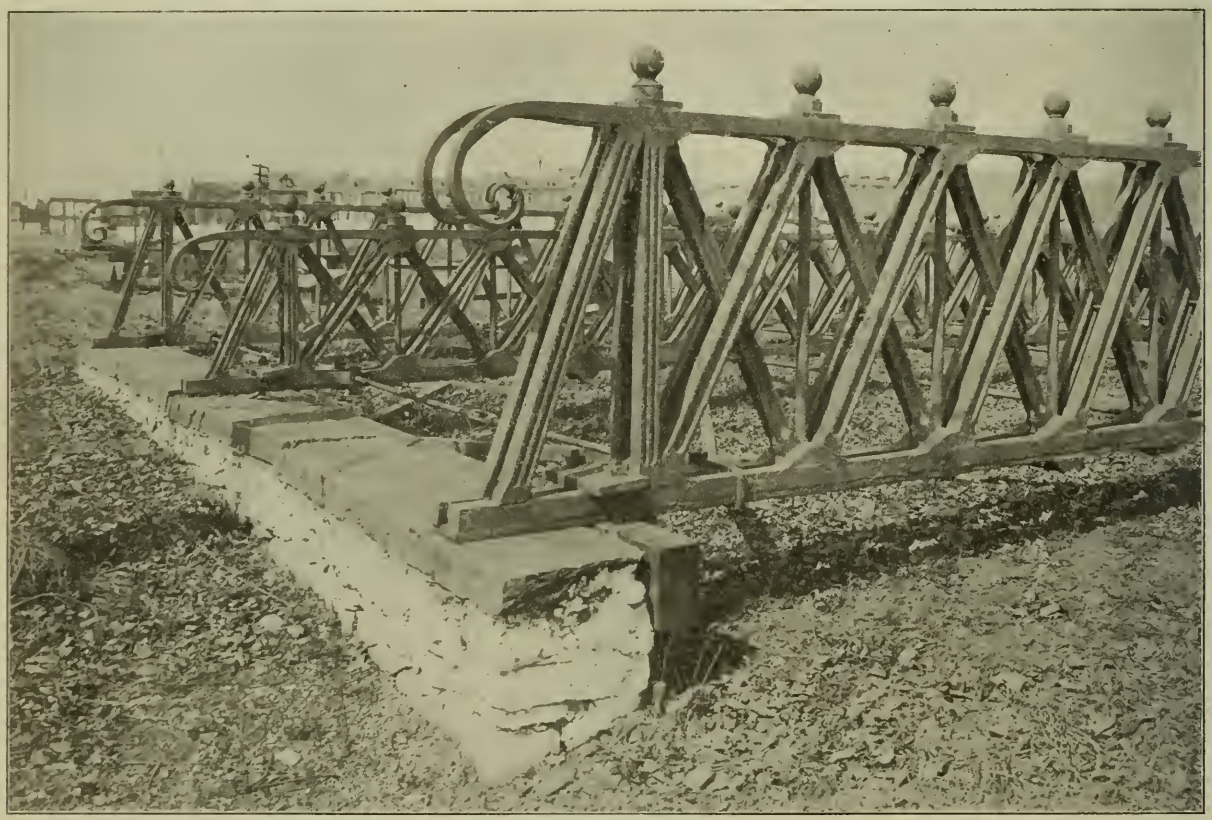
*(To be continued.)*

## The First Iron Railroad Bridge in the United States.*

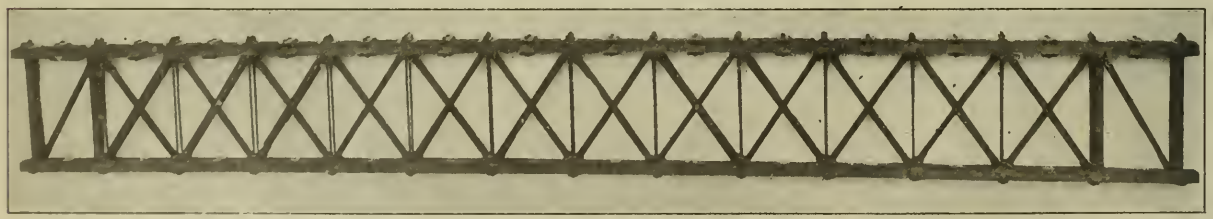
BY EDWIN F. SMITH.

Nothing more clearly illustrates the need of technical education in early engineering than the comments which are found in a report, dated 1838, of the Little Schuylkill & Susquehanna Railroad, a line which had been admirably located by Edward Miller, an accomplished civil engineer and a citizen of Philadelphia.

The high bridges upon this line were a source of anxiety to the builders, there being no precedents for such structures for railroad traffic. They were, therefore, purely experimental, and in commenting upon the first one, 579 ft. long, the chief engineer,



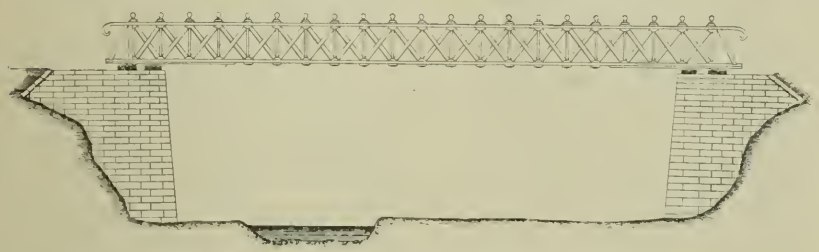
The Manayunk Bridge in Its Present Location.



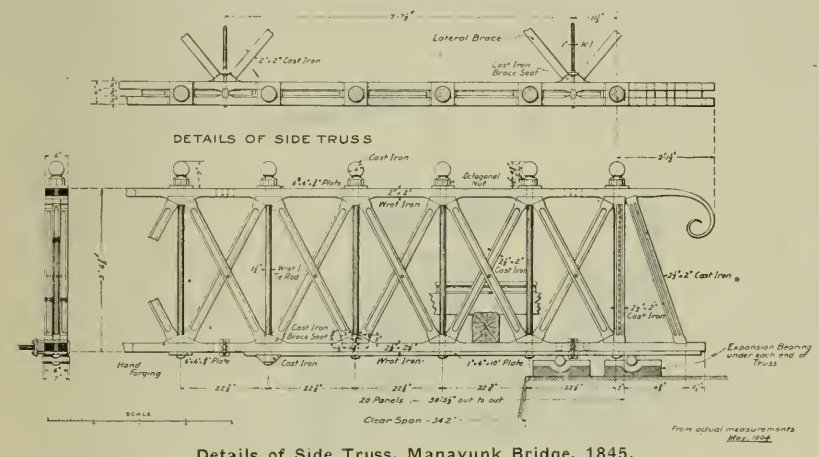
Second Type of Iron Howe Truss Bridge, Philadelphia, Reading & Pottsville R. R., 1845.

*Supplemented with an extract from an address read by the author before the Engineers' Club of Philadelphia, and printed in the Proceedings of the club.

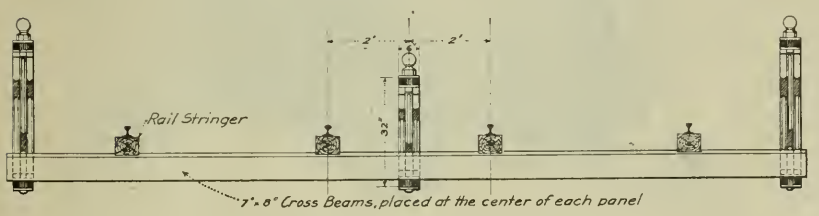
Solomon W. Roberts, says in his report: "The superstructure is of very strong lattice work, having three sets of lattice spans, well braced together. The length of the single span is 200 ft., which is that of the longest span upon the line." Then follows this remark: "This bridge was completed before the others in order to judge whether additional strength would be needed, and, if so, to learn the best mode of applying it." Also: "The lattice bridges are free from lateral thrust, and being continuous throughout, may be supported at any point indiscriminately. Such being the case, and the rivulets offering no obstruction, I propose that when the superstructure of each bridge is completed, the keys of the falseworks shall be loosened, and the falseworks allowed to remain standing within a few inches of the lower chords of the bridge, so as to obviate the possibility of accident, and, if found necessary, timber framed piers may be built half-way between the stone ones, so as to shorten the spans one-half, and to render the bridge more than strong enough to sustain any possible load. This will not be a very expensive expedient, and must be conclusive."



Elevation of Manayunk Bridge.




Details of Side Truss, Manayunk Bridge, 1845.




Cross Section of Bridge.

It was on this line of railroad, now the Catawissa Branch of the Philadelphia & Reading, and for the support of these same lattice truss bridges, that the first high trestles or timber framed piers in the country were built in the year 1840, work having commenced on the Long Hollow Trestle in June of that year. They varied in height from 53 to 129 ft., and in length of superstructure supported, from 600 to 1,000 ft. They marked the beginning of high structural works in timber, and were essentially the same in principle as the constructions in steel now employed for the same purpose on railroads, as well as for the skeletons of the high buildings of the present day. They were designed by James F. Smith, Principal Assistant Engineer, who had obtained his early training on the Allegheny Portage Railroad, the woodwork of the working model being made by him, and the bolt-work by the late Ellerslie Wallace, M.D., Dean of Jefferson Medical College in this city, then an assistant engineer on the Catawissa Railroad. This model, which is now deposited with the Franklin Institute in this city, was placed upon a solid foundation and subjected to a weight of 6,460 lbs., without causing the least deflection in the posts, when the test was discontinued. In this practical way, without any calculations whatever, the sufficiency of the trestle piers for sustaining a railroad bridge was demonstrated. The same plan of trestle work shortly after adopted for the Portage Viaduct over the Genesee River, on the New York & Erie Railroad, by Silas Seymour, Civil Engineer. Thus, from what was designed to fulfil merely a temporary purpose, there was derived the principle embodied in the structural works of the present day.

Only five years after, there was built what we have reason to believe was the first iron railroad bridge in the United States. It was designed by Richard B. Osborne, Civil Engineer, then Chief Engineer of the Philadelphia & Reading, and erected in May, 1845, for a double-track crossing over a small stream south of Flat Rock Tunnel, near Manayunk. It was in service until the year 1901, but for many years had been carried on timber trestles, on account of the heavy traffic passing over it, for which it had not been designed.

The following description is from Mr. Osborne's Journal: "During the winter of 1844, as a guide to us in arranging plans for the superstructure in iron to replace several old timber bridges, we got up plans for an iron Howe, which was the first ever constructed of that material, all others being of timber. The site we chose for this experiment was about half a mile east of the Flat Rock Tunnel—a small bridge of 34 2/10 ft. span. This was thought to afford a fair test, as the tracks were only 4 ft. apart and the ties were on the bottom chord. The center truss of this bridge would only be high enough to let the girders pass through the panels and rest on the bottom chord. This center truss was only 31½ in. high, so as to be below the platform steps of the passenger cars, while the outer trusses were 41¾ in. high. We made the bottom chords of 2¼ in. square rolled iron, which we afterward changed for other bridges into plates of 1 to 1¼ in. of greater depth, according to required area. The top chords were 2 in. square. Bottom chords were 2¼ in. square. The braces, of cast iron, 3¼ x 2½ in. hollowed and 3 ft. 4 in. long. Height of main truss, 41¾ in. Projections were welded on the chords, between which the skew back blocks rested on the chords. Height of center truss, 31½ in. It was erected in February, 1845, and cost $1.571.95 = 40.83 ft. length at $38.50. President Tucker came up to see the first trains cross it, and was pleased with it, but said it looked very light in comparison with the timber structures, and suggested that we leave the falseworks up within half an inch of the bottom chords to give it a longer test. This we did, and they remained until they fell down. This iron bridge carried many millions of tons before alterations became necessary for widening the space between the tracks from 4 to 6 ft."

There is a slight, though unimportant, discrepancy as to the date of erection. Mr. Osborne's Journal gives it as February, 1845. Later investigation has developed the fact that the work of building the trusses was begun in the shops of the company at Pottstown under Mr. Osborne's supervision in January, 1845, and finished in March. The work of erecting was commenced on Saturday night, May 3d, and the bridge was finished ready for the passage of trains on Sunday, May 4th, 1845. It was, as shown by the accompanying drawings, an iron Howe truss, with chords of solid bars of rolled iron, the upper being 2 in. x 2 in. and the lower 2¼ in. x 2¼ in. On these were hand forged lugs, for holding in place the cast iron angle blocks, on which rested the solid cast iron braces, which were fluted on the four sides and not hollow, as noted in the description. A noticeable peculiarity of the construction was the use of extra heavy canvas washers, of which a single thickness soaked in white lead was placed between the end of each brace and the lug as an abutting surface. A small portion of this, removed only lately, after having been in use for 59 years, was found to be as sound and apparently as good as when put in place.

When we consider that all of the work on this bridge was done by hand, with only such meagre facilities as were afforded by a blacksmith forge and hand tools, we can

but admire the thoroughness and attention to detail of this early bridge work. It remained in place until the year 1901, although for many years before its removal it had been supported by heavy timber trestles. In its period of usefulness—56 years—it carried, without doubt, in the minds of those knowing the enormous tonnage of the Reading Railway, the greatest aggregation of tonnage that ever passed over any railroad bridge.

This first iron Howe truss, *with solid chords*, and the only one built of that pattern, was followed in the summer of 1845 by another, all the members of the trusses of which were the same, except the top and bottom chords, which were built up of flat iron, 5 in. wide x ¾ in. to 1¼ in. thickness. Three of these bridges were erected in the year 1845, the first over Stony Creek, near Port Clinton; the second over Irish Creek, near Leesport, and the third over Bingaman street, in the city of Reading. The model of this bridge was taken to England for exhibition by the late Richard Osborne, Chief Engineer, shortly after the erection of the bridges.

## Testing Plant of the Great Western, England.*

The Great Western has recently put in the erecting shop at Swindon a plant for testing locomotives. This machine consists of a bed made of cast-iron, bolted on a concrete foundation, with timber balks interposed to lessen vibration. On this bed five pairs of bearings are arranged to slide longitudinally so that they may be adjusted for any wheel arrangement. In these bearings, axles are carried having wheels fitted with steel tires, on which the locomotive runs. These axles are also fitted with drums on which band-brakes act for absorbing the power developed by the engine. Outside these band-brakes, pulleys having an 18-in. face are provided at each end of the axle for driving link-belts, so that most of the power developed by the engine drives air-compressors, so that it may not be wasted. The hydraulic brakes absorb just enough power to enable them to govern the speed of the engine. These brakes are actuated by a water-supply from an independent pump, the outlet of this water-supply being throttled either by a stop-valve or by a throttle actuated by a centrifugal governor.

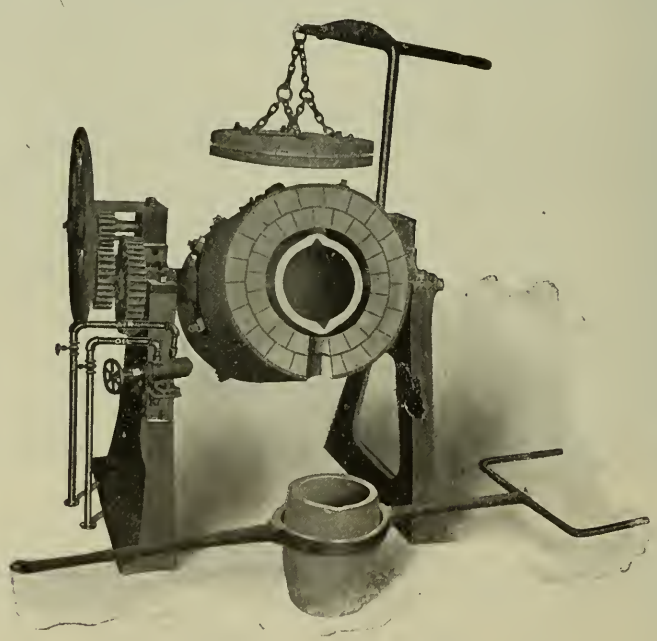
The carrying wheels are 4 ft. 1½ ins. in diameter. The main bearings are 9 in. x 14 in. This plant is intended not only for the purpose of scientific experiment, but also to do away with the trial trips of new and repaired engines on the main line. It has, therefore, been necessary to make it rapidly adjustable to take engines having wheels of different centers. The main bed is provided with a rack, and each pair of bearings is provided with a cross shaft having a pinion at each end. These cross shafts are driven from a longitudinal shaft through clutches. This longitudinal shaft is operated by an electric motor and is reversible. When running engines on trial trips it is essential that the truck and trailing wheels should be run in order that the axle-boxes take a good bearing. To accomplish this the carrying wheels are all coupled together by belts and jockey pulleys. It, therefore, follows that even when a locomotive having a single pair of driving wheels is run on the plant, all the carrying wheels are rotating and in turn run the bogie and trailing wheels of the locomotive. The jockey pulleys are necessary to retain the proper tension on the belts when the bearings are moved longitudinally.

Owing to the varying height of the footplates of different classes of engine, it has been found necessary to provide a firing stage which can be rapidly adjusted vertically. A large coal bunk is provided in connection with this stage and also weighing machines. Two water tanks are mounted on the same platform, for measuring the water used when running. These tanks are emptied alternately when a test is being made. Under the platform a dynamometer gives the drawbar pull of the engine, and this, together with counters on the wheels, enables the actual drawbar horse-power to be measured, and so compared with coal and water consumption for different classes of engines. As engines of different lengths are to be tested, and of necessity have to be fixed at the trailing end to the dynamometer, it is necessary to have a sliding chimney for carrying off the steam and smoke. This consists of a long box, having a steel plate running on rollers forming its lower surface, which plate carries a large bell-mouthed chimney. This box not only enables the chimney to slide longitudinally, but will also form a receptacle for ashes and any other matter ejected by the engine.

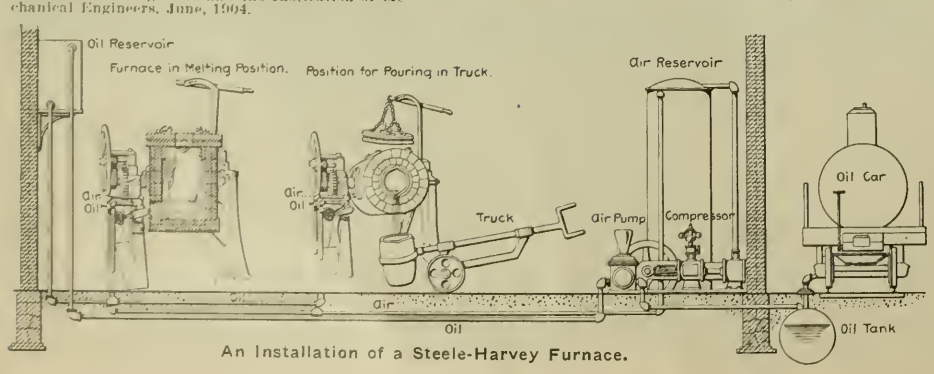
*Abstract of a paper by Mr. G. J. Churchward, read at the joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, June, 1904.

## The Steele-Harvey Metal Melting Furnace.

The accompanying illustrations show a self-contained crucible oil furnace for melting copper, brass, tin, or steel. It consists of a shell lined with a double row of fire brick, and a crucible resting on a graphite block. The crucible is held in the center of the shell by means of fire brick wedges. A flame from a vaporizing oil burner is directed against the graphite block and in turn circulates entirely around the outside of the crucible. The flame not coming in direct contact with the crucible prolongs the life of the crucible from 20 to 50 heats. A lid placed over the crucible prevents the escape of gases and also prevents the mixture in the crucible from oxidizing. It is not necessary to remove the crucible from within the furnace when pouring, and thus cool it off, as the furnace is swung on trunnions and is easily tilted to any angle by means of the gear wheels and worm connections. This furnace is especially adapted for melting brass borings and turnings. It is claimed that 100 lbs. of metal can be melted with 1½ gal. of crude oil. The Monarch Engineering & Manufacturing Company, Baltimore, Md., make these furnaces in four different sizes with capacities of 2,400 to 4,000 lbs. of metal per day.

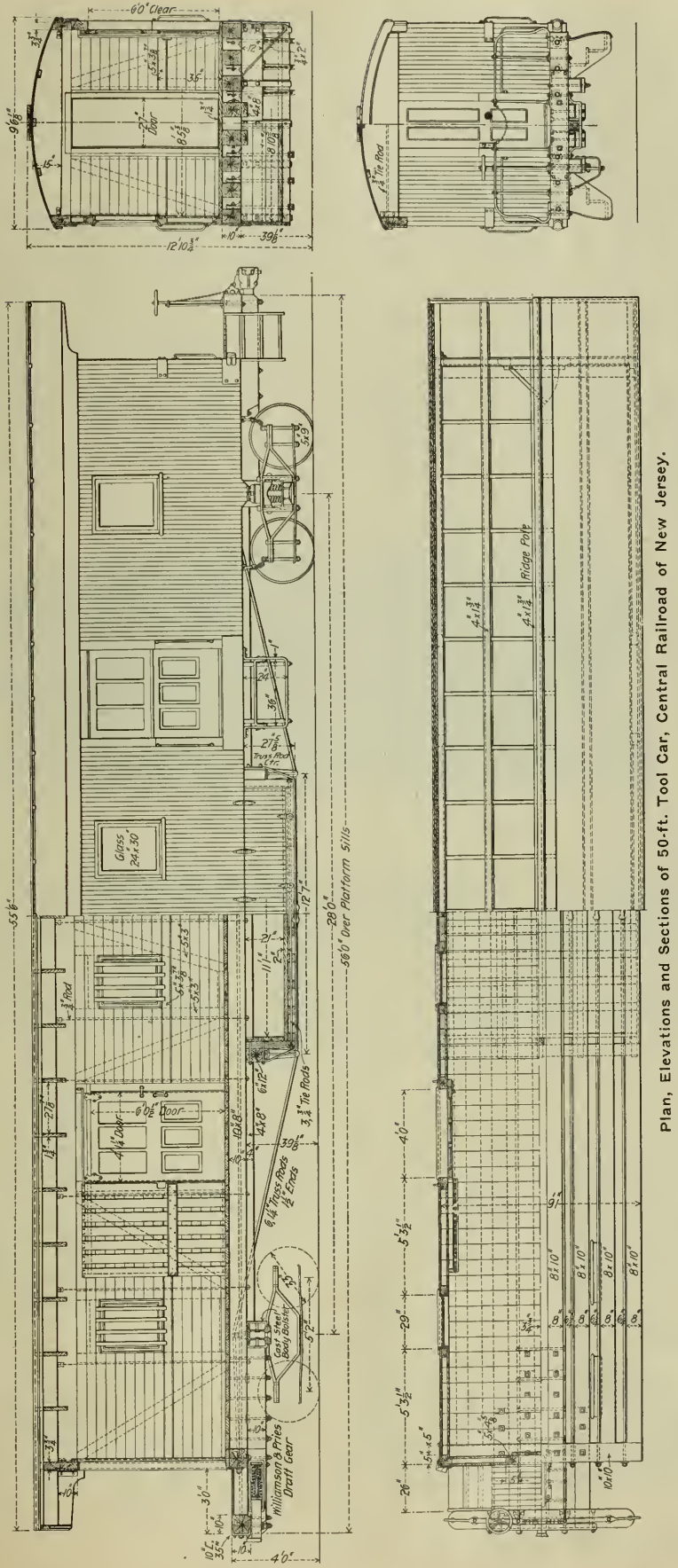


The Steele-Harvey Metal Melting Furnace.




An Installation of a Steele-Harvey Furnace.

Certain Russian cities are allowed a tax of about 5½ cents per ton on all freight shipped or received at railroad stations.




Plan, Elevations and Sections of 50-ft. Tool Car, Central Railroad of New Jersey.

## Jersey Central Tool Car.

The Central Railroad of New Jersey has built an exceptionally long and heavy tool car for the wreck train, which is shown in the accompanying drawings. It is 50 ft. long over end sills, 8 ft. 5⅜ in. wide inside and 7 ft. 2 in. high from floor to carlines. A tool car must carry a heavy load in the aggregate and for this reason and because of its extreme length the underframe for this car has been made very strong. It consists of eight sills, 8 in. x 10 in., with two 4-in. x 8-in. sub-sills under the center sills. Six 1¼-in. truss rods are hung underneath and carried over the bolster through the end sills which are 10-in. x 10-in. timbers. The body framing of the car is similar to freight car construction, except that suitable openings have been provided for the 4-ft. door openings on each side. The roof is curved on an 11 ft. 9-in. radius and all of the carlines are cut to that shape on the top edge. The outside covering is tin laid on 13/16-in. boards; no sheathing is put on under the carlines. The sides of the car are sheathed on the inside all the way up and the window openings are protected with slats.

At each end of the car is an open platform, 26 in. wide, which is carried on 8-in. x 10-in. platform sills bolted under the four middle sills of the body framing. The platform end sill is a straight timber, 10 in. x 10 in., sheathed on the outside face with a 10-in. channel. Williamson and Pries tandem spring draft gear and freight couplers are applied in the usual manner between the two middle platform sills, which are carried back to the body bolster.

Under the middle of the car, in the rectangular space formed by the truss rods and the king posts, is built a tool box 11 ft. 1 in. long, 21 in. high, and the full width of the car with hinged doors on each side. It is carried in a cradle formed of five pieces of ¾-in. x 3-in. bar iron bolted to the needle-beams. The car is mounted on arch-bar trucks with 5-in. x 9-in. journals.

We are indebted to Mr. William McIntosh, Superintendent of Motive Power, for the drawings.

## The American Railway Association.

This organization has voted to admit as associate, roads less than 50 miles long, the qualifications for admission to be passed upon, as in the case of full membership, by the executive committee. Associates may not vote. They will be assessed $20 yearly, but will not be subject to mileage assessment. The association has also formally indorsed the Master Car Builders' Association report on tank cars, which was published a year ago, and recommends that the requirements of the report be made effective, so far as new construction is concerned, from May 1 of this year. The requirement as regards safety valves in tanks is recommended to be put in force September 1 next, and that concerning the strengthening of underframes on January 1, 1905. The foregoing are the principal items of news to be found in the *Proceedings* of the April meeting, just issued, which were not given in our report of the meeting, published May 6. The report on tank cars, with the drawings, is reprinted in full in the present number of the *Proceedings*. This number also contains the report of the committee on car service, accompanied by samples of the blanks to be used in reporting the per diem earnings on interchanged cars, as approved by the association. The principal change in the rules (3 and 10) in regard to penalty

per diem notices is one making it compulsory to send the notice on the prescribed form.

The cipher code which the committee on that subject proposes to issue is to be a very complete work. The committee has considered 95,000 phrases and has conditionally approved 53,000. The book will be one of 600 pages, and the committee expects to have an edition of 1,000 copies made, so as to furnish a sample to each road. For this purpose an expenditure of $6,500 was authorized—half for editorial work and half for making the plates and books.

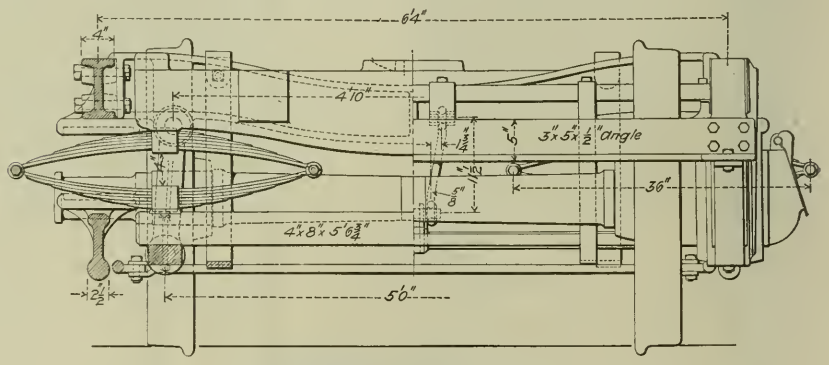
The discussion on the report of the car service committee brought out from Mr. Kouns, of the Atchison, a demand for the increase of the regular per diem rate to 30 cents a day and the repeal of the penalty rate. Mr. Kouns voiced the views of many roads working long lines, but the majority agreed with the committee that no change had better be made at present. Mr. Hale, Chairman of the committee, made a forcible argument. The statistics which he presented showed that on 42 roads, owning 1,236,000 cars, the average amount paid for borrowed freight cars, including penalty, was, for the first year, 21 cents 9 mills a day, from which he argued that the penalty had not yet imposed a severe burden on any one. One road reported its average payments at 27.3 cents, but the great majority were around 22 cents, and two reported 20 cents, showing no penalty payments whatever. Although 22 cents is an inadequate sum, still, said Mr. Hale, it is 10 cents better than owners were getting two years ago. It is only the long roads that want a higher rate. While it is true that they ought to have more, it is not fair just yet to raise the price on the little fellows; that is, the shorter terminal lines. With all the criticisms concerning the working of the penalty rule, it remains true that the penalty does move the cars quicker than the 20-cent rate. A penalty for diversion is desirable, as it always has been, and the committee has considered the question long and earnestly, but no one has yet found any acceptable way of enforcing such a rule.

In the per diem statistics reported by the committee the average value of all freight cars owned by each company reporting is given. This average fluctuates from $250 to $692. The average value of box cars carrying 30 tons or over fluctuates from $345 to $957. The names of the roads reporting are not given.

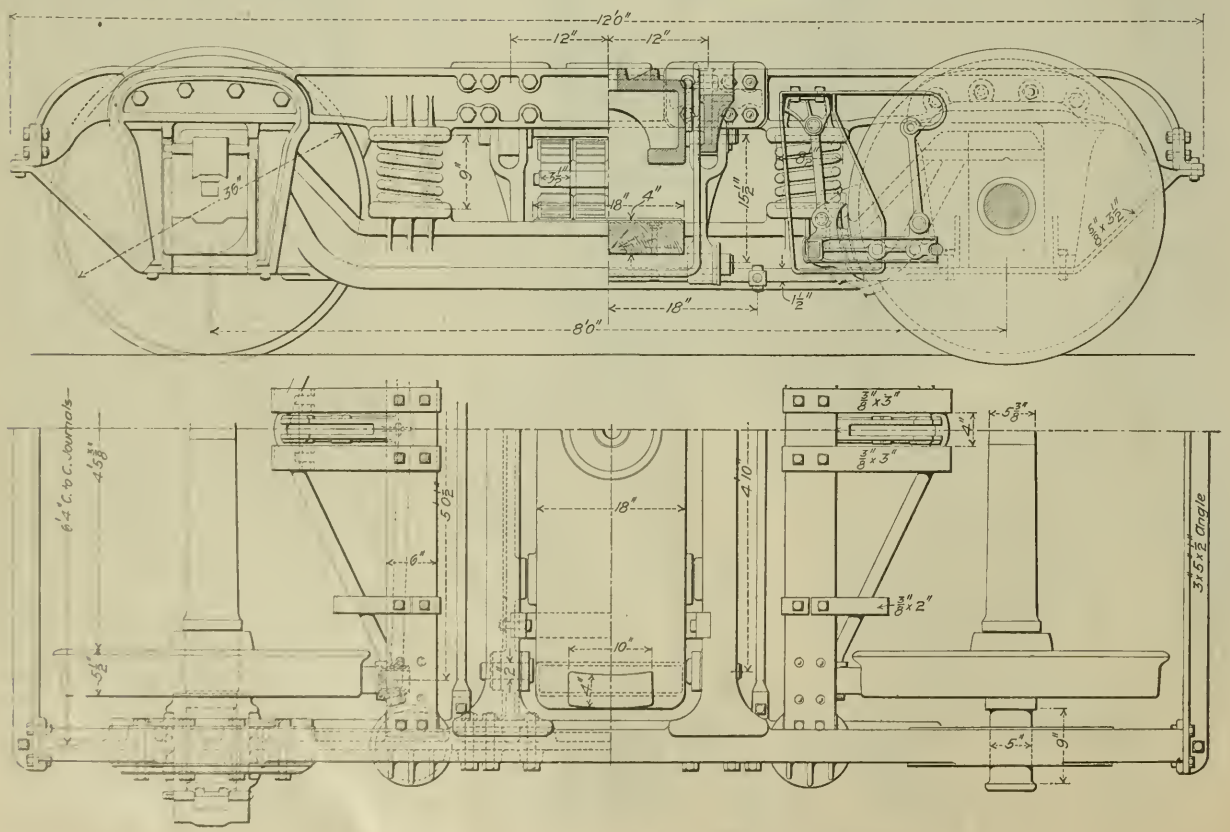
## Cast-Steel Passenger Truck for the Big Four.

The accompanying illustrations show an interesting design of cast-steel four-wheel passenger truck, a number of which have recently been built by the Big Four to be placed under some new baggage cars building at its Brightwood shops. The all metal passenger truck is not altogether a new idea for steam roads as the Lake Shore has a large number in service but the use of cast-steel is a decided innovation. The Lake Shore truck has I-beam side and end frames and transoms with a double I-beam bolster and wooden spring plank. All of the other details are similar to those used on wooden frame trucks.

The Big Four truck is all-metal with the exception of the spring plank, and all of the important members are cast-steel. It differs but little in its general appearance from a wood frame truck. It is rated at 80,000 lbs. capacity and weighs 13,000 lbs. complete. The bolster is cast in one piece with the side bearings and center plate formed on the top surface. It is a channel trough section open at the bottom and is 18 in. wide. At the ends it is 7 in. deep and at the center is 10 in. deep. The rib along the bottom of the sides is increased in thickness from ¾ in. at the ends to 1½ in. at the center to add to the vertical stiffness. The wheel piece is




End Elevation of Big Four Truck.




Plan and Side Elevation of Big Four Cast Steel Passenger Truck.

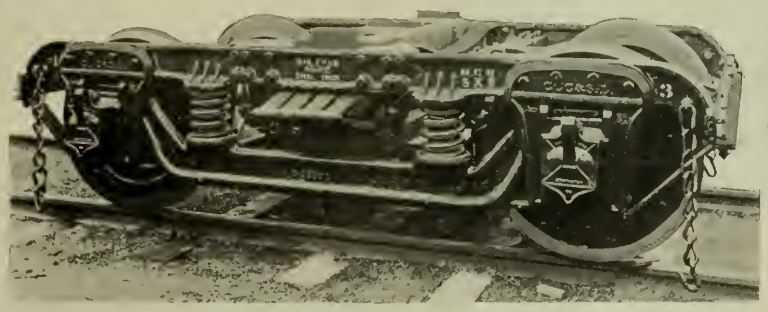
made in one casting 11 ft. 6 in. long. It has an I-section of uniform dimensions between the pedestals. The depth is 7 in. and the web is 1 in. thick. The equalizer spring caps are cast on the under side and are ribbed with three ½-in. ribs on the outside and two on the inside. Where the other parts of the truck frame are fastened on, the bearing faces are all machined and all of the bolt holes are drilled.

The transoms which are an inverted L-shape are 7 in. deep and are bent down 3¾ in. in the center to clear the body of the car. A boss, 5 in. x 6 in., cast on the inside face, acts as a bolster chafing plate, and on the ends a flange is formed 7 in. deep and 12 in. wide with a projecting lip along its top edge. This gives an ample bearing for the joint between the transom and the wheel piece and the lip which fits over the top of the wheel pieces relieves the bolts of the downward shear. The equalizer bars are an approximate I-section and have the equalizer spring seats cast on them in the same way that the spring caps are cast on the wheel pieces. They are 8 in. deep with a drop of 7½ in.

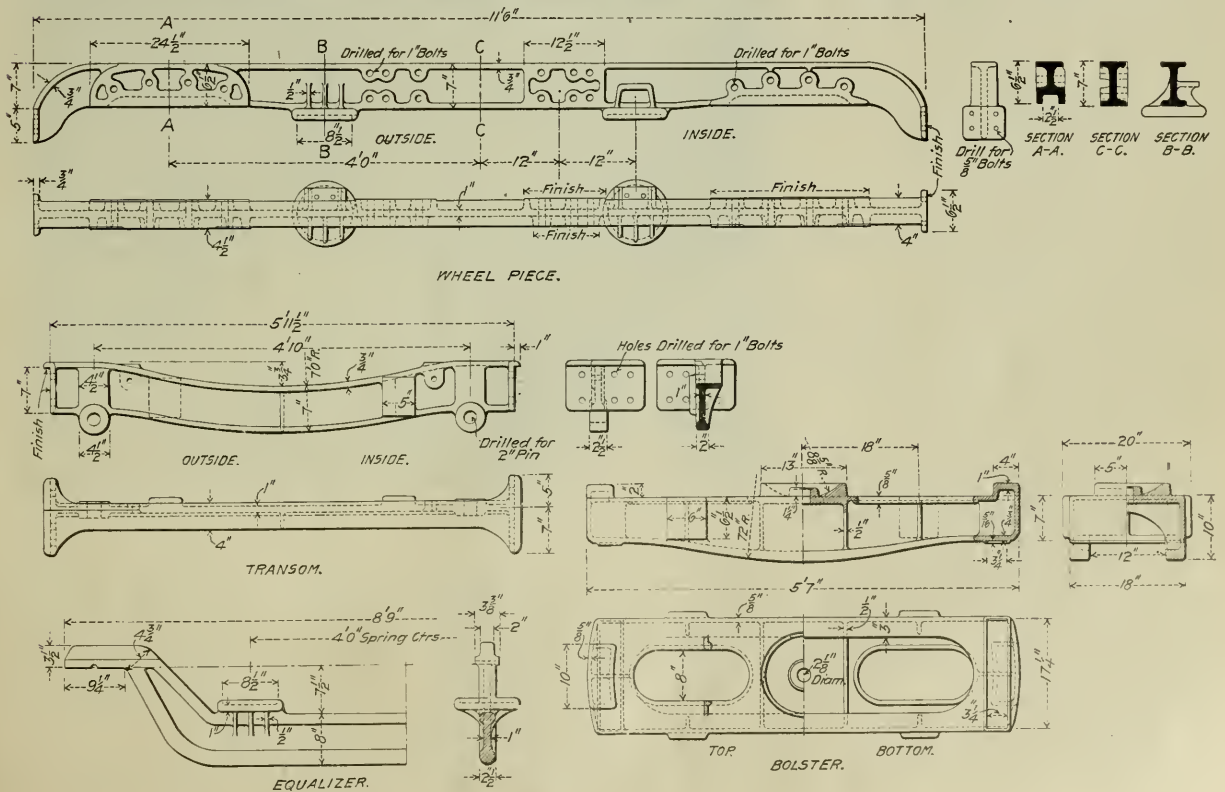
The end pieces of the frame are 3 in. x 5 in. angles bolted across the ends of the wheel pieces. The brakes are inside hung and as there are no safety beams the end pieces serve merely to tie the wheel pieces together, nothing being suspended from them. All of the brake rigging is hung from two 6-in. channels, placed flanges down just outside the transoms and bolted to lugs cast on the inside of the wheel pieces. The brake-beams are hung from two hangers suspended from carriers bolted on the under side of the channels over the brake-shoe heads, and the ⅜-in. x 3-in. release springs from which the beam is supported in the center are bolted on top of the channel.

A wooden spring plank has been used to somewhat deaden the metallic sound of the whole truck and to absorb the small vibrations set up in such a rigid construction. Two 1-in. bottom cross ties, connecting the bottom tie rods on each side, are put in to further stiffen the truck in a transverse direction. No rivets are used at any point, all the connections being machined and bolted. This construction gives the greatest possible rigidity and at the same time permits the truck to be easily and quickly dismantled for repairs. The experience of the railroads with cast-steel bolsters and other parts has been almost uniformly satisfactory, and with well designed sections such as have been used in this truck there should be little trouble from failures due to defective castings or breakages under shock.

We are indebted to Mr. William Garstang, Superintendent of Motive Power of the Big Four, for the illustrations.



Cast Steel Passenger Truck for the Big Four.




Cast Steel Details of Big Four Passenger Truck.

## The Telegraph Operator in the Railroad Service.*

BY JOHN B. TALTAVALL.

The lack of a trained understanding in the more important details of his profession on the part of the average telegraph operator is too often a serious drawback to his true usefulness. A student life is requisite for the full intellectual development of the telegrapher. But to this comparatively few aspire, and we are compelled to accept the operator as we find him. Only a very small percentage of telegraph operators possess either the inclination or the necessary perseverance to acquire telegraph and other electrical knowledge from books. Yet the careful and systematic study of books is a most influential help to the individual whose ambition is to win success in life, and operators should make the best possible use of this means of self help, reading and rereading their technical volumes, so that the matter therein treated may become familiar and firmly established in their minds. But if a railroad company desires to increase the efficiency of its telegraph staff it should detail a competent person to enlighten those operators needing information. All railroads have in their employ many persons abundantly able to fill the position of such an instructor.

A common deficiency among operators is failure to understand the management of the switchboard and adjustment of relays.

*Abstract of paper read before the Association of Railway Telegraph Superintendents at Indianapolis, June 15.

Comparatively few employes of the telegraph department of any railroad are able to make a patch or to test the wires for ordinary faults, or to manage repeaters, and to balance duplex and quadruplex apparatus, now used on many railroads. Four operators in as many different offices on a well known Eastern trunk line were obliged recently to confess their ignorance of how to make a patch. In another instance a day operator in a certain office understood how to patch, while the night man at the same point was unable to do so. The unequal conditions in the same office were the cause of much anoyance, necessitating the occasional calling of the day man to the office during the night.

Printed instructions covering switchboard practice, even when accompanied with blue prints, frequently are not understood, especially when the information is so voluminous that it confuses and mystifies the operator. Text books are all right, and their study should be encouraged; but a qualified person should call upon the operator and, by means of a specially drawn diagram, carefully explain the particular board which he is expected to handle. An explanation of a twenty-strap springjack switchboard is of little use to an operator wishing to learn how to handle an eight-strap peg switchboard.

One superintendent of telegraph informed the writer that on his road few of the operators knew how to adjust the relays properly. It never occurred to many of them, he said, that the magnets could be withdrawn from the armature or placed nearer to it, and in wet weather offices far apart could not break each other. A few minutes' personal explanation on adjusting relays would do more to lessen the burdens of many train despatchers and others than a month of reading could accomplish.

A man stationed at a busy junction not long since informed the writer that he felt impelled to resign his place because he had been given a set of repeaters to handle, the manipulation of which he did not understand. He was, in consequence, in a constant state of worry, and the daily receipt of complaints from his superintendent, from train despatchers and others, reflecting upon the inferior repeated service, made life to him a burden. All this might have been obviated if the person who installed the repeaters had been capable of instructing the unfortunate operator on their adjustment and management. This operator was a fairly bright man, and a brief explanation at the outset would have removed all embarrassment. In every office, however small, there should be diagrams showing every piece of telegraph apparatus in the station, to be kept permanently for reference. Then, in addition, if each operator had the construction of each instrument and the switchboard thoroughly taught to him the efficiency of the entire line would be distinctly improved.

## The Bettendorf Tank Car.

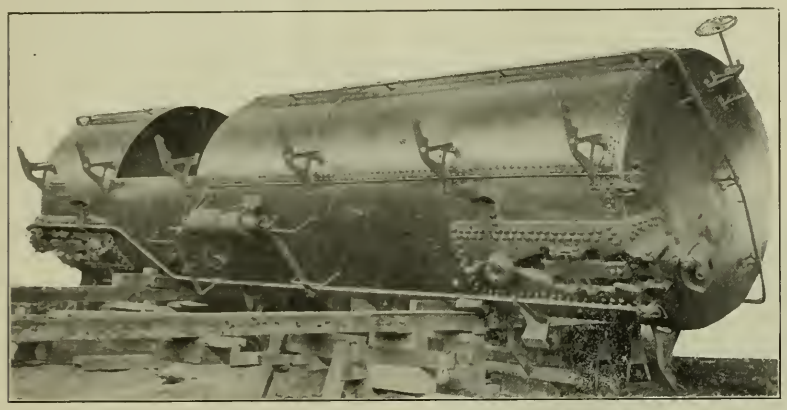
The Van Dyke tank car described in the *Railroad Gazette*, March 6, 1903, was a radical departure from previous practice in a number of respects. The most noteworthy feature of this design was the absence of underframing, the car consisting essentially of a tank and trucks. The Union Tank Line has over 600 of these cars in service, and they have given entire satisfaction.

Most tank cars have a high center of gravity, because the tank is raised well above the standard height of drawbar in order to get the draft gear in place. Mr. W. P. Bettendorf has designed the car shown in the accompanying engravings, which has a low center of gravity and which still meets all operating conditions. In general appearance the car is quite similar to the Van Dyke design, there being no underframing. The bottom of the tank is 12 in. lower than the Van Dyke car, and it is the manner of doing this that makes the design one of peculiar interest. This is done by putting the draft gear above the bottom of the tank, its center line being 5 in. above the bottom sheet. This required a special form of casting for housing the draft gear, made of thoroughly annealed steel, and which is a combined draft member and body bolster. It is let in through the bottom and end sheets, to which it is securely riveted. To relieve the tank sheets of buffing stresses and the rivets of shearing stresses, a hollow cast-steel column is interposed between the draft castings at opposite ends of the tank. This column is made in three sections with flanges and is bolted together and to the draft castings. The middle section has two supports cast on either side midway of its length, which are riveted to the bottom of the tank. The ladder is riveted to bosses cast on the top of the column. This section also has a passage cored through it vertically for the valve rod to pass through. As shown in the side elevation of the car, provision is made at each end of the column for a steam connection, enabling it to be used as a heating pipe for the oil, if desired.

Although the hollow cylinder is considered to be the best section to use for a buffing column, two I-beams or channels can be substituted if desired. The column was designed as follows: Using 10,000 lbs. per sq. in. as a safe compressive strength and assuming that out of 35 sq. in. in the bottom sheet, 20 sq. in. is available for buffing strength, this with the 22 sq. in. in the column will permit a safe buffing load of 420,000 lbs., which is ample for service requirements. The pulling load is borne by the bottom sheet, which at 10,000 lbs. per sq. in. is capable of sustaining a stress of 200,000 lbs.

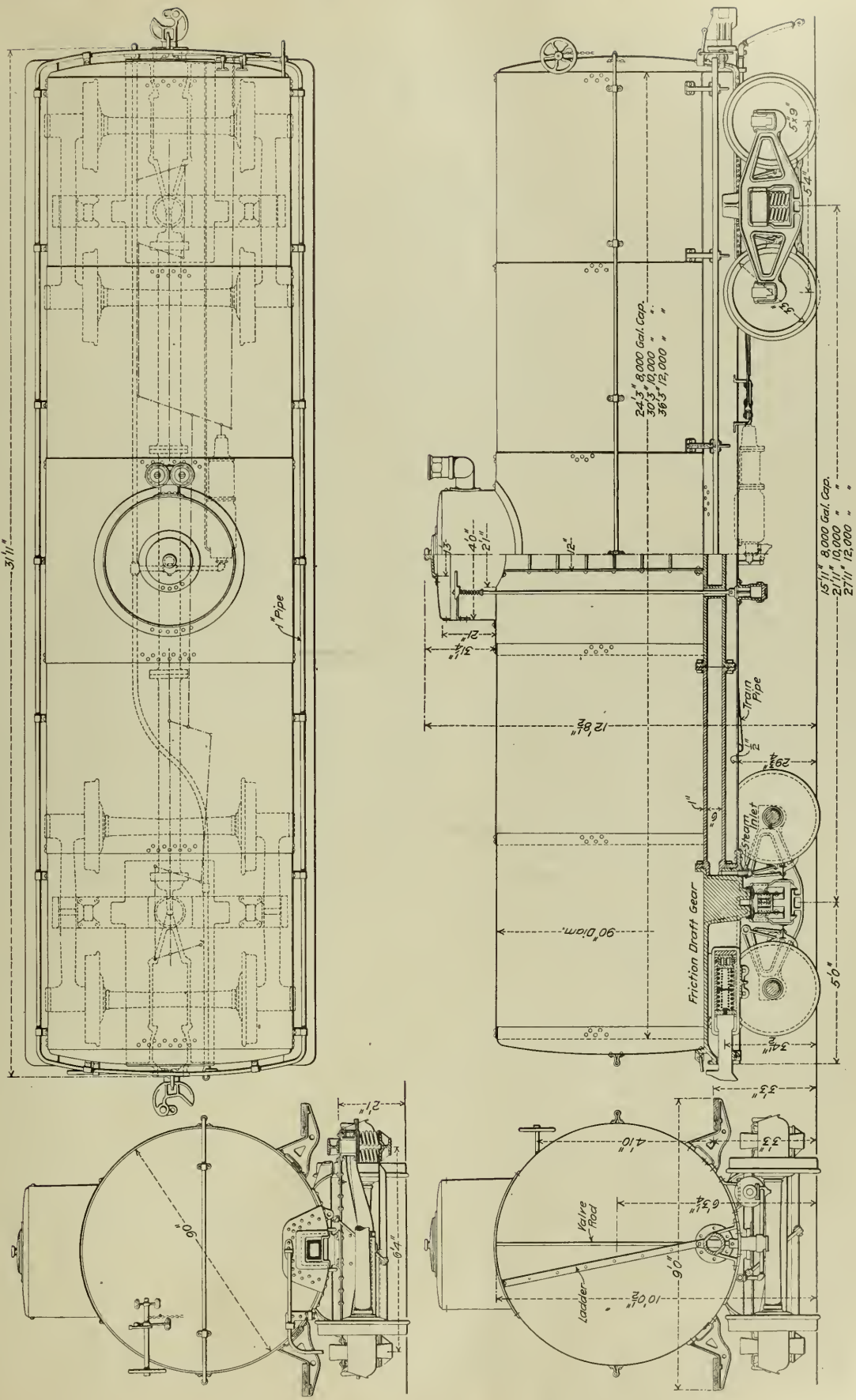
The running board is supported by six malleable-iron brackets riveted to the tank at a convenient height. The hand rail is placed at such a height that it can be reached from the ground. At each end of the truck bolster there is a step as a safeguard and convenience. The car is mounted on the Bettendorf truck described in last week's issue. In special cases, such as for volatile oils, a cover plate is riveted to the bottom of the tank over the draft casting to cover the rivets. The tank is equipped with improved duplex safety valves.

The distance of these tanks above the rails is the minimum that will permit the trucks to swivel enough to allow the car to pass



Bottom View of Tank Showing Draft Gear.

Inside of Tank Showing Draft Casting and Buffing Column.




Plan, Elevation and Sections of Bettendorf Tank Car.

around a 65-deg. curve. They are made in 8,000, 10,000 and 12,000 gal. sizes, the only difference being in the length. The weights of these three sizes are 31,000, 35,100 and 40,000 lbs. respectively. The cars are built by the Bettendorf Axle Company, Davenport, Iowa.

## The Storehouse System at Altoona.

BY GEORGE L. FOWLER.

Since Altoona is the headquarters of the mechanical department of the Pennsylvania Railroad for its lines east of Pittsburg, the storehouse at that point serves as the main distributing center. The method of receiving, storing, distributing and transferring material on so large a scale must necessarily possess the two prime requisites of simplicity and accuracy. It must be simple in order that the working cost may not be excessive, and it must be accurate, for the primary reason that inextricable confusion would result if it were not. There must necessarily be more or less of elaborateness in any system that can be adopted and worked in such a place, but a careful consideration of that in use at Altoona will show that it meets the two requirements laid down with remarkable efficiency.

The one thing that must be guarded against in the work is an exhaustion of the stock, and in order to meet any emergency that may arise, supplies for two months are kept on hand, that is to say, there is, upon the first of any month, a stock on hand sufficient for two months' consumption, while requisitions have been placed with the purchasing agent for the following month. Thus on the first of May, the inventory will show that the stock on hand is sufficient to last until July first. It is, of course, difficult, if not quite impossible, in many instances, to know exactly what the demand will be three months in advance, and, for that reason a system of averaging is used. The average consumption for the three months just past is used as a basis for the requisitions of the third month to come. If the shops are working and have been working a full time of ten hours per day, and it is expected that this will be the case on the third month to come, the full amount of the average is taken. If, however, there is to be a change, the requisition is modified accordingly. For example, if the working of the shops during February, March and April has been ten hours per day, and it is known that it will be but eight hours in July, the average is likewise cut 20 per cent. and a corresponding requisition issued. An increase in the hours of work is cared for by a corresponding increase in the requisition.

The quantities to be ordered on these requisitions are determined in this way, partly by the departments where they will be used, and partly by the storekeeper. The department attends to all matters pertaining strictly to its own work, such as the parts of locomotives and cars, which are ordered by the respective department heads, while small and manufactured articles, especially those of a miscellaneous character, such as bolts, screws, nails, tin plates, etc., are cared for by the storekeeper.

It is well known that a large portion of the supplies of the Pennsylvania Railroad are purchased on carefully prepared specifications, but these have no influence whatever upon the routine of the work of the storekeeper now under consideration. The piecework method of paying for work done in the shop, does, however, have a great influence, and that will be considered later. To give an idea of the magnitude of the work, it may be stated that there are at present upwards of twenty-five thousand items in the Altoona stock list. In discussion of the methods of handling and accounting for this material, we first come to its delivery at the storehouse, in response to the requisition. As soon as the material is received it is stored in bins if it is small, and in the yard if large, and a record of the same is placed upon a bin card, M. P. 48 of the form shown in Fig. 1.

This card is attached to the storage bin and tells, at a glance, the amount of material on hand, with reference to the inventory account that is kept in a book of the form shown in M. P. 50 (Fig. 5). It also refers to the stock book number, so that the whole history of the quantities of any one item is immediately available. It will be seen that the material on hand at the first of the month, that received during the month, and that consumed and transferred, are noted. These three items are written in whenever any change is made. As goods are received the number is recorded, and whenever an item is taken out, though it may occur twenty times a day, the fact is noted, so that the card indicates the condition of stock at all times. This card remains for the month for which it is made out and at the end of the same, the receipts and issues are totalled, from which is determined the quantity remaining, and this is entered in the column "On Hand at First of Month," for the next card.

A similar card, M. P. 49, shown in Fig, 2, carries the record in the office of what is on hand and what is still expected on requisitions. A comparison of these two cards at the end of the month, therefore, enables the storekeeper to determine at a glance what might be called the credit of any article. Form M. P. 48 gives him what is on hand; and form M. P. 49, what is expected, to which must be added enough to make up three months' supply, which is to be the requisition for the third month to come. It will be seen, then, that the requisition sent to the purchasing agent may not check exactly with that sent in by a department head. It depends upon the stock on hand and expected, whose total, in turn, depends upon the rate of consumption during the past 30 days. This requisition is also made out on a special blank. This, when filled as the result of the operations of the stock book and cards, is forwarded to the master mechanic for approval, and thence through the proper chamber to the purchasing agent.

In addition to these cards two books of permanent record are kept by the storekeeper. These are printed to the form of M. P. 226 and M. P. 182. (Figs. 3 and 4.)

M. P. 226 is a register of requisitions, and the various items are filled in after the requisition number as indicated. All but the last three columns, of the date when filled, the car number in which the goods were shipped and remarks, are filled when the requisition is received, and these later when the last of the goods have been shipped. M. P. 182 is a record of material ordered and received and occupies the two opposite pages of the book, giving full information as to the condition of an order or requisition for the renewal of supplies in the department. This is filled in from the bills as rendered with the receipt of the goods whether the shipment is in full or in part. The headings at the top of the several columns indicate very clearly the information that they are to contain and need no comment except to note that it is quite possible that some items may not need an entry under each and every column.

When this information has been taken from the bills, the latter are checked as correct by the storekeeper and sent to the master mechanic for official approval, and thence to the shop clerk who is essentially the auditor of the department: the storekeeper reporting to the master mechanic.

In order to avoid the bulky accumulation of the M. P. 48 and M. P. 49 cards and the difficulty of referring to them for past records of consumption to ascertain the needed amount to be placed upon requisition, the stock book shown in M. P. 50 is used. It will be seen by a reference to this that the stock book number must correspond with that on the card, as must also the inventory account number, the location of section and bin number, to which is added the unit for the price quotation, whether number, weight or length. The amount on hand can be taken from either of the two cards, the price from bills or from the receipt book, M. P. 182; while the monthly record of received, consumed and transferred are the totals of the corresponding columns of card M. P. 48.

This completes the record of all material received and distributed as far as the amounts in inventory are concerned. The work of the storehouse does not end here, however. Altoona, as already stated, is a general distributing center, and shipments are of daily and hourly occurrence to all of the smaller shops, roundhouses, stations and offices. In the distribution of material to outside points a number of forms are used, such as Form M. P. 201, which is merely a notice to the Altoona agent to make out way bills and forward the articles named to destination, and is not shown. Form M. P. 291 is a form of requisition used by the division of the motive power department beyond the jurisdiction of the master mechanic, and, after the approval of the superintendent of motive power, is registered in the storekeeper's office, as shown on M. P. 226. It also enables the shop clerk to enter the proper charges and credits. This form would be used, for example, were material to be ordered to the machine shop from the car shop. Form M. P. 87 (not shown) is used as a shipping notice where material is ordered irregularly, as by a memorandum, or telephone order, or by parties who do not use the regular forms of the motive power department as the transportation or permanent way departments. This form is sent to the office of the shop clerk by whom the charges are made, while the usual shipping notices are sent on the forms M. P. 87 and M. P. 7.

Form M. P. 7 is the storekeeper's notice to the consignee of the shipment of material. It is checked off by the consignee and returned to the storekeeper, to whom it is only useful as a receipt for material delivered and a means of proving such delivery or shipment. It serves its purpose just as a returned bank check may serve as a receipt for money paid. It has no bearing whatever on the inventory which is cared for entirely by the two cards M. P. 48 and 49. In this way material is received, checked and distributed to points outside the Altoona machine shops, everything being regarded as foreign. It remains now to see how the same method is followed in a distribution among the shops themselves. Here there are a series of requisitions and orders passing between the shops and the storehouse, labor charges being added to original costs in the shops.

The piecework system that pervades all departments of the shops contributes very materially to the ease with which these accounts are kept. To further facilitate the clerical work, each department such as the paint shop, spring shop, tin shop, etc., is known by a number rather than a name, and all work is done on an order number. Where there is no interchange, that is to say,

PENNSYLVANIA RAILROAD COMPANY.
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

Article _____

Section_____ Inventory Acct. No._____

Bin No._____ Stock Book No._____

Price_____

| Month | On Hand at First of Month | RECEIVED | CONSUMED | TRANSFERRED |
|---|---|---|---|---|
| | | | | |

Fig. 1—M. P. 48: Bin Card.

Deliver to Stock Room Dep't No._____

PENNSYLVANIA RAILROAD COMPANY.
PHILADELPHIA, WILMINGTON & BALTIMORE RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

Article _____

Sec. No._____ Inventory Acct. No._____

Bin No._____ Stock Book No._____

STOCK INVENTORY—ORDER CARD.

| On Hand. | | Ordered and Received. | | | Price. |
|---|---|---|---|---|---|
| Date. | Quantity. | Req'n. | Quantity. | Date. | |
| | | | | | |

Fig. 2—M. P. 49: Record of Deliveries.

Pennsylvania Railroad Company.
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

FROM_____ MATERIAL ORDER.

TO_____ 190

| DESCRIPTION OF MATERIAL | WT AND QUANTITY | PRICE PER UNIT |
|---|---|---|
| | | |

Enter on Each Card Items Chargeable to One Account Only

CHARGE TO_____

COMPLETED_____ 190 Foreman.

Fig. 8—M. P. 151: Material Order.

PENNSYLVANIA RAILROAD COMPANY
Philadelphia, Baltimore & Washington Railroad Company.
Northern Central Railway Company.
West Jersey & Seashore Railroad Company.

RECORD OF MATERIALS ORDERED AND RECEIVED AT _____ SHOPS_____ 190

| Date Ordered | Card No. | Order or Req. No. | Quantity Ordered | Quantity Received | DESCRIPTION OF MATERIAL | FROM WHOM RECEIVED Name | Address | Point or Shipping | Date Received | BILL Pond "C" Rivers | BILL Months Credited | HOW RECEIVED | MANIFEST No. | MANIFEST Date | MANIFEST Car | F O B at | Freight or Express | Price per Unit | Net Price as per Pond "C" | WEIGHT | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |

Fig. 4.—Form M. P. 182, with M. P. 226, Storekeeper's Permanent Record.

PENNSYLVANIA RAILROAD COMPANY.
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

Report of Material in Stock at_____ Shops, 19____

| ARTICLE | MONTH | ON HAND | PRICE | REC'D | CONS'D | TRANS'D | ORDERED Quantity | ORDERED Req'n |
|---|---|---|---|---|---|---|---|---|
| Invy. Acct. No. | Jan. | | | | | | | |
| | Feb. | | | | | | | |
| Stock Book No. | March | | | | | | | |
| | April | | | | | | | |
| | May | | | | | | | |
| Location | June | | | | | | | |
| Sec. Bin. | July | | | | | | | |
| | Aug. | | | | | | | |
| How Priced | Sept. | | | | | | | |
| | Oct. | | | | | | | |
| | Nov. | | | | | | | |
| | Dec. | | | | | | | |
| Invy. Acct. No. | Jan. | | | | | | | |
| | Feb. | | | | | | | |
| Stock Book No. | March | | | | | | | |
| | April | | | | | | | |
| | May | | | | | | | |
| Location | June | | | | | | | |
| Sec. Bin. | July | | | | | | | |
| | Aug. | | | | | | | |
| How Priced | Sept. | | | | | | | |
| | Oct. | | | | | | | |
| | Nov. | | | | | | | |
| | Dec. | | | | | | | |

| ARTICLE | MONTH | ON HAND | PRICE | REC'D | CONS'D | TRANS'D | ORDERED Quantity | ORDERED Req'n |
|---|---|---|---|---|---|---|---|---|
| Invy. Acct. No. | Jan. | | | | | | | |
| | Feb. | | | | | | | |
| Stock Book No. | March | | | | | | | |
| | April | | | | | | | |
| | May | | | | | | | |
| Location | June | | | | | | | |
| Sec. Bin. | July | | | | | | | |
| | Aug. | | | | | | | |
| How Priced | Sept. | | | | | | | |
| | Oct. | | | | | | | |
| | Nov. | | | | | | | |
| | Dec. | | | | | | | |
| Invy. Acct. No. | Jan. | | | | | | | |
| | Feb. | | | | | | | |
| Stock Book No. | March | | | | | | | |
| | April | | | | | | | |
| | May | | | | | | | |
| Location | June | | | | | | | |
| Sec. Bin. | July | | | | | | | |
| | Aug. | | | | | | | |
| How Priced | Sept. | | | | | | | |
| | Oct. | | | | | | | |
| | Nov. | | | | | | | |
| | Dec. | | | | | | | |

Fig. 5—Form M. P. 50: Stock Book.

No._____ Register No._____

THE PENNSYLVANIA RAILROAD COMPANY.
PENNSYLVANIA RAILROAD DIVISION.
MATERIAL SHEET.

SUPERINTENDENT M. P. Altoona, Pa. ALTOONA, PA._____ 190

Please ship to P. R. R. Co., care Master Mechanic, Altoona, Pa., for use of Altoona Machine Shop, the following material and charge Altoona Machine Shop Account.

Approved and sent to _____ Master Mechanic.

Approved: _____ Supt.

Supt. M. P.

| Quantity | MATERIAL REQUISITIONED | ACCOUNT No. _____ | Weight |
|---|---|---|---|
| | | | |

Make one entry on sheet

SUPPLIED. By No._____

| Date | Quantity | Weight | Date | How Sent | REMARKS |
|---|---|---|---|---|---|
| | | | | | |

Completed _____

Fig. 6—Form M. P. 291 for Outside Requisition.

PENNSYLVANIA RAILROAD COMPANY.
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

REGISTER OF REQUISITIONS.

| Register No. | Req'n. | Shop. | Date Rec'd. | Sent to | Date. | Wanted | Filled. | Car No | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Fig. 3—Form M. P. 226.

PENNSYLVANIA RAILROAD COMPANY.
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY.
WEST JERSEY & SEASHORE RAILROAD COMPANY.

_____ ALTOONA MACHINE SHOPS. 190____

_____

We have this day sent to your address the following articles:

| How Sent | Order No. | DESCRIPTION OF ARTICLES | Rate | Amount | How Packed |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Received, _____ 190

_____

NOTE.—This Manifest must be carefully compared with the articles received, and the same properly receipted and returned to the Storekeeper shipping the material. In the event of any discrepancies in weight or count, however, the same should be noted in red ink on the face of the Manifest and returned to the Office of Superintendent Motive Power.

_____ STOREKEEPER.

Fig. 7—M. P. 7: Storekeeper's Notice to Consignee.

where material leaves the storehouse not to return, it is issued on the presentation of a material order like that shown in form M. P. 151. (Fig. 8.)

This order is presented at the storeroom signed by the foreman of the department where the work is to be done and the material is issued, and the storehouse connection with the same ends then and there. It often occurs, however, that the storehouse puts in a requisition for some article manufactured in the shop from raw material held in store. In this connection a special form, M. P. 271, is used to obtain material manufactured at the works, which is used in the stock order system. Instead of ordering by name only, a system of shop order numbers is used, and when an article is to be manufactured, the M. P. 271 is issued and, under the words, "Charge to," a number is placed, and all labor and material necessary is charged to that number. This serves to avoid confusion where two or more orders may exist for the same kind of articles; that is, articles having the same name, but differing slightly in character. Suppose, for example 100 two-gallon cans are wanted. A requisition on the tinshop is made for them on M. P. 271, given a shop order and sent out to be filled. The foreman of the tin shop then fills out the material order, blank No. 151 (or he may use the space at the bottom of M. P. 271 if he pleases), for the tin, bail handles, wire, ears, etc., that will be needed, and when they have been received, this material order is sent to the shop clerk. When completed, the cans are delivered to the storehouse and entered as new material; while the unit price for the same is made up by the shop clerk from the original cost of the material and the piecework prices of labor, and this is used as the unit price for the manufactured article, and the latter is charged to the consuming department at this rate.

Form M. P. 151 (Fig. 8) is also used where the charge will be against what is known as a closed account; that is to say where no shop bill will be rendered, as in the case of the replacement of a broken window pane, or for tools and supplies to locomotives and the like.

This system runs along smoothly when everything is working under normal conditions, but provision must also be made for abnormal conditions which will demand a certain amount of flexibility, in order that the necessities of such cases may be met as they arise. It may happen that a sudden demand for large quantities of a certain article will exhaust the whole stock on hand. For such emergencies a special card similar to the bin card M. P. 48 is provided and a special requisition can be sent in to be filled at once. To prevent over ordering and to serve as a check on the supplies, the requisition is checked by the superintendent and given a number, which is written on it, and under which it is identified in the register of requisitions, the receipt book and other places where reference is made to it. In the matter of scrap the storehouse has little to do, for while it does handle some old material, it is only that which is utilizable, and scrap, pure and simple, is handled by each department for itself.

The storehouse proper occupies a portion of the first and second stories of a brick building standing on the eastern edge of the grounds, that also houses the physical and chemical testing laboratories, and the offices of the master mechanic, the shop clerk and the storekeeper himself. An elevated platform along one side of the building gives convenient shipping facilities, but it must not be thought that all material is sent out from this point, or that everything is kept within the rather narrow limits of this building. The storehouse itself contains, for the most part, the higher priced and light manufactured articles, such as brass work, nails, screws, rope and the like.

Scattered over the premises there are a number of storage places where heavy material is kept, each in charge of an attendant, just as in the regular storehouse. Here the bin cards are filed in drawers or other places sheltered from the weather, but the records are maintained in exactly the same way, it being manifestly impossible to conveniently arrange for cards attached to such articles as drawbars, driving wheels and the like, while the permanent record of the stock appears in M. P. 50 in the storekeeper's office.

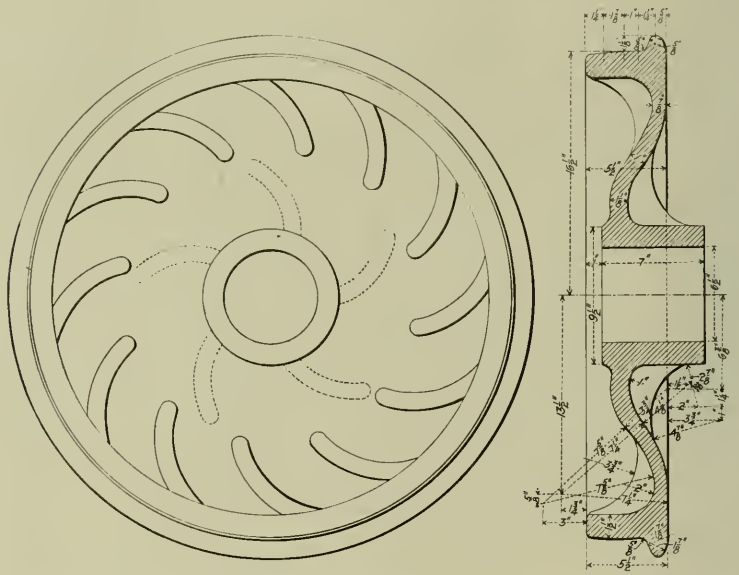
In the case of the pig and scrap used in the foundries, the records of receipts and disbursements are kept by the foundry foreman who reports the same to the storekeeper. The storekeeper is thus put in possession of the inventory record and can regulate the monthly requisitions accordingly.

In all there are about 90 employes in the storekeeper's department, including the clerical force in the office, the attendants, porters, shipping clerks and messengers.

When it is considered that Altoona is the distributing point for a circle of smaller points extending from Jersey City to Pittsburg and that supplies are sent not only to the various branches of the motive power department but to those of the transportation and maintenance-of-way as well, and that there are over 25,000 items listed, it will be seen that the whole system is exceedingly simple and must be efficient in order to operate at all. The storekeeper can tell at a moment's notice on any day of the month as to the exact condition of the stock of any item, while the monthly record of stock on hand keeps the management posted as to the value of what is carried. The storekeeper is merely a handler of material. He had nothing whatever to do with the fixing of prices, as this is done either by the purchasing agent through the bills that are rendered, or by the shop clerk who adds to the cost of raw material that of piecework price of the labor involved in working it up. But even though relieved of this portion of the work, the fact that all records even to minute details of the supplies used by a road like the Pennsylvania can be kept on what practically amounts to two cards and two form books, speaks volumes for the care and skill with which the system has been developed.

### A Single Plate Cast-Iron Wheel.

The accompanying drawing shows a new form of single plate bracket wheel which has been designed by the Louisville Car Wheel and Railway Supply Company, Louisville, Ky. More light on the car wheel question is interesting at this time in view of the probable adoption of standard designs for cast-iron wheels under 40-ton and 50-ton cars, by the Master Car Builders' Association at the convention next week. The single plate wheel has practically gone out of use since the introduction of heavy cars and the efforts of the wheel makers to design a satisfactory wheel to meet the more severe service conditions imposed by the heavy equipment have all been along the line of double plate wheels. The proposed standard designs are double plate wheels. Particular attention has been paid to strengthening the flange and distributing the metal so as to prevent seams at the root of the flange as far as possible. In the single plate wheel here shown the plate is a continuation of the flange and the tread is supported by radial brackets, whereas in the proposed double plate wheel the inside half of the tread and the flange are supported on brackets. A larger amount of metal is put in the root of the flange of the single plate wheel, and at the same time the tread is made of nearly uniform thickness. The brackets on the inside and outside of the plate meet directly above the point of contact of the tread on the rail and this gives a stress in almost a straight line through the plate to the hub. All of the sections in the wheel have been made heavy enough to withstand the maximum stresses to which they might be subjected and at the same time no unnecessary metal has been put in. The makers claim that this design is stronger than the common form of double plate wheel, as shown by comparative drop and thermal tests on the two types of wheels cast from the same iron.



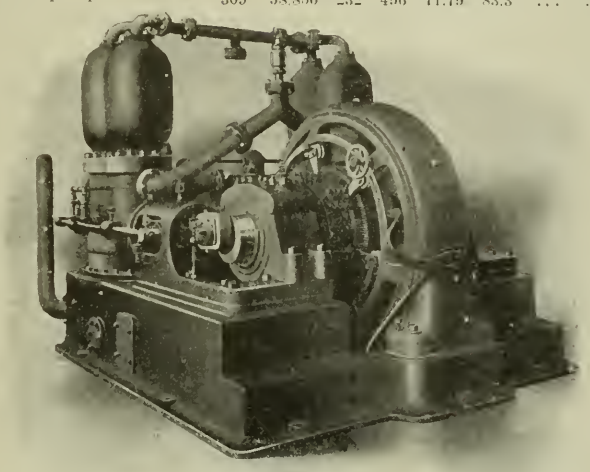
Single Plate, Bracket Car Wheel.

### High-Speed Motor-Driven Pump.

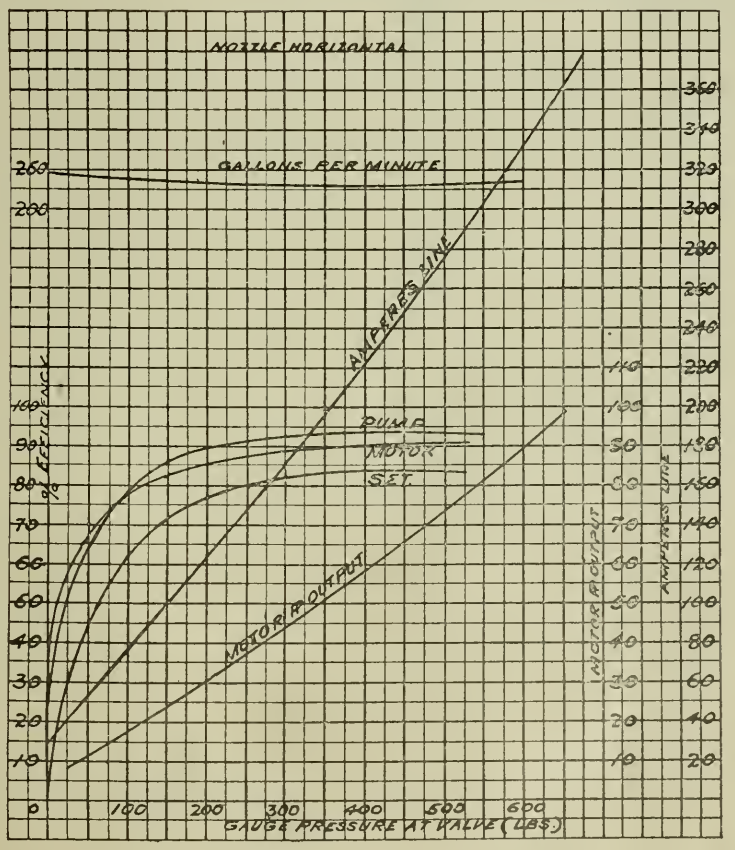
Electric-driven pumps have had one drawback, i.e., the necessity of using toothed gearing, belts or other devices to transfer the power from the motor shaft to the slow moving crank-shaft of the pump. In the pump illustrated herewith these objectionable features have been eliminated by connecting the pump plungers to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250 gallons per minute against 1,000 ft. head when running at a speed of about 300 r.p.m. The mechanical efficiency of the pump is over 93 per cent., approximating closely to that of the highest types of large steam pumping engines. The pump is the duplex type with the cranks at opposite ends of the motor-shaft set at right angles to each other. The plungers are outside-packed and the two plungers of each pump are connected by side rods. The plungers are 3½ in. in diameter and have a stroke of 5½ in. The pump is driven by a 100 h.p. General Electric motor. The results of a test are given in the accompanying table. The volume of water pumped was measured by means of a calibrated Freeman nozzle and all gages were tested before and after the test by means of a weight gage tester. The pressure at the nozzle was measured by a mercury column connected to a piezometer chamber.

*Test of a Blake-Knowles High-Speed Pump.*

| Rev. per Minute. | Motor Input, Watts. | Pump—Gallons Deliv'd. | Pump—Press., Lbs. | Pump H. P. | Efficiencies Per Cent.—Motor and Pump. | Motor Alone. | Pump Alone. |
|---|---|---|---|---|---|---|---|
| 280 | 28,800 | 237 | 110 | 32.63 | 78. | 86.5 | 90.1 |
| 280 | 40,600 | 237 | 215 | 48.94 | 82.2 | 89. | 92.36 |
| 280 | 52,550 | 235 | 321 | 62.25 | 84.4 | 90.1 | 93.66 |
| 280 | 60,200 | 234 | 425 | 74.53 | 84.3 | 90.9 | 92.74 |
| 309 | 58,800 | 232 | 496 | 71.79 | 83.3 | ... | .... |



Blake & Knowles High-Speed Pump.




Tests of Blake & Knowles Pump.

The pump and motor are mounted on a rigid box-girder frame and the unit is self-contained and occupies a relatively small space. This type of pump has lately been introduced and is built by the Blake & Knowles Steam Pump Works, New York City, in capacities of from 200 to 4,000 gal. per minute, and for heads varying from 100 to 2,000 ft. One of these pumps operated by a direct-current motor will be exhibited in the space of the General Electric Company at the St. Louis Exposition.

### The Market Value of Inferior Woods.*

During the early history of the lumber trade the consumer felt at liberty to order almost anything, with a reasonable assurance of getting it. There was no question on the part of the manufacturer but that he could produce almost any kind of lumber for which he might receive an order. Take the example of white oak—and the same will be true of pine before long, and has become true of white pine—the consumer can no longer go to the manufacturer with reasonable assurance of getting what he wants. This is true to a large extent because of the increase in the demand and an even proportionately greater decrease in the supply of forest products, and the situation is fast assuming a phase of what the consumer can get as distinguished from what he wants. To take a specific case, it was an easy thing for the purchasing agent of a railroad company to go to a manufacturer ten or fifteen years ago, or even later, and make a contract for two years for 800,000 ties. To-day the manufacturer is not in a position to accept orders for high grade material of this description, but to a limited extent he can agree to furnish any of such material as the quality of his timber enables him to supply.

The question of the use of inferior woods has for some time been prominent in the work pursued by the bureau of forestry. We have tried to keep in mind the relations which existed between the use of high-grade woods and the possible substitution of lower grade timbers for different purposes. The buyer has become accustomed to certain qualities possessed by high grade woods, such as strength, ease of finishing, long life and other qualities which go to make up a high grade material, but the time has arrived when he is no longer in a position to get such material easily. We are constantly receiving inquiries such as these: "Please tell us what we can do with beech." "Is Western hemlock any good?" The consumer has been accustomed to using a great deal of timber which he did not have to question. He must now use materials of which he knows practically nothing. This is true also of the seller. He wants to get the greatest return for the material he has to sell. If he can put the product in the most attractive form he is going to have a material he can sell for the most money. To take a concrete example, questions concerning gum and loblolly pine are coming to the front more and more. Makers of cars, and others, are asking regarding the value of inferior timbers for car sills and structural uses of all kinds. The owners of gum lands ask what their gum is worth and how they may realize on it to the best advantage. We can see in this an increasing in

*Extract from a paper by Hermann Von Schrenk, read before the National Lumber Manufacturers' Association.

terest in and demand for these inferior timbers; and the question is what we can do to establish more definitely the quality and value of each for certain uses.

The three problems we have started to investigate are, briefly:

1. To determine what the strength values of the various inferior timbers are:

2. What the lasting powers, both in the natural state and when treated chemically are.

3. How more economically to use the waste products of both low grade and high grade material, thus bringing about the utilization of all the wood in the tree, including tops, branches and slabs.

The preservation of wood, while practiced a great many years, both in this country and abroad, is still in such a chaotic state that very few know practically what to do. If you were to consider the following problem: "In connection with our saw mill we want to put up as cheap and reliable a plant as possible whereby we can preserve a certain wood, increase its hardness, increase its resisting powers to decay, decrease its tendency to warping and checking—how can we do it? What process shall we use?" If you were to ask a question like that, while there are a great many systems on the market, patented and otherwise, there has been too little effort to determine their exact value and whether they can be absolutely depended upon. What we are trying to do is to test the various forms of preservative processes used both in this country and in Europe, to test the relations between strength and chemical treatment of methods for increasing the stiffness. We are starting in these investigations in the South with gum, beech, loblolly pine and red oak; and on the Pacific Coast with Western hemlock and certain others of the market timbers in use there.

Regarding the strength of timbers, there have been a great many tests made, and the test values of timbers may be found occupying a large amount of space in the periodicals. Still these tests are of such a character that it is difficult to depend upon them. They have not been made with much system. The specimens have been taken without regard to the character of the test to be made. Many woods have received a reputation for being stronger than they are, which has hurt them when they have failed to come up to the expectations; other woods have been classed too low. I have at hand a few of the results in a preliminary form which we have obtained during the past year, and will read them.

Loblolly pine has not only a wide range of growth, but a wide range of structural merit. It is found locally in the markets of Washington and Norfolk under the name of Virginia pine, in small sap sticks 8 in. x 8 in. or 10 in. x 10 in., showing almost entirely sapwood of such a rapid growth that sometimes four rings occur in three inches. This is a second growth timber and usually very knotty. The same species occurs in the Charleston market and from there is shipped to Philadelphia and the North under the name of North Carolina pine and shows a large sized lumber, fairly free from knots, somewhat close ringed and of a high order of structural merit. As a tree it is prolific, and architects may expect to find it on the market for an indefinite period.

The chief objection to loblolly pine is that, being usually sapwood, it decays rapidly when exposed under certain conditions. It is, however, a timber that may be treated with preservatives very successfully. Some difficulty is experienced in preventing the wood from staining in the South Atlantic States, but if the timber is kiln dried it retains the pleasing grain and the clear, white finish to be found in the sapwood of the species. It is consumed very largely in the Philadelphia market for joists and mill construction.

Engineers have been for a long time specifying longleaf pine as the standard material for construction, and it is the opinion of most of them that a wood of quick growth has little merit. It is undoubtedly true that there is no structural wood that approaches longleaf pine for srength and durability, but for indoor use or for service in which severe shocks do not come on timber this quick growth loblolly pine offers one of the cheapest and most desirable building materials. Let us have some conception of the relative strength of joists of longleaf and loblolly pine. Let us compare the loads which would rupture two air dry joists 8 in. x 14 in. in cross section and 16 ft. span. One joist is of longleaf pine of good, merchantable quality, showing two-thirds heart on faces, free from shakes that show on the surface or through shakes and unsound knots. The other joist is North Carolina loblolly pine of square-edge grade, showing sap on all faces, free from through shakes or unsound knots, but of rapid growth. The longleaf pine joist will weigh 700 lbs. in an air dry condition and contain 133 lbs. of water. The North Carolina loblolly joist will weigh 500 lbs. and when air dry will contain 87 lbs. of water. The longleaf pine joist will stand 44,650 lbs. center load before failing and will deflect 2¼ in. at the time of failure. The loblolly pine joist will carry 32,650 lbs. at the time of failure and will deflect 3 in. just before failing. To state the matter in another way, if the loblolly pine joist is 8 in. x 14 in. in cross section the longleaf pine joist will have to be 8 in. x 12 in. in cross section for the same strength.

What shall we say of the red fir joist? The red fir is a wood that is found from the southern part of the State of Oregon up to Vancouver; from the west slope of the Cascade Mountains to the coast. Fully 90 per cent. of the timber in Oregon west of the Cascade Mountains is this red fir, which is sometimes called Douglas spruce, Oregon pine and Oregon fir. It grows to a large size, with old trees 10 ft. in diameter. The wood varies between a somewhat coarse-ringed growth to a hard, fine-ringed variety. The wood, however, is never, even in the fine-ringed variety, as hard as longleaf pine of an equal rate of growth.

It is found in the red and yellow colors. The two colors may exist in the same tree. It is the impression among lumbermen that in a locality of thick, dense growth, where there is a rich soil and an abundance of rainfall, the yellow color is produced in the tree, while the red color is more common in the dryer districts with poorer or more rocky soil. It is also a belief that the yellow wood is the wood of an older growth and from larger trees, while the red color is apt to be a second growth. There is a great difference in the relative hardness of the rings of red fir and also in the shrinking qualities, so that the wood when dry is apt to be of a ribbed character, with hard rings standing out from the softer rings. The wood is more durable than pine and less than longleaf pine. The great length in which the wood can be sawed perfectly free from blemishes and clear from knots renders it available for special uses. It is already a competitive wood in the markets of Chicago and as far east as Pittsburg. What will be the strength of an 8 in. x 14 in. red fir joist compared to joists of longleaf and loblolly pine, the red fir being of merchantable grade, being of sound lumber, free from shakes, large, loose or rotten knots, allowing sound knots, pitch seams, sap on corners one-third width and one-half thickness? This air-dry red fir joist will carry 30,500 lbs. at the time of failure, and will deflect 5 in. It will weigh 400 lbs. and contain 62½ lbs. of water.

The Western hemlock has suffered in reputation because of Eastern hemlock. The Western hemlock grows in large sizes up to 13 ft. in diameter, with a height of 250 ft., and is found in Washington, Oregon and Vancouver, intermixed with red spruce and cedar. It is a vigorous growing tree and after the red fir has been cut down most of the young growth seems to be hemlock. It is not so white or hard as Pennsylvania hemlock. Perhaps it approaches more the wood that is brought from Canada, being softer. It has a distinct odor and is practically immune from the attacks of insects. At the present time it is cut and appears on the market as second grade red fir, not usually being cut or sold under its own name. It has been used for trestles, locally by mills on the Pacific Coast and furnishes a very desirable and pleasing finished wood. An air-dry joist of hemlock of merchantable grade will carry 28,300 lbs. before failing, and will deflect 1½ in. It will weigh 500 lbs. and contain 112 lbs. of water.

Summing up, then, we may say of these four species—longleaf pine, loblolly pine, red fir and hemlock—that the relative carrying capacity of an 8 in. x 14 in. x 16 ft. joist is in proportion of the following numbers: 82, 62, 72½ and 52.

The sizes of the joists for equal strength will be as follows: Taking the width of the joist as 8 in. and the span 16 ft.: 14 in. for longleaf pine, 16 in. for North Carolina loblolly pine, 16 in. for red fir, and 18 in. for hemlock, the weight per 1,000 ft., B. M., of perfectly dry timber will be as follows: 3,820 lbs. for longleaf pine, 2,580 lbs. for North Carolina loblolly pine, 2,120 lbs. for red fir and 2,170 lbs. for hemlock.

The great problem of immediate interest to every one is greater economy in the use of all kinds of material; in other words, an increased getting together on standard sizes of all forms of material between the manufacturer and the consumer ought to come about. The bureau of forestry began some years ago to investigate the tie proposition as one of the most demoralized forms of the lumber trade in the United States. Every railroad buys what anybody will sell it, simply for convenience, but there has been no reason for any definite specification hitherto, because of the great cheapness and quality of the material. With the increasing expense and difficulty of securing ties and the increasing use of sawn ties, it has been necessary to adopt some form of specification.

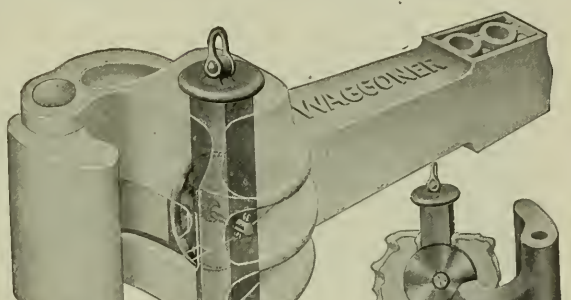
Furthermore, this problem is one of dealing with the most suitable use to be made of any material. The idea is gaining that certain kinds of material are to be saved for certain industries. We have been trying to impress upon the railroads in the Mississippi Valley that they do not want to use white oak ties—that they ought to leave that wood to industries depending upon it and use for their purpose cheaper grades of material.

Another point to be considered is unification of trade names and terms. A great deal of dispute arises because of the confusion in this regard in different kinds of timber and in different countries. I was impressed while in Europe last summer with the feeling of uncertainty which existed in regard to names of American lumber products. They were buying Oregon pine and

were getting Douglas fir, not realizing that both meant the same timber. I would suggest a campaign of education in regard to terminology of woods, which need not go into the finesse of material. For instance, certain kinds of red fir look much like hemlock and there is not much use in splitting hairs. But on the main proposition there should be a terminology established, so that the buyer on the west coast, or the east coast, or in China, when a man says "I will sell you a car of A, or B, or C, or D," will know just what he is going to get.

### The Waggoner Coupler.

A new design of coupler is shown herewith, the principal feature of novelty being the locking device. It will be seen that a simple straight pin is used which has attached to it a revolving disk, 5½ in. in diameter and ⅞ in. thick. The latter is designed to provide a large and constantly changing wearing surface, and to obviate any creeping up of the pin, the working of the knuckle against the disk simply causing it to revolve. The position of the pin and disk is such that the plane of the latter forms an acute angle with the axis of the coup'er. The back of the knuckle is made with an incline, which permits it, in closing, to slide under the disk, raising the pin. When the latter drops back into position, the knuckle bears against the side of the disk. Therefore unlocking cannot occur without lifting the pin. Also the action of the disk is such as to provide practically an anti-friction element between the knuckle and pin.



The Waggoner Coupler.

The lock is always set when the pin is raised. It is claimed that the weight of the pin and disk will throw out the knuckle ready for coupling, so that to open the knuckle for coupling it is only necessary to raise the pin and drop it. To uncouple, the trainman need only raise the uncoupling lever to the locking point of the pin and let it drop, this operation setting the disk on top of the knuckle. The pin remains in the uncoupling position until the parting of the cars opens the knuckle, permitting it to drop to the coupling position. This does not occur, however, unless the knuckle is opened to its total outward movement, thereby preventing its occurrence in the case of any slight movement of the knuckle due to the jarring in passing over frogs and switches. The formation of the coupler wall around the top and bottom of the pin on three sides is such as to form a back-stop, relieving the pin of strain, and avoiding possibility of its being bent.

The coupler was patented on May 10th by Mr. A. E. Waggoner, of Grand Rapids, Mich., who expects to have it on exhibition at the M. C. B. convention.

### Lengthened Parlor Cars of the Monon.

The Chicago, Indianapolis & Louisville has recently rebuilt two parlor and dining cars at its Lafayette shops, the work of rebuilding including the lengthening of the cars from 59 ft. 6 in. to 72 ft. 1 in. over sheathing, or 13 ft. 5 in. longer than originally built. The bodies of the cars were cut in two between the transom and needle beam and the halves separated far enough to receive the 13 ft. 5 in. double splice-piece in the side sills. The two center sills were cut off near the center of the lengthened car, the shorter ends being discarded and new pieces 13 ft. 5 in. longer were substituted, giving but one splice. The two intermediate sills were removed from their position adjoining the center sills, turned end for end and spliced, and then placed adjacent to the side sills. Two additional intermediate sills, 5½ in. x 7¼ in., were applied, making eight sills in the new underframe, instead of six as formerly. A timber, 7¼ in. x 10 ft. 6 in., was fitted between the center sills at the splice and bolted securely to them by bolts spaced 20 in. apart. The splice on the old intermediate sills was strengthened by a timber 2 in. x 7¼ in. extending 4 ft. 6 in. each way from the center of the splice and, a timber 2 in. x 7¼ in. x 24 ft. long was bolted to the side sills, overlapping both of the splices on these sills.

The bridging is spaced from 13 in. to 15¾ in. centers throughout. There are two layers of deafening material ⅞ in. thick fitted between the bridging and the sills. The side sills are 6 in. x 8 in. and their top inside corners are rabbited ¾ in. deep and 1 in. from the side to receive the flooring. There are two layers of flooring, the bottom course being 1½ in. thick, with ends rabbeted out ⅝ in. on the under side, and the top overlapping the side sills to admit of more nailing surface and to form a better tie for the frame. A layer of three-ply paper was laid over the tops of the sills, on which the 1½ in. flooring was laid crosswise.

Instead of a wooden truss plank, as used in the old car, a 10 in. 15-lb. channel, 73 ft. long, was substituted. It rests on top of the lower floor directly over the side sill and is secured to the latter by ⅝-in. bolts with ⅜ in. x 2 in. hook ends, passing down through the sill and spaced 4 ft. apart. The hook, of course, rests on the top edge of the channel, and is held in place by a bolt which passes through the channel web 2 in. from the top of the channel. The channel is also bolted to the posts. The steam heating pipes are placed in the recess between the flanges of the channel. After placing the channel in position, the upper floor, which is ⅞ in. thick, was laid, its outer edge being rabbeted to fit snugly over the lower flange of the channel. Two body truss rods were added, being located 24 in. either side of the center of car. The anchor straps of the two outside truss rods lap over both sets of body transoms. The end sills are composite, the outer member being 3 in. x 8 in. oak, the inner member 4¼ in. x 8 in. oak, and the flitch plate ¾ in. x 8 in. The posts of the side frame are gained out ¾ in. on their outside edges for the sheathing.

The interior finish of the parlor end of the car was left unchanged. An entire new golden oak finish was put in the dining room and kitchen. The only change in the smoking room was to replace two stationary seats with four additional movable chairs, making eight chairs in all. Two revolving chairs were added to the parlor, also a reclining sofa and four chairs, on opposite sides, which can be enclosed with curtains.

The old dining room could only seat eight persons satisfactorily, while in the new one 12 people can be served without crowding. The cars are mounted on the original six-wheel trucks, which were strengthened to carry the increased weight. The weight of the old car was 91,800 lbs., and of the rebuilt car 108,400 lbs. We are indebted to Mr. Charles Coller, Master Car Builder of the Monon, for the foregoing information.

### Programme of the M. C. B. Convention.

The Master Car Builders' Association will hold its 38th annual convention at Saratoga Springs, N. Y., June 22, 23 and 24. Headquarters will be at the Grand Union Hotel, and the meetings will be held in the ballroom, which has been remodeled to give it good acoustic properties. The following programme has been arranged:

OPENING MEETING.

First Session.

*Wednesday, June 22, 1904—10 a. m. to 1:30 p. m.*

| | |
|---|---|
| Opening exercises: Prayer, President's address. | 10.00 a. m. to 10.30 a. m. |
| Intermission | 10.30 a. m. to 10.35 a. m. |
| To allow visitors to retire should they wish to do so, although all are invited to remain. | |
| Reports of secretary and treasurer | 10.35 a. m. to 10.45 a. m. |
| Assessment and announcement of annual dues; appointment of committees on correspondence, resolutions, nominations, obituaries, etc. | 10.45 a. m. to 10.50 a. m. |
| Election of auditing committee | 10.50 a. m. to 10.55 a. m. |
| Unfinished business | 10.55 a. m. to 11.10 a. m. |
| New business | 11.10 a. m. to 11.40 a. m. |
| Discussion of reports: Standards and recommended practice | 11.40 a. m. to 12.00 m. |
| Triple valve tests | 12.00 m. to 12.30 p. m. |
| Brake shoe tests | 12.30 p. m. to 12.40 p. m. |
| Tests of M. C. B. couplers | 12.40 p. m. to 1.30 p. m. |
| Adjournment. | |

Second Session.

*Wednesday, June 22, 1904—7:30 p. m. to 9:30 p. m.*

| | |
|---|---|
| Topical discussions: 1. What are the advantages or disadvantages of 2-in. main steam pipe with 1¾-in. steam hose. To be opened by Mr. J. J. Hennessey | 7.30 p. m. to 7.50 p. m. |
| 2. Advisability of the Master Car Builders' Assn. adopting standard contour lines for steam hose couplings with a view of having same interchangeable, upon the same principle as the M. C. B. coupler contour lines. To be opened by Mr. T. W. Demarest. | 7.50 p. m. to 8.10 p. m. |
| 3. To what extent does friction draft gear reduce repairs, expenses, etc. To be opened by Mr. E. B. Gilbert. | 8.10 p. m. to 8.30 p. m. |
| Discussion of reports: Standard location of third rail for electrical operation | 8.30 p. m. to 8.50 p. m. |
| Stenciling cars | 8.50 p. m. to 9.10 p. m. |
| Coupling chains | 9.10 p. m. to 9.30 p. m. |
| Adjournment. | |

MIDDLE MEETING.

First Session.

*Thursday, June 23, 1904—9 a. m. to 1:30 p. m.*

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|---|---|
| Discussion of reports: Draft gear | 9.00 a. m. to 9.20 a. m. |

| | | | |
|---|---|---|---|
| Stake pockets | 9.20 a. m. | to | 9.40 a. m. |
| Best preventive of rust on steel cars | 9.40 a. m. | to | 10.00 a. m. |
| Rules of interchange, including report of arbitration committee and committee on prices for repairs of steel cars | 10.00 a. m. | to | 11.30 a. m. |
| Outside dimensions of box cars | 11.30 a. m. | to | 12.00 m. |
| The use of steel in passenger car construction (An individual paper by Mr. Wm. Forsyth) | 12.00 m. | to | 1.00 p. m. |
| Cast iron wheels | 1.00 p. m. | to | 1.30 p. m. |

Adjournment.

Second Session.

*Thursday, June 23, 1904—3:00 p. m. to 5:00 p. m.*

| | | | |
|---|---|---|---|
| Topical Discussion: | | | |
| 1. To what extent will a more rigid inspection of car couplers at terminal points reduce accidents and repairs. To be opened by Mr. James Macbeth | 3.00 p. m. | to | 3.25 p. m. |
| 2. The advantages and disadvantages of the different varieties of side bearings now in use. To be opened by Mr. L. H. Turner | 3.25 p. m. | to | 3.50 p. m. |
| 3. Cannot the present method of securing spring pockets to couplers for freight cars be improved upon? To be opened by Mr. J. S. Lentz | 3.50 p. m. | to | 4.15 p. m. |
| 4. Brake-beams. The proper hanging of brake-beams to secure brake shoe clearance. To be opened by Mr. W. E. Fowler | 4.15 p. m. | to | 4.40 p. m. |
| 5. Stronger draft gear for passenger cars. Wherein should present practice be modified? To be opened by Mr. H. LaRue | 4.40 p. m. | to | 5.00 p. m. |

Adjournment.

CLOSING SESSION.

*Friday, June 24, 1904—9:00 a. m. to 1:30 p. m.*

| | | | |
|---|---|---|---|
| Discussion of reports on: | | | |
| Air brake hose | 9.00 a. m. | to | 9.30 p. m. |
| Rules for loading long materials | 9.30 a. m. | to | 10.30 a. m. |
| Steam and air line connections | 10.30 a. m. | to | 11.00 a. m. |
| Tank cars | 11.00 a. m. | to | 11.30 a. m. |
| Conference with Interstate Commerce Commission | 11.30 a. m. | to | 11.40 a. m. |
| Subjects | 11.40 a. m. | to | 12.00 m. |
| Unfinished business: | | | |
| Reports of committees on correspondence, resolutions, etc. | 12.00 m. | to | 1.00 p. m. |
| Election of officers | 1.00 p. m. | to | 1.30 p. m. |

Adjournment.

## Railroad Shop Tools.

High-speed tool steel has been chiefly responsible for the important changes which have been made in the design of machine tools. By its use, both the depth of cut and the speed have been greatly increased. Machine tools which were designed 10 years ago and even five years ago are seldom strong enough to pull the heavy cuts possible with the new tool steel. In some cases, the weak point in the machine is the belt, while in other instances the gears, or tool post, etc., are the weak points.

Lack of belt power has been overcome by the use of electric motors which also offer a ready means for varying the speed of the machine without shifting belts. Cast-iron gears are now seldom used, their place being taken by cast, wrought and semi-steel cut gears. Tool posts, head stocks, beds, etc., have also been strengthened. In many cases, however, the extra weight has not been put where it will do the most good. In other words, many so-called "modern" tools are but the old style tools on a large scale.

Owing to the introduction of high speed steel and the more rigid construction of machine tools, it has been possible to greatly decrease the cost of doing certain classes of work in railroad shops, but the actual saving has not been so marked in railroad shops as in manufacturing shops. This is due to the fact that the size of the parts of locomotives and cars has kept pace with these advances in shop methods. That is to say, it requires proportionately more time to turn out a modern driving axle 10 in. in diameter by improved methods than it did ten years ago to turn out a 6 or 7 in. axle with the old tools. The cost and speed of removing one pound of metal is now much less, but a greater number of pounds must be removed from the same part than was hitherto necessary.

The machine tool art is still in a state of transition, but a description of the present state of the art will no doubt be interesting. The following descriptions are the beginning of a series of articles which are to appear giving examples of the machines used in all departments of railroad shops.

### AXLE LATHES.

The double cutting off and centering machine shown in Fig. 1 is used for cutting off and centering axles and shafts of any diameter up to 12 in. The axles are held in place by two self-centering chuck jaws. The heads are adjustable along the bed. The heads are driven by a large cone of three changes of cross feed operating simultaneously or separately, as desired. Centering heads when furnished, have revolving spindles driven from a separate countershaft, and may be moved quickly in or out of position by means of convenient levers. To facilitate the handling of work the machine is furnished with the adjustable rollers, shown in the half tone. The countershaft for driving main heads has pulleys 20 in. in diameter for a 6-in. belt, with two speeds 250 and 350 revolutions per minute. The countershaft for driving the centering heads has pulleys 12 in. in diameter for a 5-in. belt, and makes 150 revolutions per minute. This machine is equipped with motor drive when so desired.

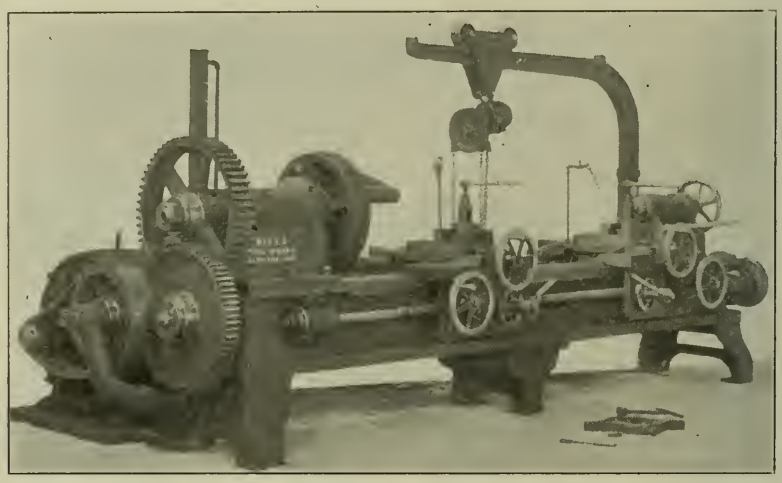


Fig 2—Niles-Bement-Pond Single Axle Lathe.

Fig. 2 shows the Niles-Bement-Pond extra heavy single axle lathe. This machine is driven by a direct connected No. 5 20 h.p. Westinghouse motor, through a Morse silent chain. The motor has a speed variation from 375 to 1,500 r.p.m. This lathe was designed for turning the heaviest locomotive axles. The swing over carriage is 12 in. and the maximum distance between centers is 8 ft. The axle is driven from the end of a double equalizing driver plate. The carriages have three changes of feed by a heavy lead screw, and positive gearing. Both carriages have opening nuts, quick hand movements and hand cross feed. The lathe is also provided with formers on the back, so that any desired contour to the axle can be secured.

An exceptionally powerful machine built by the Niles-Bement-Pond Company is shown by Fig. 3. This machine is known as the Niles No. 3 extra heavy double axle lathe. It is driven by a 20 h.p. motor having a speed variation of 2 to 1. This is a particularly rigid machine designed for use with modern high-power tool steel. The main gear is placed in the middle of the bed and carries on its face an equalizing driver-plate, which takes hold of both ends of the double axle driving dog. This allows an irregular

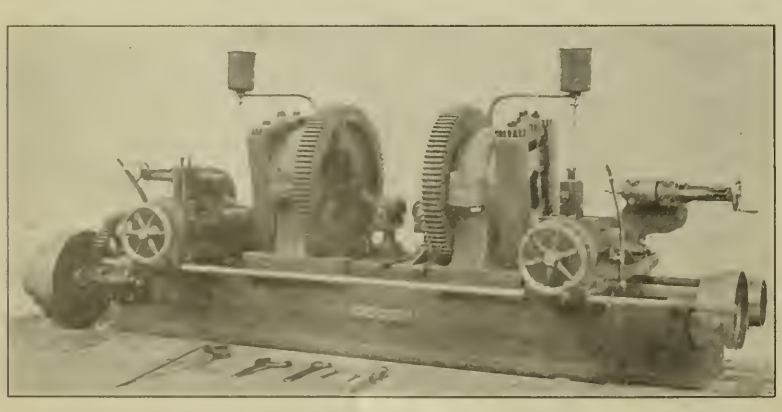


Fig. 1—Niles-Bement-Pond Cutting-Off and Centering Machines.

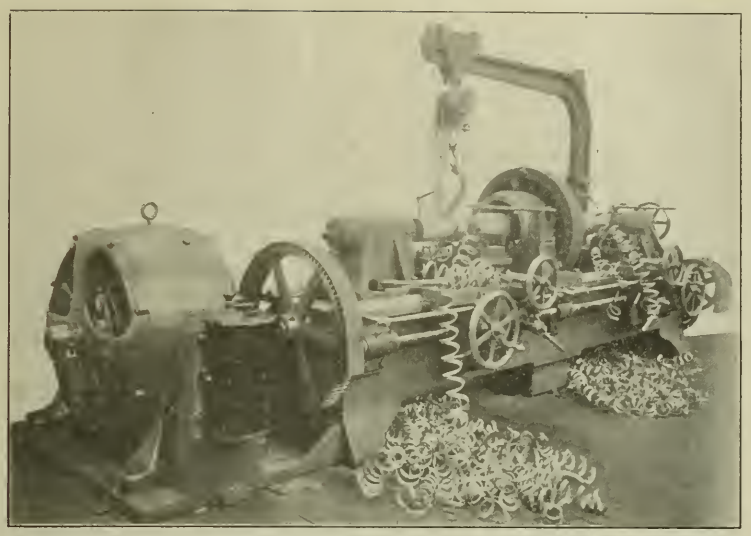


Fig. 3—Niles-Bement-Pond No. 3 Double Axle Lathe.

or crooked forging to revolve without setting up bending-strains. The axle is held on dead centers, both tail-stocks being adjustable and one having a sliding-spindle and hand-wheel.

There are two carriages having power-feeds by a right and a left-hand lead-screw positively driven by gearing. Lead-screw nuts, with an instantaneous automatic opening device, are placed in both carriages and released by set-collars on the rod in front. Quick movement and cross-feeds are made by hand. Lubrication of tools is provided for by a pump, jet pipes, reservoir, and collecting channels. A crane for lifting the axles in and out is placed on the bed. This crane has a convenient gripping and hoisting outfit, and is easily handled by one man. The opening in the center is 12½ in. in diameter, and the distance between centers is 8 ft. When it is desired to drive this machine by belt, a 30 in. diameter cone with three steps for a 5 in. belt is provided.

The Niles-Bement-Pond No. 6 extra heavy convertible center and end-drive axle lathe is shown in Figs. 4 and 5. When running at its full capacity it requires 60 h.p. to drive it. The driving pulley is 42 in. in diameter for a 10-in. belt, and it is driven either directly from a variable speed motor or by a two-speed countershaft. The tool posts and the carriages are of massive construction. Both the tailstock and the sliding-head are furnished with reinforcing pawls for taking the end thrust. The bed is 37 in. wide, 28 in. deep, and 15 ft. long, and is of box section, resting on a foundation its entire length. The driver, which is double and self-adjusting, has an opening 12 in. in diameter and may be placed in the center of the bed (Fig. 4), when turning both ends of an axle at the same time, or at one end (Fig. 5) when it is desired to turn the center of the axle. Carriages have power longitudinal feed variable from $^1/_{80}$ to ¼ of an inch through friction disks. The feed can be instantly changed from either carriage. The weight of this machine is 40,000 lbs.

*(To be continued.)*

## Fuel Economy.

BY GEORGE M. CARPENTER.*

It is a well-known and self-evident fact that the fuel account on all railroads is by far the largest single item of expense, and for this reason economy in its use is being practiced on all well-managed roads. Managements grasp at anything which might in their opinion lead to a less consumption of fuel, or, in fact, whereby they can make a better showing in any of their respective departments. Looking back only a few years at the cost to operate for a given period any department and comparing those results with what is now being obtained, we may feel inclined to ask why we should not be satisfied, and congratulate ourselves on our economical showing. What has brought about this higher degree of economy? Is it not simply the work of brains combined with a higher standard of education in general? If such is the case, since economical results are being obtained in other branches of the mechanical department, and we attribute these results to a more advanced stage of mechanical education, why cannot the same be applied to the saving of fuel?

To-day there is probably no practice of railroading where economy is more sought after, and the conditions which surround the situation so complicated, as in the use of coal. Much has been written and many devices and suggestions have been offered, the most of which has proven of but little or no value. Often that which is written is from a theoretical standpoint, and even though it be understood, the conditions involved may be such as to prevent the ideas being put into practice; therefore while the principles involved may be correct, they are valueless except as theories.

"Fuel economizers" have been offered and tried, only to be found impractical, for one reason or another, so that to-day in locomotive practice the mechanical world has faint hope of obtaining fuel economy through the use of mechanical devices. Suggestions meet us on every hand, and while we often perceive in them valuable points and put them into practice, expecting satisfactory results to follow, the usual result is an increase of engine failures, delayed trains, increased correspondence, and everybody asking "what's the matter?" So we again find ourselves back in the same rut as before, with engines steaming as well as formerly, delays no longer occurring, correspondence reduced to its normal proportion, and we acknowledge that all we have gained is the experience of having tried the other fellow's suggestions. Therefore, although these suggestions may be worthy of recognition, such experiences teach that they cannot be accepted unconditionally, consequently each road should have "thinkers" of its own to study closely the conditions peculiar to its own system, and they should work to that end and that alone.

The old adage tells us that if we wish to save money, we must first learn the value of a dollar. This same idea might be applied to the saving of coal; first learn what coal is and the laws which govern its burning, and thus learn its value. To-day fully 90 per cent. of our enginemen have absolutely no knowledge as to what coal is, what it contains or what is required to burn it successfully or economically. Where these conditions prevail, economy in the use of coal could hardly be expected. Enginemen are required to be proficient in their knowledge of every part of the locomotive and its

*Fuel Inspector, Nashville, Chattanooga & St. Louis R. R.

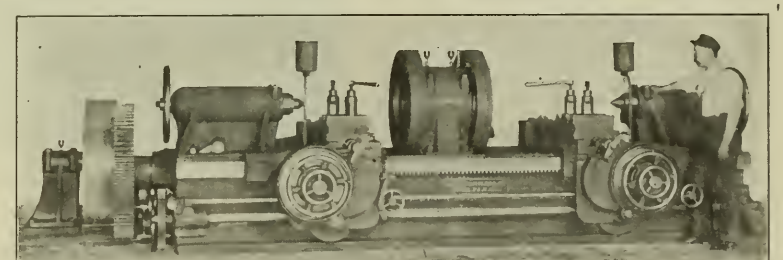


*Fig. 4.—Center Driven.*

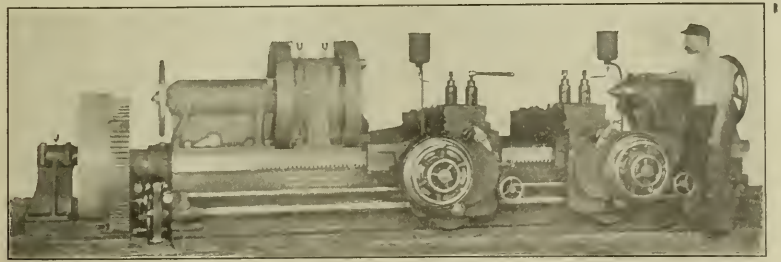


*Fig. 5.—End Driven.*

Figs. 4 and 5—Niles-Bement-Pond Convertible-Drive Axle Lathe.

attachments, and many of them are continually seeking to broaden their knowledge of their vocation, requiring time and study. Why should not some of this time be devoted to acquiring a more thorough knowledge of coal, and the laws which govern its combustion? It is daily being demonstrated on several of our larger railroads which have recently adopted the "education-in-coal" system among their enginemen, that great economy is being shown, and the approval of education along these lines is fast meeting with favor among many of our broad minded railroad managers and is considered by them as the most important step to be taken in fuel economy.

Railroads will find it to their advantage to have in their employ some one who is not only a practical engineman and fireman, but who has at some time made a study of coal, from its natural bed to the fire-box, all from a practical standpoint. He should visit as often as practicable the various collieries from which the coal is obtained and if necessary install inspectors who are familiar with coal and its preparation to oversee personally the loading of every car intended for his company, and to see that it is as free as possible from the many impurities and foreign matter which are too often the cause of engine failures and delays; also to see that the grade of coal is kept to a standard in accordance with contract. He should, furthermore, be capable of instructing enginemen as to what coal is and the conditions which should prevail in order to obtain the best possible results from its combustion. This requires no high degree of education and can be easily acquired by anyone possessing ordinary intelligence and devoting a little time to study. The duties above outlined do not by any means cover the requirements; still they are stepping stones to fuel economy. A clean uniform grade of coal, it matters not whether it be of the highest or of the medium grades, combined with a knowledge of what it is and the requirements to burn it properly, are bound to show a certain degree of economy.

It is an erroneous idea that the engine crew alone are responsible for the excessive amount of fuel consumed, or that they can attain to a high degree of saving without the concerted effort and support of the executive as well as the transportation and mechanical departments. Also, enginemen and firemen should be equally well informed on the subject and should work in harmony with each other, for with the fireman doing his utmost to save fuel and the engineman entirely indifferent as to the way the engine is run, the latter can, through his indifference, waste in five miles all that the fireman might have saved in 20; therefore the importance of both working to the same end.

The duties of the traveling engineer and traveling fireman enter largely into the saving of fuel. They should obtain all information possible pertaining to the fuel used and study well its requirements, meantime making it a point to see that each engineman is striving to do his part by following any and all instructions given him along these lines. They should also study well the drafting of the engines in their respective classes (a feature too often neglected) and endeavor to have the draft adjusted to give the best possible results with the grade of coal furnished. As bituminous coal from various collieries varies in its general make-up, much better results can be obtained as a whole by separating as far as practicable the different coals, and drafting the engines in accordance with the particular coal used on the different divisions of the system.

Blows in the cylinders and valves and other leaks all cause a waste of fuel; and under any and all circumstances pop valves should be released as little as possible, as about 1 lb. of fuel is wasted for every 15 seconds the ordinary pop valve remains open. The efforts of master mechanics and roundhouse foremen should constantly be directed to repairing the leaks and blows which mean a waste of fuel and thus contribute their part toward the saving.

The transportation department may contribute very largely to the saving of fuel, for while ambitious to move at the smallest possible expense the largest number of cars, they must recognize the fact that each engine can do about so much and no more. To overload an engine, compelling it to double hills; stalling and slipping and lying on side tracks on accounts of being unable to make meeting points, all takes coal; therefore the co-operation of this department is needed if the best results are to be obtained. A railroad well known to the writer began some ten months ago to practice fuel economy from a common-sense standpoint. The general manager having realized that, in order to do this his personal efforts must be put forth, he at once impressed the heads of the respective departments with his intention and placed a competent man at the head of the "Fuel Saving Department." Imagine his surprise when on the first of the present month (June) he was informed that through the concerted efforts of all, a saving of over $70,000 had thus far been made; and in the same proportion at the end of the year a saving of over $100,000 would be shown as compared with the fuel expense for the preceding year; all of which is attributed to giving the coal situation the same attention as would be deemed necessary to give any other department where economical results are expected.

### The Grease Plant of the Chicago & North Western.

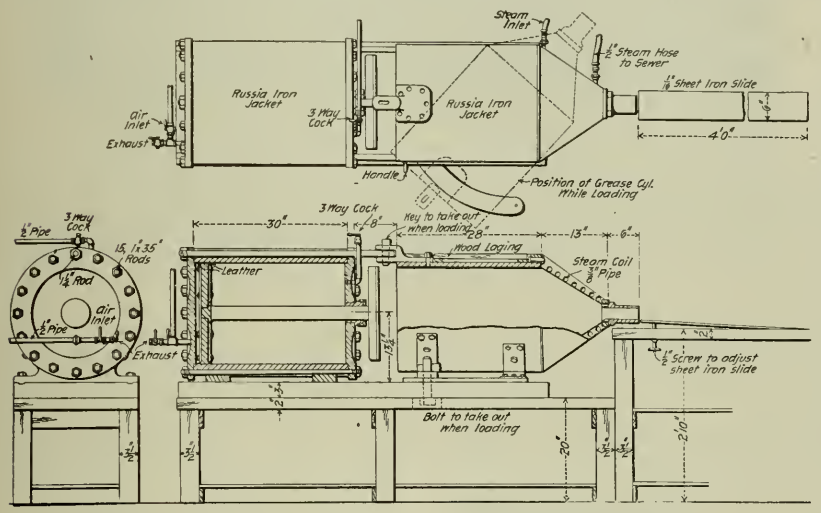
The accompanying illustrations show the plant used for making rod-cup grease at the Clinton shops of the Chicago & North-Western, at which place all rod-cup grease used on the system is made and pressed into stick form so as to be placed in the rod-cups without loss. When rod-cup grease was first used on this road, it was made in bulk and the enginemen got it from the storehouse in varying sizes and shapes. This practice not only resulted in considerable waste, but the grease was not in good shape to be used, thus taking considerable time to fill the cups. To overcome this wastefulness and to facilitate filling of cups a press was built to be operated by air. The press is made of two cylinder bushings, one 19½ in. and the other 18 in. in diameter.

Grease Plant of the Chicago & North Western.

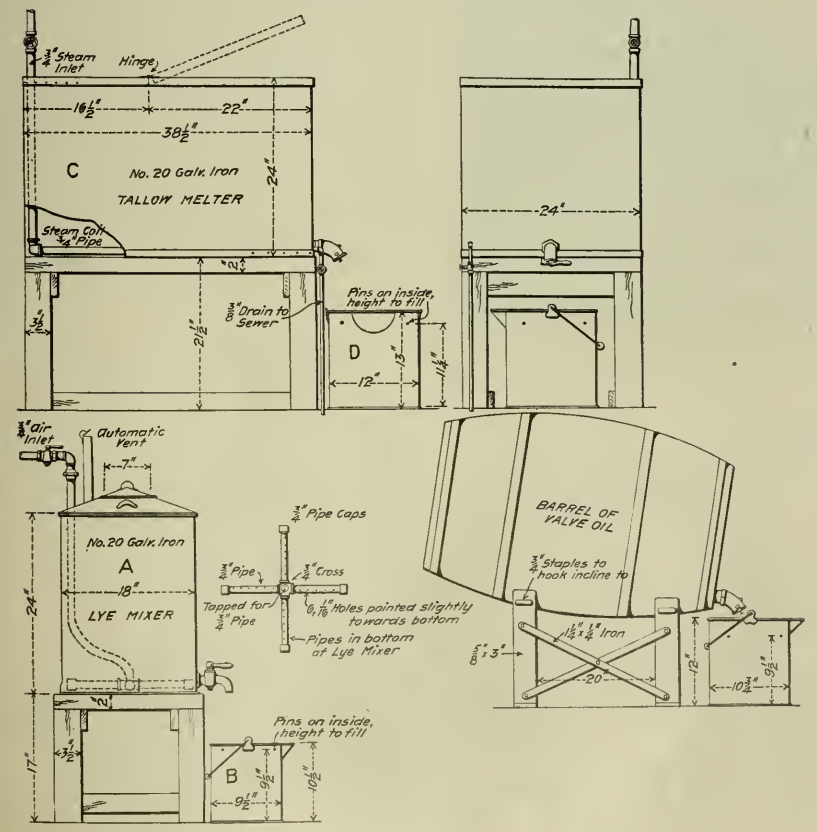
Grease Plant of the Chicago & North Western, Showing Compressor Cylinder Open.

The grease is made in the following manner: Caustic soda in pulverized form is mixed with water, tallow and valve oil according to a fixed formula. The caustic soda is dissolved in water the day before it is needed, so that it will be cold before being used. This caustic soda is placed in the 60-gallon air mixer "A," where it can be kept in continual motion until it is dissolved. The air mixer has a faucet in the bottom so that the fluid can be drawn into a bucket "B," which is gaged to the correct amounts required. The next day the rod grease is

made. An iron tank, "C," holds two barrels of tallow. This tank has a steam coil in the bottom, by means of which the tallow is brought to 120 deg. F., after which the tallow is run in liquid form into a bucket, "D," which is gaged to the formula requirements. Valve oil is then drawn from barrels and the tallow and valve oil are each placed in tapered cans, "E," of 168 lbs. capacity. After thoroughly stirring the tallow and oil together, the caustic soda is added and thoroughly stirred for a short time, after which the grease is allowed to stand for 48 hours. These cans are tapered so that by turning them over the rod grease will readily leave the can. After the grease has stood for 48 hours, it is placed in the rod grease press and pressed into stick form of two sizes, to fit the different kinds of cups on engines. The sticks are cut off 9 in. long, and when the grease is put in cups it can be cut to any length. The contents of one of the large cans, or 168 lbs., is placed in the press, the grease end of the machine revolving on a pivot. The press is then turned around in a direct line with the air piston and the pressure is applied. From 100 to 130 lbs. air pressure is required to operate the press. One end of the grease cylinder is conical, with a detachable nozzle. The conical portion of the cylinder is encircled with a steam coil, so that the grease will flow smoothly through the nozzle and come out in compact stick form.




Compressor Cylinders—Chicago & North Western Grease Plant.




Accessories at the Grease Plant of the Chicago & North Western.

The capacity of this plant is about 2,640 lbs. in 10 hours. One man operates the machine and cuts the sticks, and another places the sticks on shelves, where they lay for five days before packing into boxes for shipment. The air pump in connection with the press is used when the air pressure falls below that required to run the press. This rod-cup grease is made and pressed under the supervision of the foreman of the paint shop, and this work is done with practically no extra cost to the company, because the work is done when the paint force is not busy.

We are indebted to F. G. Benjamin, Master Mechanic, for the above description.

## Some Old High-Speed Engines.

BY HERBERT T. WALKER.

The locomotive engine is an offshoot of the stationary engine, for while it is a goodly branch, exceeding in historical interest, perfection of development, and far-reaching influence that of the parent tree, the reader hardly needs to be told that the designs of Trevithick, Hedley and Stephenson were evolved long after James Watt had perfected his steam engine. As it takes time to overcome the inertia of established ideas, we find that when the locomotive men came into the field, they were naturally influenced by stationary engine traditions and practice, even against their imperfect knowledge of the changed conditions under which their engines would have to work; for Watt's beam engine of low pressure and slow speed used chiefly for pumping water, was the only practical steam engine up to that time, and it was not to be expected that the early locomotive designers could strike out on original lines.

We thus see how it was that the primitive locomotives were distinctly of the fixed engine type; upright cylinders and working beams, with a low piston speed being (with the exception of Trevithick's designs) the general arrangement. These ideas were even applied to the track, for the rails were laid on stone sleepers after the manner of stationary engine foundations. With the exception of Trevithick, with his direct-acting, high-speed, high-pressure "puffers," it is interesting to note the small progress made by his successors, and how much the influence of the coal mine practice impressed itself on their locomotives; for, like Trevithick, both Hedley and Stephenson were brought up within sound of the slow, mournful throb and wheeze of the deep mine pumping engines.

Another hindrance to the introduction of the high-speed non-condensing engine was the personal influence of Watt himself; for, although he described a steam carriage in his patent specification of 1784, he took no steps to develop it, the origin of his want of interest in this form of the steam engine being, doubtless, his rooted prejudice against high pressure steam and high piston speed, for the miserable boilers of his time were useless for pressures over 5 or 6 lbs. per in. Although he proposed, as far back as 1765-66, a direct-acting pumping engine, he preferred to develop the engine with a ponderous working beam which, for obvious reasons, was dangerous to run at anything like high speed. When Trevithick introduced his cylindrical boilers and pressures of 150 lbs. per sq. in., Watt went so far as to say that the Cornish mine "captain" deserved hanging for bringing into use the high pressure engine. The great Scotch engineer, however, suffered from dyspepsia and intense headaches, and sometimes said things he was sorry for afterwards; and, while we would not for a moment cast a shadow of

depreciation on the illustrious name of Watt—for, as a French engineer with characteristic enthusiasm said, "The part which he played in the mechanical application of the force of steam can only be compared to that of Newton in astronomy and of Shakespeare in poetry,"* still we incline to agree with Zerah Colburn, who declared that "No man did more to retard the introduction of the locomotive engine than James Watt."

Soon after the advent of Stephenson's "Rocket," it began to be recognized that trains would have to travel faster than 30 miles an hour, for, as Brunel put it, "Speed within reasonable limits is a material ingredient in perfection in traveling;" but engineers appeared to think that the only way to increase the speed capacity of the locomotive was to enlarge the diameter of the driving wheels, since it had long been laid down as a principle that the piston speed of locomotives should be kept as near as possible to the usual rate of Watt's engines, namely, 220 ft. per minute. Even Brunel with his great mind and far-seeing eye could not detach himself from this fixed idea, for when ordering the express engines for the Great Western he set a limit on the piston speed, which was one reason why the builders provided such large driving wheels that some of the engines were, for all practical purposes, useless.

*E. M. Bataille "Traité des machines à Vapeur." Paris, 1847-49.

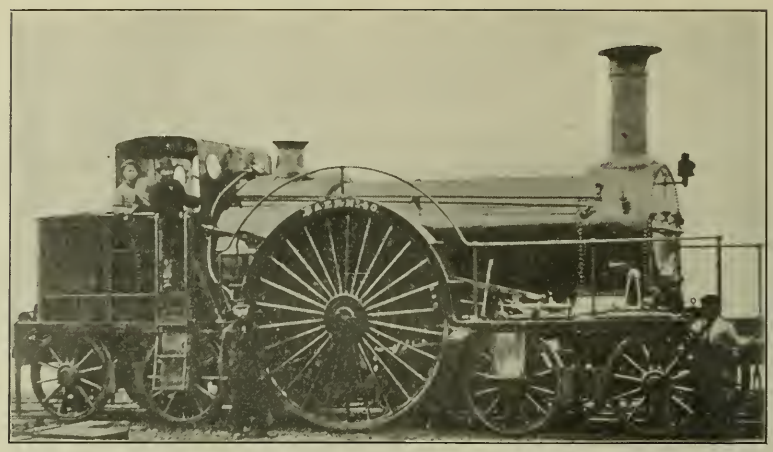


Fig. 3—Pearson's Engine, "No. 40," as Rebuilt in 1868-70.

With the foregoing remarks in mind, we will examine some English express engines which, for certain reasons, are of historical interest.

In the year 1847, James Pearson, locomotive superintendent of the Bristol & Exeter Ry. patented (British patent No. 11,885) a design of locomotive engine, which had a leading four-wheel truck, any desired number of driving wheels, and a four-wheel trailing truck; but about five years elapsed before he practically developed his ideas. The Bristol & Exeter had a track gage of 7 ft., as it joined the Great Western at Bristol, and was opened as far as Bridgwater in 1841; but it was not until 1844 that the line was completed to Exeter. It was on a portion of this railroad that Daniel Gooch made his celebrated series of experiments on train resistance in 1847.

Pearson was of a reserved disposition and kept interviewers at a distance, for which reason some inaccurate statements regarding his engines were circulated, his indifference to public opinion being such that he seldom took the trouble to reply to his critics or correct their errors. He was formerly engaged on the South Devon Ry (which was originally worked on Samuda's Atmospheric System) and was, doubtless, associated more or less with Brunel and Gooch, for his engine designs show the earmarks of the Great Western practice. Before the year 1853 his ideal express engine had taken tangible shape, and Rothwell & Co., of Bolton-le-Moors, received orders to build eight engines to his design for the Bristol & Exeter. Three of them (Nos. 39 to 41) were delivered in 1853, and the remaining five (Nos. 42 to 46) were completed in the following year. They were 10-wheel tank engines and

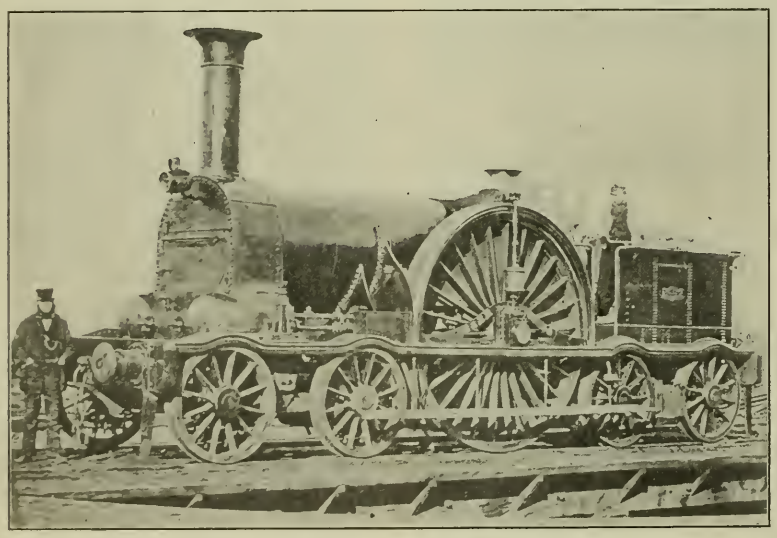


Fig. 2—Pearson's Engine, "No. 44," Bristol & Exeter, 1854.

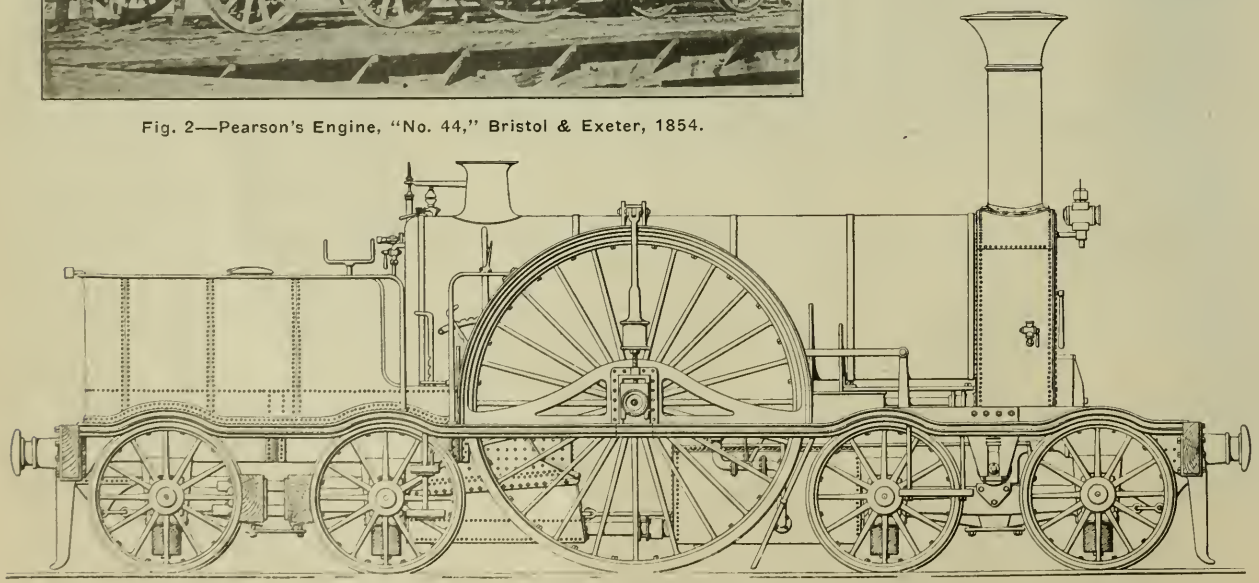


Fig. 1—Pearson's 4-2-4 Engine, "No. 40," Bristol & Exeter, 1853.

were all practically duplicates, a side elevation of No. 40 being shown in Fig. 1. The principal dimensions were: Cylinders, 16½ in. x 24 in.; driving wheels, 9 ft. diameter with treads (no flanges) 6 in. wide; truck wheels, 4 ft. diameter; boiler, 4 ft. 0½ in. diameter x 10 ft. 9 in. long; heating surface of tubes, 1,067.2 sq. ft. (the fire-box heating surface is not given, but the total heating surface did not probably exceed 1,150 sq. ft.); boiler pressure, 130 lbs. per sq. in.; weight in working order, 94,080 lbs. The adhesive weight is not known, but it was probably about one-third of the total weight, say, 31,360 lbs. From the above data, the tractive effort would be about 6,685 lbs. and the piston speed at 60 miles an hour would be 747.08 ft. per minute.

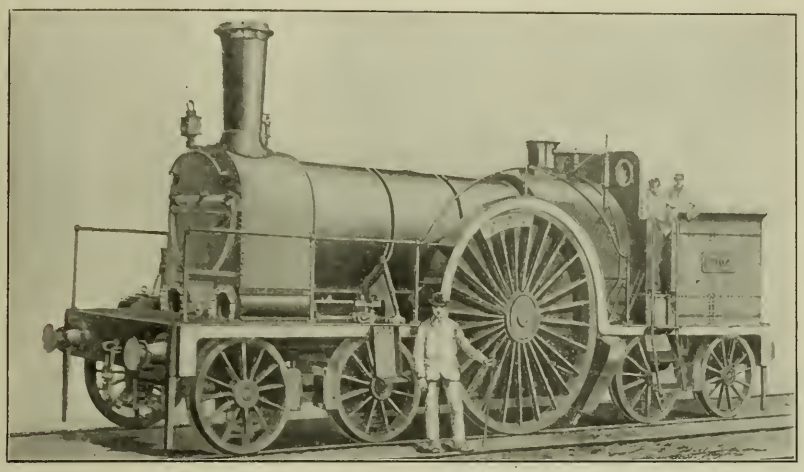


Fig. 4—Pearson's Engine, "No. 2002," as Overhauled by the Great Western, 1876.

At the period under notice, engines with 7-ft. driving wheels were common on the standard gage, and some of Crampton's engines had 8-ft. driving wheels. On the 7-ft. gage 8 ft. was the usual diameter for express engines. In 1838 engines with 10 ft. driving wheels were tried on the Great Western but never went beyond the experimental stage. In 1855 a four-coupled engine was built for the Western of France, having driving wheels of 9 ft. 4 in. diameter, but it was not a success. A side elevation of this engine will be found in Colburn's "Locomotive Engineering and Mechanism of Railways," and a photographic reproduction of the engine itself was published in the "Locomotive Magazine" (London), Vol. VI., page 204. When Gooch's engine "Great Western," with 8-ft. driving wheels attained a speed of 78 miles an hour in the year 1846,* Francis Trevithick, a son of Richard Trevithick, and division master mechanic of the London & North-Western, could not be satisfied until he had built a standard-gage engine, with larger driving wheels and higher speed capacity than any engine on the broad gage. His ideas were embodied in the engine "Cornwall" of 1847,† which had 8 ft. 6 in. driving wheels and attained a speed of 79 miles an hour, thus beating the "Great Western" by one mile an hour. Pearson, who was a broad gage champion, felt in duty bound to maintain the supremacy of the 7-ft. gage locomotives, and this was one reason why his engines under notice had driving wheels 9 ft. in diameter, being 6 in. greater than those of the "Cornwall." They were the largest ever practically used, and the speeds attained reached to within a fraction of 81 miles an hour, the highest speed recorded up to that time and for many years afterwards.

Some of the details of these engines are of interest. The main frames and driving boxes were inside, but there was an angle-iron extension, which formed the running board, and this supported a kind of bracket frame outside the driving wheel, and to this was fitted an axle box, so that each driving wheel had two journal boxes, one outside and the other inside the wheel. These journal boxes were connected by rods and springs to the two ends of a short equalizer which was pivoted to a heavy beam bolted transversely to the top of the boiler. The outside spring was a block or disk of india-rubber, enclosed in a polished brass casing, and that on the inside was a steel volute spring. Of course, only one end of the beam and one end of one of the equalizers appear in the drawing, but from a photograph of engine No. 44, reproduced in Fig. 2, the arrangement can be seen better. The bracket frame also supported the wheel guard and a large semi-circular disk plate, so that the main driving box with its steel volute spring and the boiler could not be seen behind the driving wheel. The truck wheels had india-rubber springs, which can be seen below the journal boxes (Fig. 1); but it was not long before they were removed and double elliptical plate springs substituted. From the drawing it would appear that the carrying wheels are rigid, but the bolsters are obscured by the main frame.

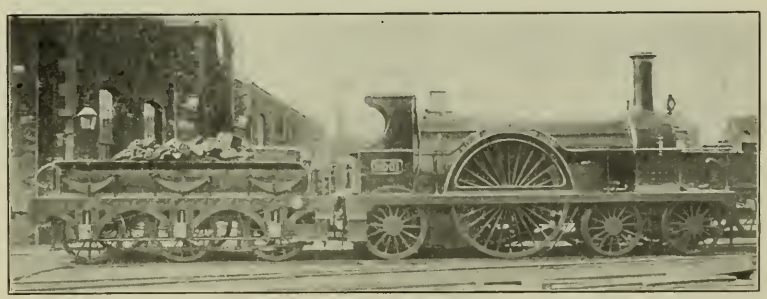


Fig. 5—Pearson's Engine, "No. 2001," as Rebuilt (with Tender), 1876.

There were three water tanks, one suspended to the frames below the boiler barrel, the next formed the floor of the ash pan, and the third was in the coal bunker. They were connected together by leveling pipes, one of which, with its expansion joint, appears in the drawing. The pumps were worked from the cross-heads, the suction being connected to the forward tank, the delivery checks entering the boiler behind the driving-wheel disk plates. As the engine was inside connected, it might appear from the drawing that the cranks would strike the boiler, but it must be remembered that this was a 7-ft. gage engine and there was ample room for the cranks to work between the boiler and driving wheels.

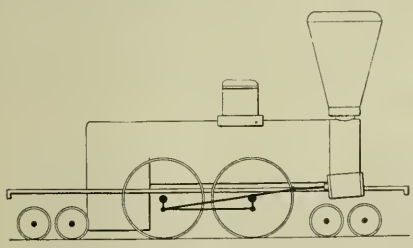


Fig. 6.

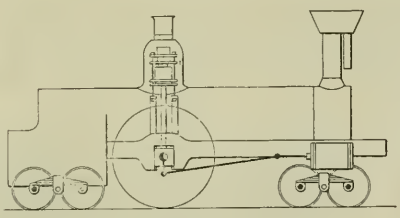


Fig. 7.

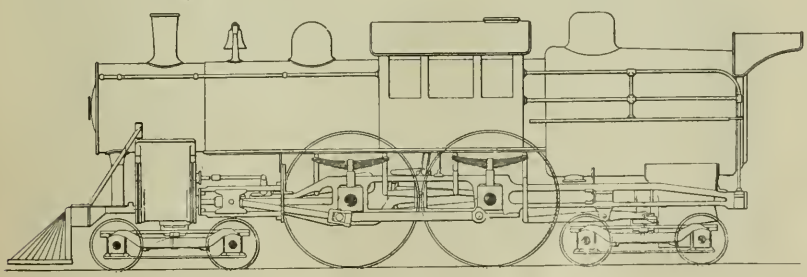


Fig. 8.

Engines with Leading and Trailing Trucks.

*See "Railroad Gazette," Vol. XXXV., page 736.
†See "Railroad Gazette," Vol. XXVI., page 208.

All published accounts of these engines agree in stating that they attained speeds at a rate of between 80 and 81 miles an hour, and Pearson himself affirmed that these speeds were made during official tests; also that for a mileage of 100,000 miles the average consumption of fuel (coke) was only 21¾ lbs. per train-mile. This record appears good, for we find that the grades of the Bristol & Exeter are by no means easy. The total length of the road is about 75 miles. Leaving Bristol there is a climb for five miles at the rate of 12 ft. to the mile and, after running down on the other side of the summit, there follow 35 miles of practicaly level grade to Taunton. Then comes the Wellington bank, the hardest 10 miles of the whole distance, grades of 30, 58⅔ and 66 ft. to the mile being encountered. From the summit to Exeter, a distance of 18 miles, the road falls about 300 ft. over undulating grades. The above figures are approximate only.

As no record of the weight of the trains hauled by these engines could be found, nor has any been published as far as the writer knows, he opened a correspondence with Mr. W. Babbage, Sr.; a veteran engine driver, who was born in 1835. Mr. Babbage saw hard service on the Bristol & Exeter, Great Western and Somerset & Dorset until 1898, and is now living in retirement in the county of Somerset. He joined the Bristol & Exeter road in 1853, and drove engine "No. 40." His account of these engines is somewhat disappointing, for he says that the recorded high speeds were made when running down grade and without a train. The average regular speed did not exceed 60 miles an hour on the level, but on the up-grades the engines wanted a lot of coaxing, and, with a greasy rail an assistant engine was required up the Wellington bank. The trains consisted of from four to six coaches, and, as these would not exceed 10 long tons apiece, the weight of the train was only about half as much more than that of the engine itself.

As the business of the railroad increased it was found that these engines could not keep time with the heavier trains, and in 1868-70 Pearson decided to rebuild some, if not all, of them. The cylinders were increased to 18 in. diameter, and the boiler and fire-box were enlarged, giving a total heating surface of 1,235 sq. ft. The bracket frames and journal boxes were removed, together with the transverse beam and equalizers, the driving wheels having inside bearings only. The ash pan tank was cut out and the leveling pipes continued back to the bunker tank. There were other minor changes and additions, and the engines, as rebuilt, weighed 111,428 lbs., of which 41,440 lbs. rested on the driving wheels. The engines then did good work on a consumption of coal of about 25 lbs. per engine mile and a low average cost of repairs. A photograph of engine "No. 40" in its altered state is reproduced in Fig. 3.

In 1876 the Bristol & Exeter and the Great Western were amalgamated, and four of these engines (it is presumed the other four went to the scrap heap) were overhauled and kept for express work. They were renumbered 2001 to 2004 and No. 2002 is shown in Fig. 4. It appears that the Bristol & Exeter allowed their track to fall into bad order some time before the amalgamation, so that when the Great Western took charge of the road they found that extensive renewals would be necessary, for the rails were of the bridge pattern, weighing about 68 lbs. per yard, laid on longitudinal sills 14 in. x 7 in., with transome 11 ft. apart, and the roadbed was poor. But, before anything could be done, the up-express, known as the "Flying Dutchman," met with an accident on July 27, 1876, when going at full speed through the Bourton cutting near Long Ashton. The engine, No. 2004, left the rails and after plowing up the track for some distance turned over and was a complete wreck. The engine driver and fireman were killed and many of the passengers seriously injured. This accident was attributed, by those who ought to have known better, to the large wheels and high center of gravity of the engine, but when the usual Government investigation was made, Captain Tyler reported that where the derailment occurred no less than six rail fastenings were loose, and the general condition of the track left no doubt as to the cause of the disaster.

Soon after the above events the three remaining engines were again rebuilt with 8-ft. driving wheels and a pair of trailing wheels in place of the rear trucks. The coal bunkers were cut off and 6-wheel tenders were added. Fig. 5 shows engine No. 2001 in this the final stage of Pearson's notable tank engines. They did good service until 1892, when the 7-ft. gage was abolished.

These engines were the culmination of the large driving wheel theory in England, and, although American engineers did not keep clear of this fallacy, wheels of excessive height were short lived in the United States, and our designers were among the first, if not the first, to introduce fast engines with small driving wheels and high tractive effort, recognizing the desirability of large steam ports with a quick acting valve and a free exhaust.

Nearly all the interesting features of Pearson's engines are now obsolete and will never be revived; there is, however, one part of the design that might be worth repeating, namely, the forward and rear trucks; for engineers who have traveled on these locomotives agree in saying that they were really delightful to ride on, being remarkably steady even at the highest speeds, and, in fact, the enginemen used to say that the faster they went the easier they seemed to ride. They rounded curves with ease and were light on the track as the weight distribution gave about four tons to each wheel. American practice is not without examples of this wheel arrangement, for in Clark & Colburn's "Recent Practice in the Locomotive Engine," 1860, an outline of a double-truck engine built in 1847 at Springfield, Mass., is given and a copy is presented in Fig. 6, while Fig. 7 represents an engine built by Ross Winans in 1849 (some authorities say 1843). This was the "Carroll of Carrollton" and was operated on the Boston & Worcester Railroad. It had 7 ft. driving wheels, and steam cylinders were mounted on the dome, the pistons being made to press down upon the driving boxes, so that the adhesion might be varied between three tons and 12 tons when necessary.

Of late years locomotives with a pair of trailing wheels have come into use, and for express work the Atlantic or 4-4-2 type of engine has been found satisfactory; but in some cases with a heavy fire-box the single pair of trailing wheels carries more weight than the leading truck, so that on entering a curve the front end of the engine, carried on the four-wheeled truck, readily conforms to the new direction, but the heavy sluggish rear end on a single pair of wheels does so in a lesser degree, and, consequently, at high speeds some severe lateral and vertical movements take place, and the disturbing effect on the track is great, even to the bending of the rails. Enginemen have also complained of the rough riding of some of these engines.

It thus appears that with the ever increasing size of fire-box, a better wheel distribution than that afforded by a single trailing axle would be desirable, and Mr. S. M. Vauclain has recently patented a design of engine with this object in view, an outline being shown in Fig. 8. As all the wheels back of the forward truck are equalized it should make an easy riding engine, and it is probable that a locomotive of the 4-4-4 type will be with us at no distant date. As is well known, a German engine with this wheel arrangement has been built and tested on the Berlin-Zossen high speed line.

The half-tone illustrations accompanying this article have been reproduced from photographs by the courtesy of the Locomotive Publishing Company, London.

## Baldwin Electric Trucks.

The conditions which must be met in electric street or interurban railroad operation are in many ways much more severe than those existing on steam roads, and the mechanical problems involved in designing a satisfactory truck for such service are complicated and difficult. As a rule the track is not up to the standard of steam railroads, while the speeds are nearly if not quite as high. The car bodies are lighter, and to prevent excessive vibration and rocking, a sensitive, equalized spring arrangement is necessary. To round the sharp curves on city streets, a short wheel base must be used, and every member of the truck frame must be strong and rigid enough to resist the stress imposed by applying the motive power directly on the axle. The dead load of the motor suspended on the truck with-

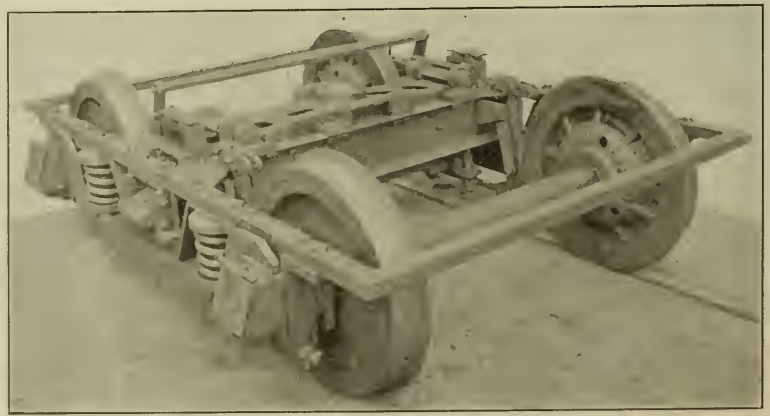


Fig. 1—High-Speed Truck for the Illinois Central Traction Company.

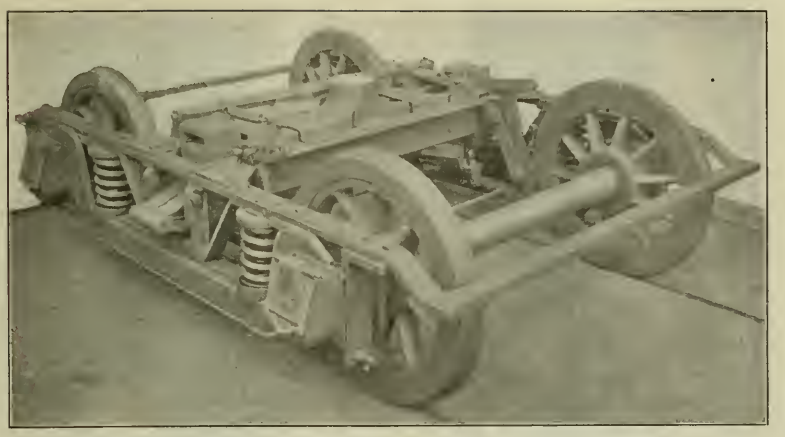


Fig. 2—Truck for the Twin City Rapid Transit Company.

out the interposition of springs to absorb the shocks produced at high speed, imposes another condition to be met. Added to these is the difficult problem of providing space for two motors of as much as 200 h. p. each, within the limits imposed by a gage of 4 ft. 8½ in., and a wheel base rarely exceeding 6 ft. 8 in. The earlier forms of electric trucks were adapted from the running gear used under horse cars, but nearly all of the recent designs of high-speed trucks are patterned after steam railroad four-wheel passenger trucks in the arrangement of springs and equalizers, although some few have adopted pedestal springs without equalizer bars. In the *Railroad Gazette*, June 19, 1903, p. 432, a number of types of electric trucks were illustrated and described, which represented the latest developments in this branch of car building. Among them were two designs of the Baldwin Locomotive Works. Since that time this company has designed and built four new types of trucks which differ in many of the details of construction from those shown last year.

The truck shown in Fig. 1 was built for the Illinois Central Traction Company, to be mounted under a high-speed interurban car. It is designed to carry 26,250 lbs. on the center plate, and weighs, without motors, 11,000 lbs. Two General Electric, 73 C motors are mounted on it. The spring suspension is the usual arrangement with a double elliptic spring 30-in. long under each end of the bolster, and double coil equalizer springs 7¼ in. in diameter. The truck frame is wrought iron throughout, the top member of the side frames and the end frame being a one-piece forging of 2 in. x 3 in. bar iron. This insures that the side frames will remain parallel at all times. The transoms are 10-in. channels, and are rigidly fastened to the side frames by gusset plates over the top, and by cutting away the top flange, running the web through the arch-bar side frame, and bolting it to the columns. The pedestal jaws are wrought iron, bolted to the top bar of the side frame. The chief difference between this truck and a standard passenger car truck for a steam road is the absence of any cross bracing under the transoms between the tie-bars, and the substitution of a 3-in. x 1-in. wrought iron bar for the usual channel or timber spring planks under the bolster. The bolster springs rest on wrought iron bars supported by the hangers, which are carried up inside the transoms, and these are tied together by the light bar used for a spring plank. A cast steel bolster is used and double equalizer bars. The wheels are 33-in. steel tired, and the axles are 5½-in. in diameter in the center, with journals 4¼ in. x 8 in.

The truck built for the Twin City Rapid Transit Co., and shown in Fig. 2, is a much lighter truck than Fig. 1, although of the same general design. It weighs 6,300 lbs., and is designed to carry only 18,000 lbs. on the center plate. Instead of the 10-in. channel transoms, 3½ in. x 7 in. angle iron has been used, and correspondingly lighter construction has been used throughout.

In Fig. 3 is shown a light truck for street railroad service, which has a peculiar spring arrangement and equalizing system. The equalizer springs are in this case placed outside the boxes and the equalizer bars pass under the boxes, being hung from yokes which pass up over the top of the boxes in front and back of the pedestal. The wheel base of this truck is only 4 ft., which necessitated some such arrangement in order to retain the advantage of a long equalized spring base, which prevents any serious tilting of the truck when the brakes are applied. The top member of the side frame is a shallow diamond arch-bar, to which the 6-in. channel transoms are rigidly connected with gusset plates and by bolts through the column and the web of the channel. Cast steel pedestals of a peculiar form are used. The top forms a bearing for the side frame, and is extended out beyond the jaws, and dropped down at the end, forming with a leg cast on the lower end of the jaw, a triangular space in which the equalizer springs are set. The spring caps are cast on the pedestals, and the 3¾-in. x 3¾-in. angles which form the end pieces of the frame are bolted on the projecting ends. This truck weighs 5,300 lbs., and is designed for a load on the center plate of 14,000 lbs. The brakes are outside hung on account of the short wheel base.

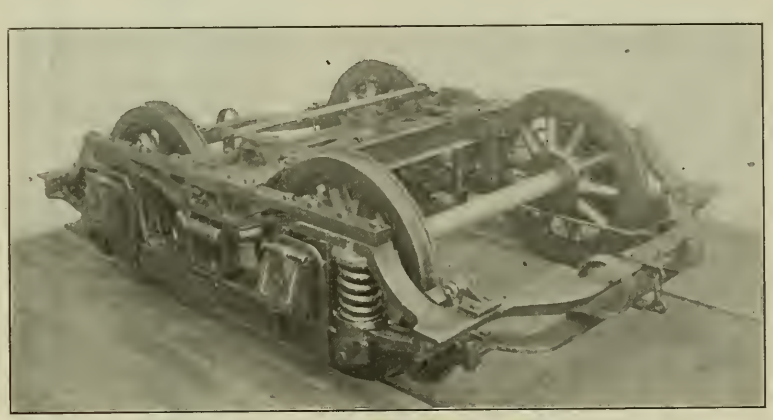


Fig. 3—Truck for Street Railroad Service.

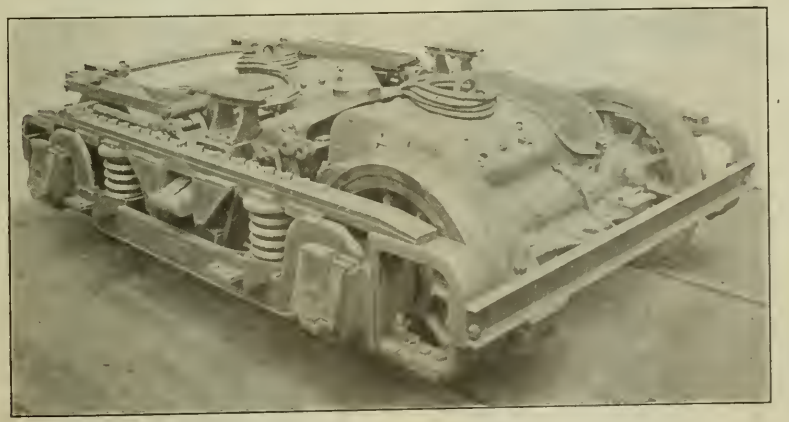


Fig. 4—Truck for the Interborough Rapid Transit Company, New York.

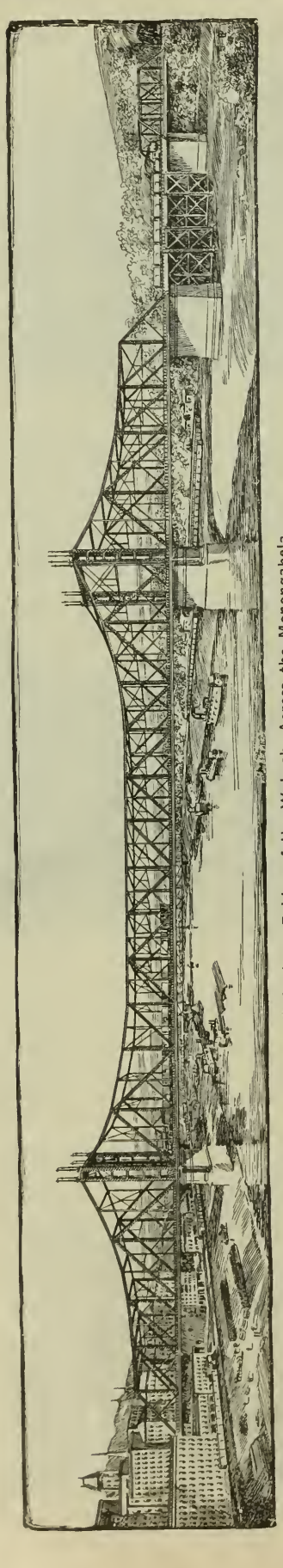
The trucks for the new cars of the Interborough Rapid Transit Company, of New York, operating the subway system, are, perhaps, the heaviest and most powerful that have ever been built for electric traction. One of them is shown in Fig. 4. It is designed to carry 25,000 lbs. on the center plate, and weighs, without motors and gear case, 12,500 lbs. Two Westinghouse motors, No. 86 B, are mounted, one on each axle. These motors, which were described in the *Railroad Gazette*, April 3, 1903, are 200 h. p. each, and can exert a tractive effort at the circumference of a 33-in. wheel of 4,150 lbs. at a speed of 19 m. p. h. The motor equip-

ment complete for one truck weighs about 5,500 lbs. The design of this truck is very similar to the one shown in Fig. 1, with the exception of the pedestals and the use of a separate 5-in. channel for the end frame. The same form of trussed side frame with a heavy 2½-in. x 4-in. top bar is used, but the connection at the transom is stiffened by the triangular filling pieces inserted. The pedestals are wrought iron, securely bolted to the side frame, and the outside jaw is bent around, as shown in the engraving, to form a bearing for the end frame, which is bolted to it.

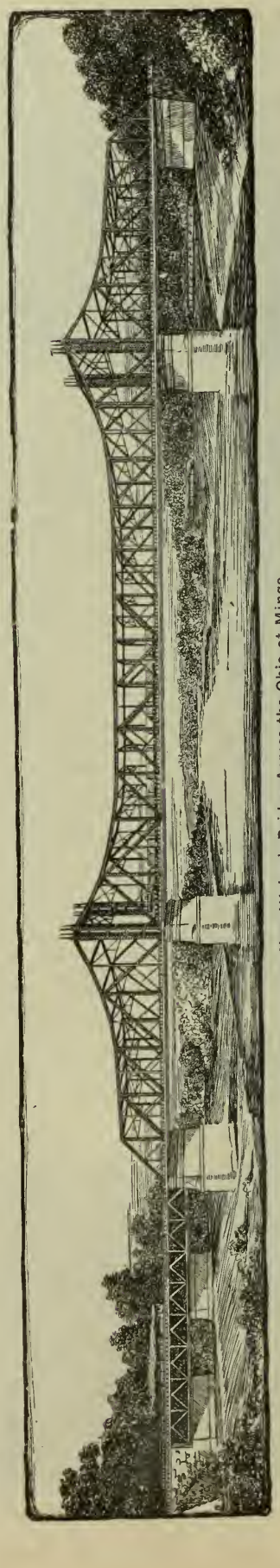
All of these trucks are machine fitted, and all of the connections between members of the frame are bolted. This construction insures a rigid truck throughout, and one which can be easily dismantled or erected. The same shop methods to secure interchangeability and accurate finish are used as are used in building locomotives. Wherever possible the number of parts has been reduced by combining in one forging or casting several members of the frame, and the result is a stiff, easy-riding and noiseless truck.

## Bridges on the Pittsburg Extension of the Wabash.

The accompanying illustrations show the two largest bridges on the new line of the Wabash in Pittsburg. One is across the Monongahela at Pittsburg and the other is across the Ohio at Mingo, Ohio. Both have been completed within the last two months. The Monongahela bridge is the longest span cantilever bridge in the United States, the main channel span being 828 ft. It is double tracked and will carry all the Wabash trains in and out of the city of Pittsburg. The bridge over the Ohio has a shorter main channel span, but, including the approaches, it is longer than the Monongahela bridge. The main span is 650 ft. long and 90 ft. above low water. Messrs. Boller & Hodge, New York, were the engineers for both bridges and the American Bridge Company was the contractor.



Pittsburg Bridge of the Wabash, Across the Monongahela.



New Wabash Bridge Across the Ohio at Mingo.

## Comparative Railroad Statistics for 1901.

The *Journal of the German Railway Officials' Association* for May 7, 1904, contains a careful compilation of figures covering the railroads of the leading countries, and their operations during 1901. In the following tables, based on the above, to which the proper figures for the railroads of the United States have been added, the Prussian railroads are those owned by the government, and include those of Hessia, recently acquired; the railroads of Holland include only those owned by the government; the same of those of Belgium; the French railroads include only the main lines. The other headings explain themselves.

The relative density of railroads in various countries is indicated by the number of miles of railroad to each 100 square miles of area. The figures are as follows:

| | | | |
|---|---|---|---|
| Belgium | 22. | Switzerland | 9.4 |
| Saxony | 19.2 | Holland and Luxemburg | 9.1 |
| Baden | 14.5 | | |
| Alsace-Lorraine | 12.8 | Bavaria | 9.01 |
| United Kingdom | 11.3 | France | 8.8 |
| Germany | 10.85 | United States | 6.64 |
| Prussia | 10.49 | Austria-Hungary | 5.2 |

This great disparity in the relative density of railroads looks differently when the railroad mileage is proportioned to the number of inhabitants. The next table gives the railroad mileage per 10,000 inhabitants.

| | | | |
|---|---|---|---|
| United States | 25.52 | Belgium | 6.03 |
| France | 7.46 | Würtemberg | 5.04 |
| Switzerland | 7.33 | United Kingdom | 5.28 |
| Baden | 7.24 | Austria Hungary | 4.66 |
| Prussia | 6.54 | Holland and Luxemburg | 3.79 |
| Germany | 6.4 | | |

These two tables indicate clearly the striking characteristic of our American railroads as compared with those of the old world, their enormous extent compared with our population, and their small mileage compared with our area. Closely connected with this comparison is that of the passenger and freight traffic on either side of the Atlantic. In relative extent the former falls far behind the European figures. The following figures indicate the number of passenger-miles per mile of track:

| | | | |
|---|---|---|---|
| Belgium | 678,396 | France | 340,371 |
| Prussia | 474,339 | Switzerland | 318,398 |
| Saxony | 462,090 | Austria-Hungary | 230,773 |
| Germany | 413,820 | United States | 89,721 |
| Holland | 351,803 | | |

The relatively higher development of European passenger traffic is also reflected in the revenue of the railroads from that source.

| | Passenger-Revenue-Mile. | Per Cent. of Total Revenue. |
|---|---|---|
| United Kingdom | $10,050 | 43.76 |
| Baden | 5,660 | 31.14 |
| Belgium | 5,360 | 34.07 |
| Switzerland | 5,090 | 45.87 |
| France | 5,085 | 43.56 |
| Prussia | 4,840 | 28.32 |
| Holland | 4,416 | 24.04 |
| Germany | 4,403 | 28.91 |
| Bavaria | 3,375 | 30.11 |
| United States | 2,219 | 22.12 |
| Austria-Hungary | 2,184 | 24.04 |

Moreover, the heavy European passenger travel, and the traffic conditions, have made low rates possible as compared with ours. In passenger revenue per mile our railroads stand near the foot of the list; in revenue per passenger-mile they stand first.

| | Revenue in Cents Per Passenger-Mile. |
|---|---|
| United States | 2.013 |
| France | 1.53 |
| Switzerland | 1.48 |
| Bavaria | 1.21 |
| Holland | 1.19 |
| Baden | 1.16 |
| Germany | 1.024 |
| Prussia | 0.986 |
| Austria-Hungary | 0.909 |
| Belgium | 0.767 |

In one other particular passenger traffic in the United States represents a striking difference from that abroad. The typical passenger rides a longer distance than in other countries.

| | Length of Average Passenger Trip, Miles. |
|---|---|
| United States | 28.58 |
| Austria-Hungary | 21.4 |
| France | 19.3 |
| Bavaria | 18.6 |
| Holland | 18.3 |
| Prussia | 15.5 |
| Germany | 14.6 |
| Belgium | 13.8 |
| Switzerland | 12.6 |

As regards freight traffic, on the other hand, the figures present quite a different picture. First, in the matter of density of freight traffic, the railroads of this country stand among the first.

| | Ton-Miles per Mile of Track. |
|---|---|
| Alsace-Lorraine | 905,067 |
| Prussia | 773,586 |
| United States | 760,414 |
| Germany | 651,590 |
| Baden | 624,647 |
| Saxony | 526,955 |
| Bavaria | 446,336 |
| Austria-Hungary | 441,721 |
| France | 425,873 |
| Holland | 371,500 |

The statistics of freight revenue do not show such a divergence as exists in that of passenger traffic, though the American railroads are near the bottom of the list. It is noticeable, moreover, that the proportion of freight revenue to total revenue is largest in their case, barring only Austria-Hungary.

| | Freight Revenue per Mile. | Per Cent. of Total Revenue |
|---|---|---|
| United Kingdom | $11,440 | 49.71 |
| Prussia | 10,930 | 65.32 |
| Belgium | 10,010 | 64.22 |
| Baden | 10,080 | 57.05 |
| Germany | 9,480 | 63.34 |
| Saxony | 9,350 | 56.27 |
| Bavaria | 6,670 | 60.21 |
| Austria-Hungary | 6,410 | 71.3 |
| France | 6,374 | 54.58 |
| United States | 5,804 | 70.4 |
| Switzerland | 5,452 | 48.85 |
| Holland | 4,680 | 45.39 |

The next table indicates the well known and striking difference in the character of railroad freight traffic in this and other countries, as regards length of haul.

| | Average Haul of Freight, Miles |
|---|---|
| United States | 251.98 |
| Bavaria | 87.9 |
| France | 81.3 |
| Prussia | 70.8 |
| Austria-Hungary | 64.6 |
| Germany | 62.4 |
| Holland | 56.1 |
| Baden | 48. |
| Switzerland | 34.6 |

The extension of American long distance freight traffic has gone hand in hand with a policy of low freight rates. As regards the average receipts per ton-mile the American railroads stand far below all others, as the following figures show:

| | Revenue in Cents per Ton-Mile. |
|---|---|
| Switzerland | 2.68 |
| France | 1.5 |
| Bavaria | 1.46 |
| Austria-Hungary | 1.44 |
| Germany | 1.41 |
| Prussia | 1.33 |
| Baden | 1.25 |
| Holland | 1.19 |
| United States | 0.75 |

These figures are, of course, averages, and are valuable only to that extend. They do, however, suggest the leading differences between American railroad traffic and policy at home and abroad.

## A Vestibuled Stock Car.

The accompanying illustration shows a vestibule attachment for stock cars which has been devised by Mr. William A. Buckner, of Cleburne, Texas. It is simple and inexpensive, and by its use the operation of loading, unloading or transferring stock from car to car can be rapidly and conveniently accomplished, without danger to the stock, and without shifting the cars. The end posts of the car, which are made heavier than usual, are separated far enough to allow the stock to pass through, one at a time, and from them are hinged a pair of end doors. A platform extending almost the width of the car, and wide enough to rest on the end sill or buffer blocks of the adjoining car, is hinged to the end sill, and when not in use is folded up against the end of the car. When it is desired to establish connection between adjoining cars, the two platforms are lowered, one resting on top of the other, and the end doors are thrown open at right angles to the ends of the cars, the relation of the parts being such that a telescoping vestibule is formed.

The drawings, which are merely sketches, do not show working details. In order that the inside doors of the vestibule will be held in their open position each of the doors is provided with a slot through which eyes on the inner doors project, to be engaged by hooks secured to the end of the car. Another scheme for accomplishing this same object is shown in Fig. 5, a metallic strip being attached horizontally to the inside of the door, and having its upper edge cut out in such a way as to form a groove next to the side of the door. A hook secured to the door, above this strip, is made to engage the groove on the adjoining door.

An advantage claimed for the vestibuled car is that it will expedite loading, particularly at one-chute pens. By setting the middle car of a train of stock cars opposite the chute, and opening the vestibule doors between all cars, the stock may be driven through the train and all cars filled with only one setting. The use of a switch engine and crew is thus avoided. Pick-up stock trains, which leave terminals light and pick up cars of stock along the line, would save much time in loading where there is more than one car at a station. Where there are 10 or 15 cars at a station the time thus saved would often amount to two or three hours. In case of a breakdown, or if for any reason it is necessary to transfer stock from one car to another, an empty vestibule car can be placed next to the loaded car, and the transfer quickly made without taking the car to a chute, or of building a temporary chute in case of a breakdown.

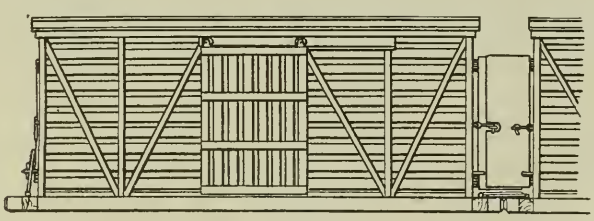


*Fig. 1.*

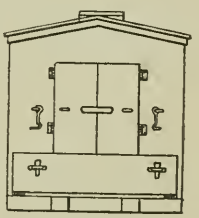


*Fig. 4.*

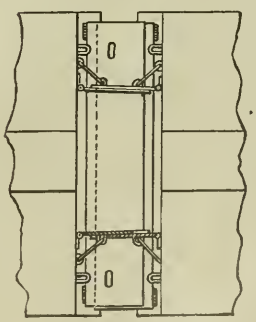


*Fig. 2.*

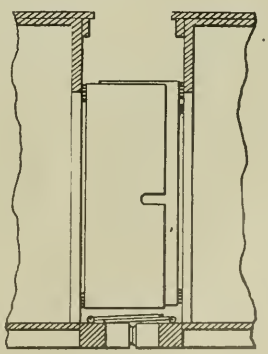


*Fig. 3.*

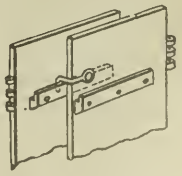
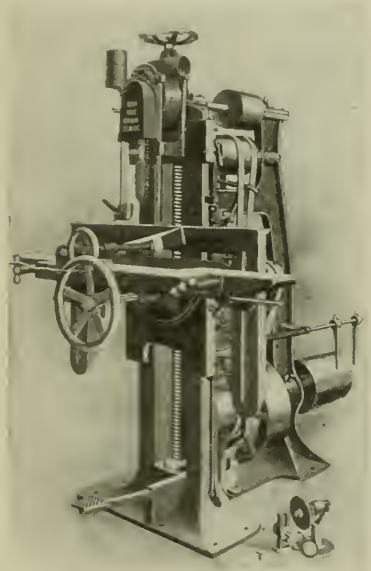


*Fig. 5.*

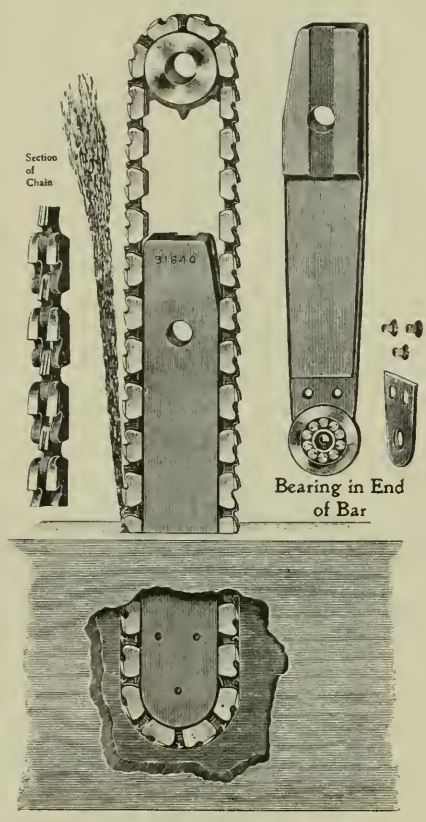
The Buckner Vestibuled Stock Car.

### A Chain Mortising Machine.

The accompanying illustration shows a chain saw mortise made by the New Britain Machine Company, New Britain, Conn. The mortise is cut by a steel chain, each link of which carries a cutter. These cutters have a cutting speed of about 1,500 f.p.m. The chain is driven by a sprocket wheel. A fan is mounted on the same shaft with the sprocket wheel and revolves with it, and sucks away the chips which are brought up by the cutters. The chain is guided by and runs over a bar which has a roller bearing at its end. The cutting takes place at the lower end. The work is clamped to the table, which is fed up by means of a foot lever. The machines have a capacity for cutting mortises from ¼ in. to 1 in. wide and from 1½ in. to 3½ in. deep when using light bars. By using a heavier bar a mortise 6½ in. deep can be cut. These machines are used by the Pennsylvania, the Canadian Pacific, New York Central, and other roads.



A Chain Mortising Machine.




Details of Chain Saw Mortiser.

### Standard Code on the Rock Island.

General Manager H. I. Miller of the Chicago, Rock Island & Pacific Railway Company, has issued a new edition of the rules and regulations for the operating department, and the books are now being distributed. From the order on the first page it appears, however, that the rules do not go into effect until the first of next August.

The rules are based on the latest edition of the Standard Code of the American Railway Association. Of general rules there are one more than in the Standard Code, the additional rule being one to require accidents and other unusual occurrences to be promptly reported by telegraph. The definitions under block signaling and interlocking follow immediately after the other definitions. Rule 2 is in the standard form, but the form of watch certificate does not appear in the book. Under rule 3, paragraphs *a*, *b* and *c* give directions about getting standard time when a standard clock cannot be reached, and require conductors and enginemen to compare time with each other, as of old. For rule 4 form B is used. Rule 6 prescribes D, N, DN, to indicate telegraph offices, but does not show abbreviations for leave and arrive. Rule 10 specifies *a* red, *b* white, *c* green. With rule 12 the pictures are given on the same page. Under rule 14, signal *e* is followed by two other whistle signals, for flagmen on branch or auxiliary lines. These are, from the west or south, four long and one short; from the east or north, five long and two short. The rest of the whistle signals, therefore, have letters different from those in the Standard Code, and after the station signal two others are added. The first (q), consisting of two short and three short sounds, is to call the attention of conductor and brakemen to a 19 train-order signal. (The order is, presumably, to be taken without stopping the train.) The next signal, one long and one short, is to warn a train on another track that it is too close to the train ahead of it.

Rule 18 has a supplementary paragraph requiring a white light on the top of the tender when an engine is backing at night. Rule 19 has supplementary paragraphs requiring additional markers on both passenger and freight trains, and indicators in cabooses. Rule 23, clause *a*, forbids taking off markers too soon. Rule 32, clause *a*, forbids sounding whistles near passenger trains.

Rule 83 (a) tells of train registers and their use; rule 88 (a) authorizes extra trains in the superior direction to hold the main track. Rule 90 (a) regulates the meeting of trains on sidings which are used in both directions. Rule 97 (a) reads: "Yard limits will be indicated by yard-limit boards. Within these limits yard engines may occupy main tracks, protecting themselves against overdue trains. Extra trains must protect themselves within yard limits." Rule 99 reads: "When a train stops or is delayed under circumstances in which it may be overtaken by another train, the flagman must go back immediately with stop signals to a point where he can have an unobstructed view of an approaching train for at least one mile, and as much further as is necessary to insure full protection. He must at once place one torpedo on the rail on the engineman's side, and will remain until recalled. When recalled he may return after placing a second torpedo on the rail 60 ft. from the first one. If an approaching train is in sight or if a passenger train is due within ten minutes he must remain until it has been stopped. The front of the train must be protected in the same way when necessary by the fireman."

Rule 104 (a) requires enginemen after having backed into a siding to see that the switch is properly set. Rule 106 is in full-face type.

Immediately following rule 106 are rules 151-153, requiring trains on double track to keep to the right; requiring protection by flag when crossing over; requiring caution where a train is receiving or discharging passengers at a station [not elsewhere] and requiring enginemen to watch for trains which are running too close together and call their attention to the fact.

Rule 207 (a) requires the initials of foreign locomotives to be used in train orders. Rule 210 (a) requires conductors to show train orders to flagmen, baggage men, brakemen and porters; and enginemen to show orders to the firemen and the head brakeman; and these subordinates are required to read and bear them in mind.

Rule 211 (a) forbids the use of "19" orders to restrict right or superiority. Rule 212 (a) defines the meaning of the signal X. Rule 216 (a) prescribes the method of delivery of orders to persons in charge of work requiring the use of track in yards. For rule 221, form A is used. The fixed signal is used to enforce the time interval between trains. Rule 223 has no abbreviation for the word complete, and does not contain S. D. (for stop displayed); the X response is not to be given until the train order signal has been displayed.

In the examples under the forms of train orders, towns along the line of the road are used instead of the Oriental names given in the Standard Code. Form D does not appear. Under form E there is a fourth example under which what is practically a schedule is made by saying that the train will wait at

Topeka until nine twenty, 9:20 p. m.,

Bishop until nine twenty-eight, 9:28 p. m., and so on for a half-dozen or more stations. One double-track form is given to provide for a movement against the current of traffic.

The rules for the telegraph block system adhere quite closely to the Standard Code. For rule 317 form B is used, and for permissive signaling a caution signal (not a caution card) is used. Rule 318 is given in both forms A and B. Rule 331 does not prescribe any time interval, and permission to proceed may be given either by a caution signal or a caution card. Under the head of interlocking, rules 611 to 636, inclusive (the instructions to signalmen), are not given; neither are those for repairmen (681-686). Following rule 669 are four rules describing the theory on which signals are designed and set up. Beginning with No. 701 rules, severely condensed, are given for trainmasters; for all of the classes of employees usually provided for in books of this kind, and also for levermen, chief despatchers, train despatchers, linemen, road foremen of equipment, master mechanics, engine house foremen, car inspectors, division engineers, the signal engineer and captains of police.

## TIE SPACING AND RAIL BRACES.

In Mr. von Schrenk's study of tie shapes and tie spacing, in another column, he assumes that the heavier rail sections, being stronger as beams, may be supported with the same safety on fewer ties to the rail than are needed for the lighter sections. This is one of those things which ought to be but are not always true. On one road more than thirty 100-lb. Carnegie rails, supported on 18 ties, have broken during the past year. One break caused a bad accident, and in one other case there was a narrow escape from a fearful loss of life. If any engineer has succeeded in getting 100-lb. rail of as good, or anywhere nearly as good, quality as those of lighter weights we should be glad to be informed. Tie spacing, within reasonable limits, has little to do with the undertaking to get an unyielding support for the wheels. Careful observation of the movement of heavy wheel loads on rails from 80 lb. to 100 lb. shows no noticeable flexure between the tie supports. It often shows pronounced waves of depression, usually at the joints, but it not unfrequently happens that, with joint ties well tamped and with 6-bolt angle-bars bolted tight, the joint ties hold up and there is quite a uniform bending of the rail. The reason for this seems to be that a heavy angle-bar with the nuts newly tightened is quite a 100-per cent. joint, and that the three selected joint ties, set a little closer together than the others, can be made the high spot in the track. This is simply confirmation of the truth that, with track in good order, and within resonable limits of tie spacing, the measure of efficiency is the amount of timber bearing surface on the ballast. Mr. von Schrenk seems not to have made this point as clear as it should be; nevertheless, he arrives at an economical conclusion. He gets, from an 11½-in. diameter-stick a tie with a 10-inch base and a heart-wood upper surface of 6 in., which is a decidedly better tie than the 7 in. x 9 in. ordinarily hewed or sawed from the same sized log. He also gets three boards, a clean saving from the ordinary waste. He should have pointed out that, with ties so cut with 10-in. bases and laid 17 to the rail, he may have somewhat more bearing surface than with 7-in. x 9-in. ties laid 18 to the rail. This is a saving of 1-18 of the cost of ties and tamping, with quite equally good results.

One consideration, however, in reducing the number of ties under each rail seems to be ignored. The increasing equipment of freight cars with air brakes has introduced new track disturbances, and partially equipped freight trains, now so common, intensify them. The weights and speed have been largely and safely increased, but, when the brakes are applied to these huge trains on a curve, the side thrust is such as was not known a dozen years ago. With the present tie spacings, spreading track is not unusual, and the tendency is toward still higher freight-train speeds and heavier loads. Any reduction in the number of spikes, due to fewer ties, must surely be compensated on curves by rail braces or by tie plates designed to hold.

## RAIL AUTO-CARS.

Many of the railroads in this country have much revenue adjacent to their tracks which has not yet been developed. That is to say, additional traffic could be obtained if links were built between railroad stations and outlying districts which need improved traveling facilities. The truth of this statement has been proved by the experiences of many through steam roads which have been benefited by interurban electric roads which act as feeders. In the early days of interurban electric competition, the steam roads sought to win back local traffic by cutting rates, but this procedure was soon found to be ineffective. Most steam road managers now realize, or should realize, that the most attractive features of the electric road are frequent service, high speed and accessibility to the passenger, and unless the steam road can offer these same advantages, the bulk of local traffic will continue to go to the interurban roads which use electric motor cars. The only hope for purely local steam roads is in electrification. Steam roads doing mainly through business have nothing to fear from local electric roads for the reasons before mentioned.

A good many attempts have been made by steam roads to duplicate the service of electric roads without the necessity of a large investment in electrical apparatus, overhead or third-rail construction, motor cars, etc. New and powerful steam locomotives have been tried and found wanting, as for example, on the Great Eastern of England. On a great many roads, especially in the western part of this country, there are branch lines on which passenger trains cannot be operated with profit. The high wages now paid enginemen and trainmen and the necessity of employing two enginemen and two or three trainmen even on a short train, makes the service too expensive. The alternative of the railroads has been either to take off the service entirely or to run a mixed service and the result is that the communities are grumbling and asking for electric roads.

With the above considerations in view it is quite evident that there is a field for a rail auto-car built on the principle of an automobile and run by steam or gasolene. The term "auto-car" is used to designate cars which generate their own power, from motor cars, which get power from overhead or third rail conductors. From an operating point of view the use of such cars would solve many troublesome problems, but so far, difficulties have been met in designing a car suitable for the service required. Auto-cars will probably never be designed which will be capable of competing with the electric interurban car, for at least 250 horse-power per car is required in order to get high acceleration and speed and at the same time have a little reserve power for climbing grades. In fact, most interurban electric cars have 300 horse-power or more in electric motors, and some have as high as 600 horse-power. The auto-cars so far designed have not had motors exceeding 100 horse-power. The North Eastern auto-car, which was described in the *Railroad Gazette*, April 29, last, has an 80 horse-power petrol motor driving a dynamo. The current thus generated is used in motors on the trucks. The petrol motor and dynamo take up about one-fifth the total length of the car and nearly all the width of the car, so that a larger motor could not well be used. If steam is used as motive power, the space occupied by the boiler and coal and water is large. Steam cars are used by the Great Western, London & South Western, Taff Vale and other foreign roads. They have also been tried in this country. Tests on the London & South Western car, which seats 46 passengers, show that the maximum speed of 25½ miles an hour is reached 55 seconds after starting.

It is quite possible that the development of the automobile will point the way to a rail auto-car which will work smoothly and economically at moderate speed. High speed and acceleration such as is possible by electric motor cars will undoubtedly never be possible with auto-cars. But there is a field for the auto-car even in its present state of perfection. There are many places where there are good-sized communities 10 or 15 miles from the nearest station of a steam road. It is this sort of revenue adjacent to the tracks that was referred to in the opening sentence of this article. By building short branch lines of light construction into such communities and running auto-cars at intervals to connect with main line trains enough traffic could no doubt be obtained to pay for the investment. In such cases the auto-car would take the place of the farmer's horse and wagon.

## THE VALUE OF HEATING SURFACE

Mention has already been made in these columns of the desirability of making tests to determine the rate of evaporation in the fire-box and tubes of a locomotive boiler. Few tests of this sort have been made, and those carried out by M. Petiet, in 1865, are the most complete. But the apparatus which he used and the conditions under which the tests were made make his results of little value to-day. Of late years the necessity for accurate data on the subject has been particularly urgent, and it has been suggested that a sectional boiler be built so that the number and length of flues and the grate area, etc., can be varied and the rate of evaporation under each condition accurately measured. This process would, of course, give the desired results, but the apparatus would be costly and the large number of variables to be considered would increase the liability of error in the measurements.

In another column Mr. Lawford H. Fry suggests a method of making such tests on existing boilers by measuring only the quality of the fuel, the amount of the products of combustion, and the fall in temperature at intervals between the fire and the smoke-box. His analysis is based on fundamental principles and gives a scientific basis for making comparisons. The only difficult observation to make is the temperature of the gases in a tube at different points in its length. But this can be obtained by means of a thermal-electric joint on the end of a long pipe, which slips through a stuffing-box in the front of the smoke-box. This pipe need not be larger in diameter than about ¼ in. and the wires from the thermal-electric joint could pass through the pipe, thus

protecting them from the hot gases. Graduations on the outside of the pipe at predetermined points would indicate the exact position of the thermal joint in the boiler tube. The thermal-electric joint and connections is similar in every respect to the Le Chatelier pyrometer, which is used in measuring high temperatures. The apparatus can be accurately calibrated and the temperature reading can be got with great accuracy. Of course, the presence of the pyrometer in the boiler tube would tend to obstruct the passage of the gases, but if made small, as suggested, the error on that account would no doubt be small enough to be disregarded.

The final equation deduced by Mr. Fry, giving the total evaporation of a boiler, involves only the grate-area and the heating surface. His analysis is based on the fundamental consideration that the heat is transferred from the grate to the water by direct radiation from the fire and by the products of combustion. The heat given off by direct radiation must be absorbed by the fire-box surface and the tube ends immediately adjacent to the fire-box. A part of the heat carried by the gases is, of course, given up to the fire-box sheets, but the greater portion passes on into the tubes. With a grate of given area producing a known quantity of heat per hour, it is possible to determine the proportion of radiated heat, which is all absorbed by the boiler. The amount of gas-carried heat absorbed depends on the extent of heating surface over which the gases pass. An interesting fact developed is, that in substituting good coal for medium coal, the increase in evaporation is due chiefly to the increase in the amount of radiated heat; for example, by using coal of 15,000 B. T. U. per pound instead of coal of 13,000 B. T. U., the total evaporation is increased about 35.6 per cent., while the actual heat at the grate is only increased 26.8 per cent. This may explain why some English locomotives give such high evaporative performances. Good Welsh coal frequently contains 15,000 B. T. U. per pound, whereas many American locomotives use coal having but 8,000 or 10,000 B. T. U. per pound.

## WATER SOFTENING.

In referring to the losses from bad feed water for locomotive boilers, in the excellent paper on "The Loose Ends in the Motive Power Department," a liberal extract from which was printed in these columns two weeks ago, the author says that a system of reservoirs to hold rain water, where good water cannot be obtained, is the only sure remedy. A few years ago this statement would probably have been accepted unreservedly; for although American roads excel in many ways, the question of chemically treating the feed water before it goes into the tank has remained in the background until the last few years. In Europe, water softeners have been a well-recognized factor in railroad economy for a long period, and in this country they are coming to be recognized as an operating necessity by roads having bad boiler water to contend with. Their use offers a remedy, equally, if not more, sure, and in many respects more practical and satisfactory than the one suggested above. By far the largest user of water softening plants in the United States is the Union Pacific Railroad, with 36 stations in operation or under way, the total capacity of which will be 3,000,000 gals. daily, and the presentation in another column of the economical results which have attended an improved quality of water supply, together with the expense for the operation of the softeners, furnishes a valuable and interesting contribution to the rather meager data on this comparatively new question in American railroad practice. As the paper states, the limited period for which comparative statistics are available at this time prevents their showing full value on many points, on some of which it will take considerable time, years perhaps, to realize fully the extent of the benefits derived; but of the figures given, the increase in average monthly engine mileage of 27 per cent. and the decrease in repairs to locomotives per engine mile of 34 per cent., are impressive. Washing out has been reduced 50 per cent. on all locomotives, with the exception of those engaged in one particular class of passenger service. The flue mileage of freight locomotives has been increased 150 to 200 per cent., and of passenger locomotives 400 per cent., while the effectiveness of each pound of coal put into the fire-box has been enhanced 7½ per cent. On the Union Pacific, for the four years ending June 30, 1902, the expense for repairs and renewals of locomotives was 10.19 per cent. of the total operating expense, while fuel for locomotives was 10.8 per cent., and the expense for engine and roundhouse men was 10.1 per cent., these three being the largest single items in the expense account. As each of these is directly and appreciably affected by the use of better water, the economic influence which a judicious and adequate use of treating plants exerts on total operating expense is obvious. Chief Engineer Berry, of the Union Pacific, in a statement made last fall regarding water softening on his road, said that the saving in boiler repairs alone warrants the outlay made for softeners; and after stating the cost of chemicals per 100 lbs. of incrusting solids removed he said: "Even though this figure were doubled, it would still be an economy, as any experienced man knows that 100 lbs. of scale cannot be removed from boilers for any such figure."

## MACHINE SHOP BELTING.

One effect of electric driving in railroad machine shops has been a reduction in the amount of belting used. Nevertheless, the amount still used in a majority of modern shops is sufficient to affect the efficiency and the cost of operation, maintenance and repairs. A study of the belting system even in a new shop often shows where economies can be effected. When experts are called in to organize and systematize an existing shop, it is usual for them to ask for an invoice of all belting and for records showing the cost of maintenance, repairs and renewals. By properly classifying and tabulating these figures the high spots can be found and an effort made to get few interruptions to operation on account of failing belts. Where old belted tools using high-speed tool steel are used and are worked to the limit of their strength, unless it has been possible to increase the belt capacity—and this in many cases, probably a majority, is impracticable—the belts are overloaded and frequent interruptions occur. The time lost by a machine while waiting for belt repairs or renewals may be sufficient to more than offset the increased work obtained from heavier cuts and feeds.

Mr. F. W. Taylor in his well-known experiments on belting, found that the total life of belting, cost of maintenance and repairs and the interruptions to operation are dependent chiefly upon the total load to which the belts are subjected, more than upon any other condition. By total load is meant the total stress per inch of width, or square inch of section, on the tight side while in motion. He found that the average cost per double belt per year of service, including the original cost and cost of maintenance and repairs, was $6.72 when the belt is used under the ordinary rules of belting, viz., 111 lbs. total load per inch of width. Also the annual cost of maintenance, repairs and renewals averages per year about 37 per cent. of the original cost of the belt.

Other conditions named as chiefly affecting the durability of belts are (1) whether spliced, or fastened with lacing or some of the patent devices, (2) whether they are properly greased and kept clean and free from machine oil, and (3) the speed at which they run. The following table gives some recent experiments with new leather belting to determine its strength, and also the strength of different sorts of joints. The figures are per square inch of cross-section.

| | Lbs. | Per cent. |
|---|---|---|
| To tear new double leather belt.... | 6,400 | 100 |
| To tear the same belt at 5-in. splice. | 5,680 | 90 |
| To tear the same belt at riveted splice ..... | 3,800 | 60 |
| To tear out (patent) spiral steel-wire joint with rawhide hinge... | 2,700 | 42 |
| To tear out brass wire lacing..... | 2,440 | 38 |
| To tear out ordinary rawhide lacing. | 2,250 | 35 |
| To tear out brass studs..... | 1,920 | 30 |
| The rule of the Buckeye Engine Company for working tension of belt is | 275 | .. |
| F. W. Taylor's rule, based on a minimum of interruption to operation. | 200 | to 225 |

The range covered by these tests was limited and they cannot therefore be regarded as complete, nevertheless the results are interesting and useful. Ordinarily, a properly scarfed and cemented joint is considered as effective as any other part of the belt. In these tests this joint showed an efficiency of 90 per cent., and was 50 per cent. stronger than the next best joint. The efficiency of the best laced or wire joint (spiral steel wire with rawhide hinge) was 42 per cent. Brass studs were the poorest joints, showing an efficiency of only 30 per cent.

Mr. Taylor recommended, for maximum economy, a belt speed of from 4,000 to 4,500 f. p. m. and an average total load for double belting of 65 to 73 lbs. per inch of width, or 200 to 225 lbs. per square inch of cross-section. This load corresponds to an effective pulling power of 30 lbs. per inch of width. He found that belts yielding the most economical results were under a total load of 54 lbs. per inch of width, and an effective pull of 26 lbs. per inch of width, under which conditions the yearly service cost was $5.70, and the average cost of maintenance, repairs and renewals was 14 per cent. of the first cost. Proper attention to belting, especially where the system is large and complex, means increased efficiency and an appreciable reduction in the cost of operation.

The New York, New Haven & Hartford Railroad Company recently adopted a new

timetable, which makes no provision for stops by four express trains which heretofore have stopped at the city of Meriden, Conn., on the Boston & Albany route, between New York and the Massachusetts capital. Hence an outburst of wrath among the citizens of Meriden, a call by the President of the Meriden Board of Trade for a fund to bring the New Haven road to book in the courts, and repeated appeals to the Connecticut Railroad Commission to compel the abolition of grade crossings in the city, the slowing of trains which have not hitherto stopped at the Meriden station, and other plans of a more or less retaliatory and coercive nature. The anger of the Meriden folk is very likely justified, and certainly, in the nature of human nature, is the sort of thing to be expected, when a thriving New England city finds itself even qualifiedly side-tracked. But below the surface is a stratum of rich humor. For a good many years the Boston & Albany has been demanding from the New Haven faster time on through express trains, and the new timetable is a *quasi* concession to the demand. But what the New Haven really craves is the haul of all Boston-New York passengers on its own route by the Shore Line and Providence, where it has a trackage almost 100 miles longer than on the route *via* Springfield and the Boston & Albany. And, but for the demand for quick service by such cities as Meriden and Hartford, and Springfield, we venture the guess that most of the through express trains *via* Springfield would long ago have lapsed into desuetude. We can fancy, therefore, the equanimity with which the New Haven company contemplates any retarding policy of a Connecticut city on the "short haul" route, and that its Oriental calm would burst into positive glee if, for example, the Connecticut Commissioners should compel it to stop at every station between New Haven and the northern Connecticut State line. When Meriden openly, and the railroad corporation covertly, approve the "stop" theory on the Springfield route, we have not the least doubt that the Connecticut Railroad Commission will prove complaisant, and, in due season, a letter with regrets at having to "yield to authority," pass from President Mellen to the official head of the esteemed sister corporation.

## TRADE CATALOGUES.

*Arthur Koppel*, 68 Broad street, New York, issues supplement No. 2 to catalogue No. 77. This supplement illustrates some types of Baldwin locomotives which are generally used for industrial purposes. An agreement has just been made between Arthur Koppel and the Baldwin Locomotive Works so that the former is now in a position to furnish Baldwin locomotives of all classes and sizes for any gage and for all kinds of motive power, including steam, electricity and compressed air. The last page of the catalogue is in the form of an inquiry sheet which may be filled out if estimates or specifications are desired.

*Marshall & Huschart Machinery Co.*, Chicago and Cleveland, has issued a new catalogue containing illustrations and descriptions which the preface states covers only a portion of the various lines of machine tools and kindred devices the company carries in stock. This company represents 30 different makers of such machinery, including many of the most prominent in the country. The catalogue is 9 x 12, has 151 pages and is printed on heavy enamel paper, only one side of a leaf being used. The covers are board, bound in cloth.

*The Stanley Electric Manufacturing Company*, Pittsfield, Mass., is sending out a wall map of the S. K. C. system for long distance transmission in California. The points between which transmission has already been installed are marked on the map by means of full lines and those between which it is proposed to install the system are marked by broken red lines. The longest transmission at present is 232 miles from De Sabla to Sausalito. Ten thousand horse-power is being regularly delivered into San Francisco from the Electra-power station by way of Stockton and Mission, San Jose, a distance of 147 miles.

*The Ingersoll-Sergeant Drill Company*, 26 Cortlandt street, New York, publishes catalogue No. 35 in the form of a portfolio showing its standard types of air compressors. The book is fully illustrated with excellent half-tones and contains tables of dimensions with brief footnotes describing the main features of each machine. The photograph of the new works of the company at Phillipsburg, N. J., is also shown. These works are the largest of their kind in the world. Illustrations are also shown of the new electric-driven air compressor, a number of which have recently been installed by the St. Louis Transit Co. for a new system of storage air-brakes.

# CONTRIBUTIONS

### An American Memorial to George Stephenson.

29 Great George Street,
Westminster, London, S. W., June 8, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

A movement is now being made to establish an American memorial to George

George Stephenson, 1781-1848.

Stephenson, the British engineer and pioneer of railroads. Probably every American engineer knows of the heartbreaking difficulties that constantly faced him in his railroad work. The British landlords were against him, one of them saying that his ten-miles-an-hour locomotive would spread dismay among cattle plowing in the fields or grazing in the meadows, and the professional engineers at Westminster ridiculed his projects, calling them absurd; while his evidence was described as trash and confusion and he was called unstintedly an ignoramus, a fool, and a maniac. His Parliamentary bills to obtain rights to build the pioneer railroad were ignominiously thrown out in the first attempt, and it is said that this was the most severe trial he went through in the whole course of his life. It almost appears as if Nature herself was using her forces to prevent the success of a man who has perhaps contributed more toward the material well-being of more people than have all the emperors, military heroes, statesmen, and philanthropists from the beginning of time.

It is believed that the reason the United States has not acknowledged any part of the gratitude to George Stephenson is that no one so far has indicated a way in which this gratitude can find a suitable outlet. The creator of railroads lies in the little Church of Holy Trinity, in the town of Chesterfield, England. This Church of Holy Trinity has only a very small congregation, who are either poor, or, at the best, of very moderate means, and although the vicars of the church have for many years desired to extend the dimensions of the miserably inadequate chancel containing the grave of the illustrious railroad engineer, it has thus far been found difficult to secure the $10,000 required to effect the structural alterations. George Stephenson's grave is simply covered with a plain stone, in which are cut the engineer's initials.

It is now suggested that American citizens, especially those associated with railroad engineering, might care to make the construction of this proposed chancel and the provision for a fitting tomb their especial work to repay the depth of gratitude they owe to the illustrious dead. Those in sympathy with the memorial proposal are asked to send their communications to the address here given.

B. W. THWAITE, *A. M. Inst. C. E.*

### Foreign Railroad Notes.

It is reported that April 30 for the first time the sound of the blasting explosions at one face of the Simplon Tunnel was heard at the other end, about ⅝ of a mile distant. During April 379 ft. advance was made at the north end and 575 ft. at the south end.

A delegation of the women employed on the Austrian State railroads last April asked the Railroad Minister, amongst other things, that the maximum monthly pay might be advanced from $22 to $24. How greedy!

The pressure of military traffic on the Siberian Railroad has been such that the population of Siberia, small as it is, complains that it cannot obtain its usual supply of the goods which it imports from European Russia, and especially sugar is lacking. In consequence it has been ordered that such merchandise be forwarded first to the Siberian border, and there stored till opportunity is found to send it to its destination.

The Prussian State Railroads are in the market for 516 passenger cars, 120 baggage cars and 3,188 freight cars, to be delivered by the end of next March. Only works which have built cars for these railroads are permitted to bid.

A committee has been formed in Budapest to collect money for the relief of the families of railroad employes imprisoned or discharged in consequence of the late strike.

## Four-Cylinder Balanced Compound for the Prussian State Railways.

The locomotive exhibited by the Hannoversche Maschinenbau Aktien-Gesellschaft of Linden-vor-Hanover at the St. Louis exposition is shown herewith. The Prussian State Railways have 29 of this type in use or building, 19 having been ordered this year. The engine is the four-cylinder balanced compound Atlantic type with von Borries simplified valve-gear and a Pielock superheater. The four cylinders are set in a line across the engine on the center line of the leading truck. The two high-pressure cylinders are between the frames and the two low-pressure cylinders are outside the frames. Each pair of high and low-pressure cylinders is cast in one piece with their corresponding steam chests. The two groups of cylinders are bolted together and carry the smoke-box. They rest on the frames, which are the bar type at the front of the engine and the usual plate form at the rear. The four pistons all drive on the forward axle. The cranks of the high-pressure and low-pressure cylinders on the same side of the engine are set at an angle of 180 deg. to each other. The reciprocating parts balance each other almost perfectly as will be seen by the following table:

| | H. P. | L. P. |
|---|---|---|
| Piston, lbs. | 78 | 156 |
| Piston rod, lbs. | 67 | 108 |
| Cross-head, lbs. | 152 | 152 |
| Main rod, lbs. | 244 | 182 |
| Total | 541 | 598 |

This arrangement of cylinders is the same as that employed by Mr. Vauclain for the Baldwin four-cylinder balanced compounds.

The valves of the high-pressure cylinders are the piston type with inside admission, and the valves of the low-pressure cylinders are the balanced Trick type. Both valves on one side of the engine are driven by a single gearing. The two valves are controlled by a single link which receives its motion from one eccentric, but the stem of each valve is coupled to a lever which receives its motion from the crosshead of the corresponding piston. The link movement is transmitted to the outside valve by a rod with levers of different lengths so proportioned that the ratio of steam admission is 55:30 for low-pressure and high-pressure cylinders in both forward and backward gear.

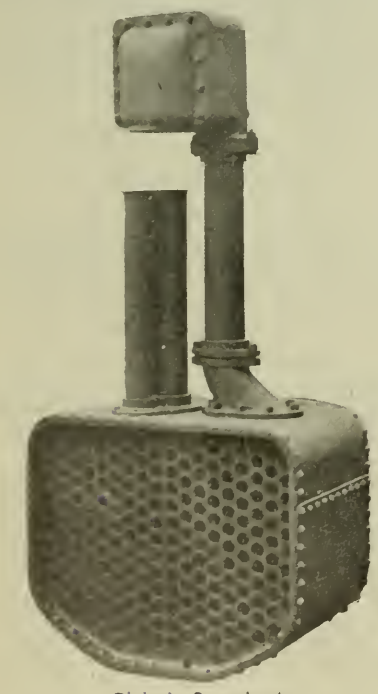
The cylinders of this engine are $14^{3}/_{16}$ in. and $22^{1}/_{16}$ in. x $23\frac{5}{8}$ in., and the drivers are $77^{15}/_{16}$ in. in diameter. The total weight of the engine in working order is 132,650 lbs., with 67,000 lbs. on the drivers. The weight on the trailing wheels is 26,630 lbs. The working steam pressure is 200 lbs. The total heating surface in the boiler is 2,013 sq. ft. divided up as follows: Tubes, 1,632 sq. ft.; fire-box, 108 sq. ft.; superheater, 279 sq. ft. The grate area is 29 sq. ft. The maximum tractive effort is 16,083 lbs., which is calculated by the following formula:

$$T = \frac{2\,d_1^2\,l\,p}{3\,D} + \frac{d_2^2\,l\,p}{4\,D}$$

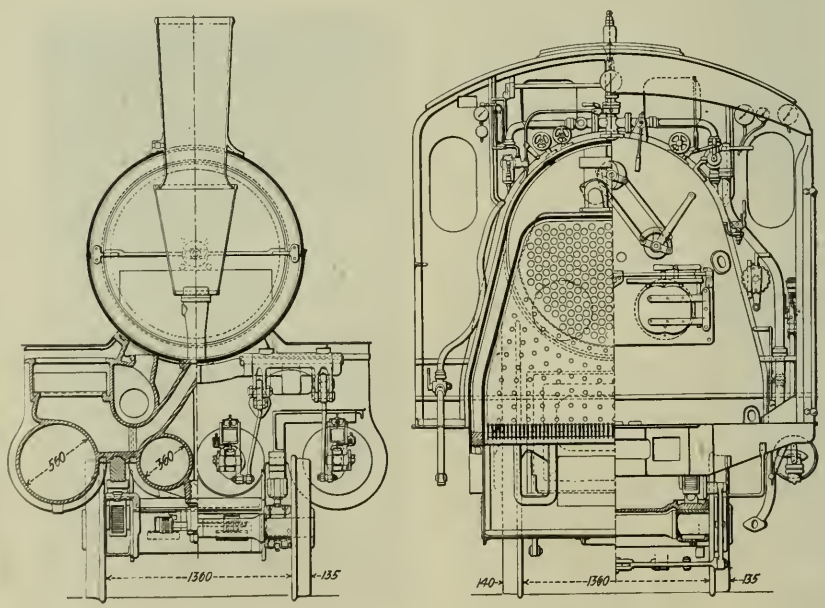
in which $(d_1)$ is the diameter of the high-pressure cylinder in inches, $(d_2)$ is the diameter of the low-pressure cylinder in inches, (l) is the stroke in inches, (p) is the boiler pressure in lbs. per sq. in., and (D) is the diameter of the drivers in inches.

The Pielock superheater with which the engine is fitted is built into the shell of the boiler so as to use the heating surface of the boiler tubes for superheating the steam. It is far enough from the fire-box so that the tubes cannot be overheated. The main part of the superheater consists of a box, into the ends of which the boiler tubes are lightly rolled. This box is divided into compartments by plates parallel to the tubes, so as to get a long contact of the steam with the heating surface. The steam passes at boiler pressure into the superheater and through the several compartments. A tube fitted with a draincock for ascertaining if the superheater is water tight, passes through

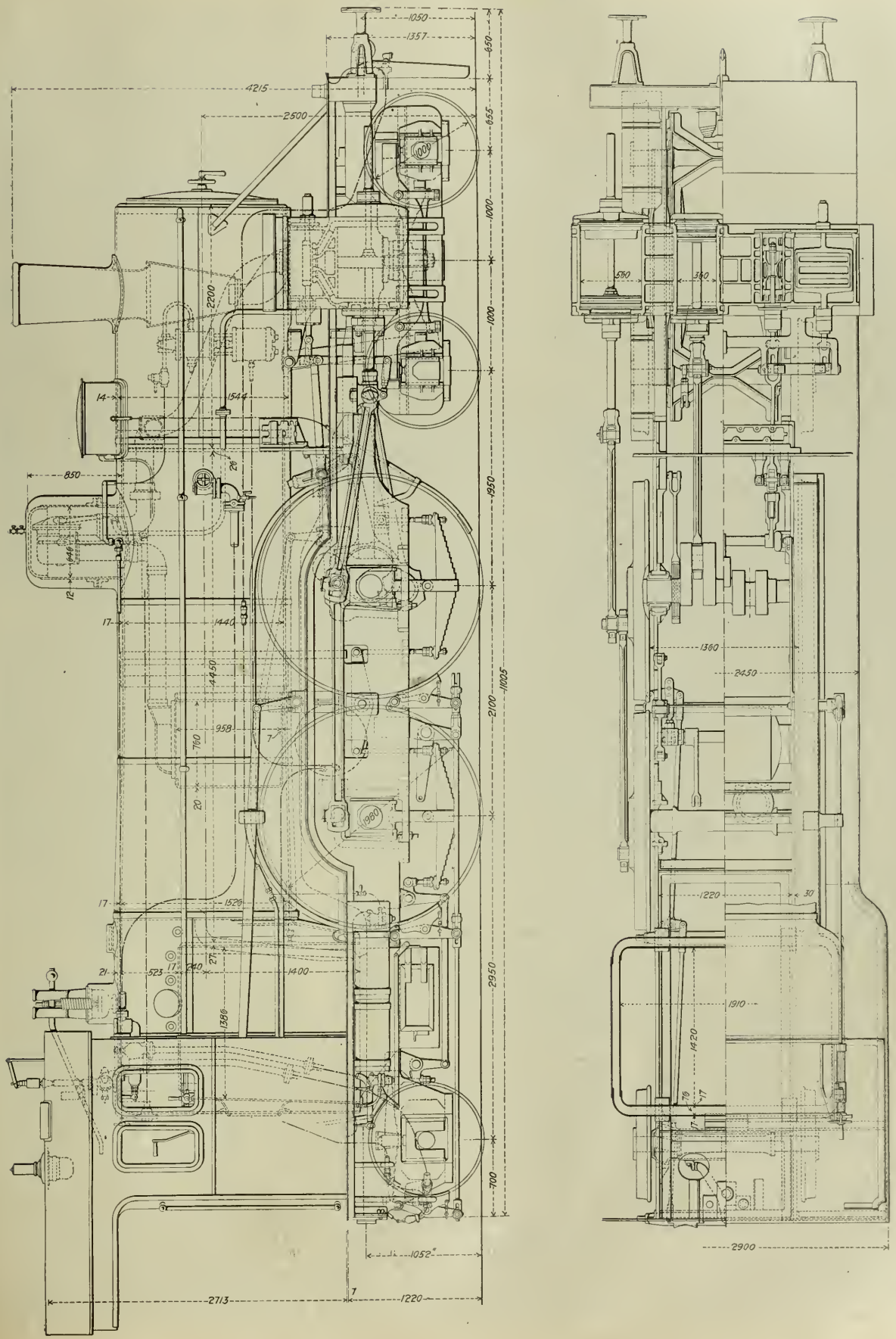
Four-Cylinder Balanced Compound Locomotive—Prussian State Railways.



Pielock Superheater.




Prussian Four-Cylinder Balanced Compound.




Four-Cylinder Balanced Compound Locomotive for the Prussian State Railways.

the bottom of the superheater and boiler. A thermometer on the dome is connected by a pipe with the steam chamber of the superheater. The scale of the thermometer is placed so that it can be read from the cab.

Before being shipped to St. Louis, the locomotive was run on the Hanover Division for several days. The engine hauled trains weighing 300 tons at a maintained speed of 62 miles per hour on level track. On grades of 1 in 200 the speed was 50 miles an hour.

## The Value of Heating Surface.

BY LAWFORD H. FRY.

By a paper* recently read before the Western Railroad Club, Mr. H. H. Vaughan has quickened general interest in the question of the relative value of the various parts of the heating surface in a locomotive. There is a good deal of talk about the advisability of making a series of tests to throw additional light on this important subject. If tests are to be made, it appears desirable to make an advance investigation of the ground to be covered, starting from first principles and endeavoring to determine the line of least resistance along which tests can be made. In the present article a preliminary survey is attempted which is an elaboration of a discussion of Mr. Vaughan's paper before the Western Railroad Club. Further investigation shows the necessity for modifying to some extent the formula then developed. In the present case each step in the argument is presented for criticism and correction if necessary.

It has been suggested that for purposes of experiment a special boiler be built, so that the length of flues, the number of flues, and the grate area can be altered, and the actual evaporation measured under various conditions. Probably, also, the method of introducing the feed water is of importance and should be included in any investigation. A set of tests on these lines would be costly and tedious to carry out; and owing to the large number of variables, it would be difficult to obtain any conclusive results. If, however, on any existing boiler a measurement is made of the change of temperature between fire and smoke-box, the evaporation due to each part of the boiler can be deduced, and by carrying out such experiments on a number of boilers the influences of varying conditions could be seen. In carrying out such tests it would be necessary to observe the quality of the fuel, the amount of the products of combustion, and the fall of temperature at intervals, between the fire and the smoke-box. The temperature measurements could be made as has been similarly done for stationary boilers by means of an electrical pyrometer.

An attempt is made below to show how such a series of tests could be used and the form which the results would probably take. As a basis for the examination, Professor Goss's test of the Purdue boiler is taken. Information as to the conditions of combustion, etc., is given in the appendix below.

In carrying out the investigation the leading idea has been to study the principles governing the production of the heat at the grate and its transference to the water in the boiler. The formulæ obtained are probably applicable to general conditions, but they are offered here as an illustration of the form of the results to be expected from a series of temperature tests, and are not recommended for immediate adoption without further investigation.

In the appendix it is shown that in the case under consideration the heat production and distribution are as given in the following table. The figures given show the heat produced in an hour by each square foot of grate surface. The conditions are such as may be ordinarily obtained in locomotive practice.

| Classification of Heat. | Amount of Heat per Sq. Ft. of Grate per Hour in B. T. U. | Percentage of Total Heat Produced. |
|---|---|---|
| Heat radiated from grate— | | |
| Effective in evaporation.. | 219,000 | 18.6 |
| Lost by outside radiation. | 4,000 | 0.3 |
| Total heat radiated.... | 223,000 | 18.9 |
| Heat carried from grate by gases— | | |
| Effective in evaporation.. | 546,000 | 46.4 |
| Lost by outside radiation.. | 11,000 | 0.8 |
| Lost in smoke-box..... | 399,000 | 33.9 |
| Total gas-carried heat. | 956,000 | 81.1 |
| Total heat produced at grate per square foot of grate per hour ..... | 1,179,000 | 100.0 |
| Heat lost by ashes and cinders ..... | 333,000 | |
| Total heat of coal..... | 1,512,000 | |

In this table and in the following investigation the transfer of the heat from grate to water is considered under two heads: (a) The heat radiated direct from the fire. (b) The heat carried from the fire to the heating surface by the products of combustion.

As pointed out by D. K. Clark in *The Steam Engine*, the heat leaves the fire surface in two forms. In the first place the glowing coal radiates heat direct through the ether to the fire-box walls, without affecting the atmosphere through which it passes. In the second place the gaseous products of combustion being heated to the temperature of the fire, carry off the remainder of the heat, of which they give up a certain portion as they come in contact with the surface of the fire-box and tubes. Pambour, in his treatise on "The Locomotive Engine," published in 1836, noticed these two forms of heat and pointed out the distinction to be observed between what he calls "radiative caloric" and "communicative caloric."

The amount of heat radiated by the fire is dependent only on the temperature of the fire and the surrounding fire-box. Peclet investigated the question of radiation, and his formula with a curve to facilitate its use is given in the appendix. It will be seen that in the case here considered the fire temperature is 1732 degrees F., giving a radiation of 223,000 B. T. U. per hour from each square foot of grate, or 18.9 per cent. of the heat produced at the grate. This radiated heat must be entirely absorbed by the fire-box surface, irrespective of the area. The fire-box heating surface and the tube ends immediately adjacent to the fire-box are the only parts exposed to the action of the radiated heat, and there is no opportunity for any radiation to escape.

Of the heat carried from the fire by the gases, a part is given up by the gases as they pass over the surface of the fire-box and the tubes, the remainder being carried with the gases into the smoke-box and lost. The amount of heat absorbed by the heating surface during the passage of the gases depends on the extent of the surface over which the gases pass, their rate of flow, and the rate at which the heat is transferred from the gases through the metal to the water. The laws governing this heat transference can be well studied by measuring the gas temperature at a number of points in the length of a flue. Such a series of tests not being immediately available, an attempt has been made to develop from first principles a formula to represent the relation between the heat extracted from the gases and the surface over which they pass. The methods adopted and the result obtained are set forth in the appendix. The formula (4) shows that with constant conditions of combustion, the heat absorbed is dependent only on the extent and not at all on the arrangement of the heating surface. That is to say, long and short tubes will absorb the same amount of heat, the amount of heating surface and the volume of gas being the same in both cases. This result was unexpected at first, but it appears to have a reasonable explanation. When two boilers have equal heating surfaces and tubes of different lengths, the shorter tubes must exceed the longer in number, and consequently offer a greater area for the passage of the gases. As the volume of gas passing per hour is the same for both boilers, it passes more slowly through the shorter tubes and the gases are in contact with the heating surface the same length of time in both cases. Though making an equal showing as to boiler economy, the shorter tubes show to advantage when the locomotive is considered as a whole. The two engines can be driven to the same power with less back pressure in the cylinders of that with the shorter tubes. The area of the tubes is greater, the length less, and the rate of gas travel slower, so that the resistance to the passage of the gases is less, and with the shorter flues a smaller smoke-box vacuum will maintain the same draft.

The formula (4) may be used for calculating the temperature at any point along the length of the flues. This was done for a number of points in the length of the Purdue boiler under the assumed conditions. The curve in Fig. 1 is plotted from these results and extended to show the temperature from the formula at the end of a 30-ft. flue.

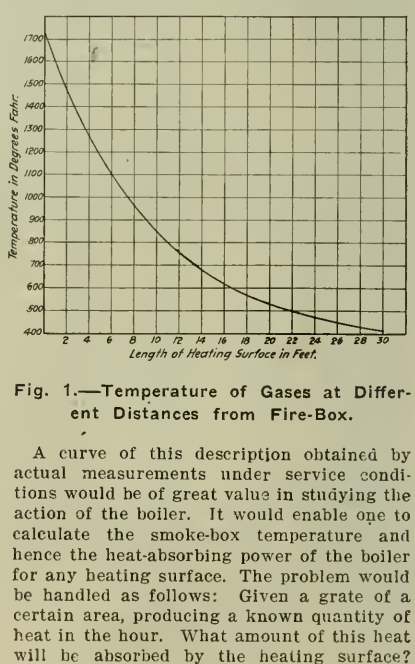



Fig. 1.—Temperature of Gases at Different Distances from Fire-Box.

A curve of this description obtained by actual measurements under service conditions would be of great value in studying the action of the boiler. It would enable one to calculate the smoke-box temperature and hence the heat-absorbing power of the boiler for any heating surface. The problem would be handled as follows: Given a grate of a certain area, producing a known quantity of heat in the hour. What amount of this heat will be absorbed by the heating surface? The temperature of the fire can be found from the known conditions of combustion, and hence the amount of radiated heat is easily found from the curve in Fig. 3. This heat is all absorbed by the boiler and can be counted on for evaporation. The remainder of the heat is carried off by the gases, and of this a certain proportion is absorbed. The proportion of heat absorbed depends, other things being equal, on the heating surface passed over by the gases. Now, if the grate remains of the same size, a change in the area of the heating surface means a

*See *Railroad Gazette*, April 22, 1904.

change in the ratio of grate area to heating surface. Consequently, an increase of the heating surface in proportion to the grate gives an increase in the proportion of the gas carried heat which is absorbed. Or, in other words, the proportion of gas-carried heat absorbed, is dependent on the ratio of grate area to heating surface. This relation is shown by the curve in Fig. 2, which is based on formula (5) of the appendix. The formula for the curve is not convenient for general use, but for all ratios of grate to heating surface between 40 and 100 the following approximate formula gives results very close to the actual curve.

$$p = 6.5 \sqrt{\frac{S}{G}}$$

where (p) is the percentage of heat absorbed from the gases, (S) is the heating surface, and (G) is the grate area; or

$$p = 6.5 \sqrt{C},$$

where (C) is the ratio of grate to heating surface.

In the case examined above the heat radiated from the grate amounts to 18.9 per

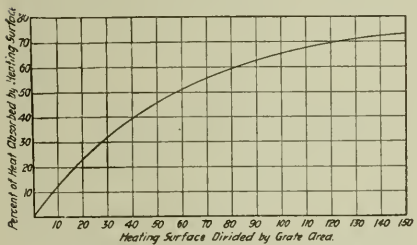

Percent of Heat Absorbed by Heating Surface
10 20 30 40 50 60 70 80
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Heating Surface Divided by Grate Area.

Fig. 2.—Curve of Heat Absorption.

cent., or, say, 19 per cent. of the total produced, leaving 81 per cent. to be carried off by the gases. Of this 6.5 $\sqrt{C}$ per cent. is absorbed, or 52.6 $\sqrt{C}$ per cent. of the total heat produced. Now to convert these figures into terms giving the evaporative power of the boiler. Under the assumed conditions each square foot of grate produces 1,179,000 B. T. U. per hour. The heat lost from the boiler by outside radiation would be a complicating factor in the following calculation, but for present purposes no great error will be made by deducting it directly from the heat produced at the grate, and taking no further account of it. This outside radiation loss was only taken into the former calculation for the sake of completeness, and not because it has any vital effect on the final results. Then deducting the outside radiation from the total heat produced, the remaining net heat available per hour for each square foot of grate is 1,164,000 B. T. U. If the feed water is supplied at a temperature of 65 degrees F., this heat is sufficient to produce 1,000 pounds of steam at 180 pounds boiler pressure. As the radiated heat is 19 per cent. of the heat produced, it will generate 190 pounds of steam per hour for each square foot of grate. The heat absorbed from the gases will generate 52.6 $\sqrt{C}$ pounds of steam per hour for each square foot of grate. Consequently, the evaporative power of the boiler is given by the formula:

$$V = 190\,G + 52.6\,G\,\sqrt{C},$$

or,

$$V = 190\,G + 52.6\,\sqrt{S.G} \quad ..(1)$$

where

V = pounds of steam at 180 lbs. boiler pressure produced per hour from feed water at 65 degrees F.

G = grate area in square feet.

S = total heating surface in square feet.

C = heating surface divided by grate area.

Under the conditions of the Purdue test this formula gives a correct value for the hourly evaporation, but it appears to give results which are rather too low for general conditions. The evaporation is only 5.65 pounds of water per pound of coal, while 6.5 or 7 would represent more nearly the best practice. If fuel of better quality is taken, the constants in the formula are increased and the relative amounts of gas-carried and radiant heat are considerably altered. For example, instead of coal of 13,000 B. T. U., take coal of 15,000 B. T. U., burning at 120 pounds per square foot of grate per hour, losing 18 per cent. of the heat in cinders,

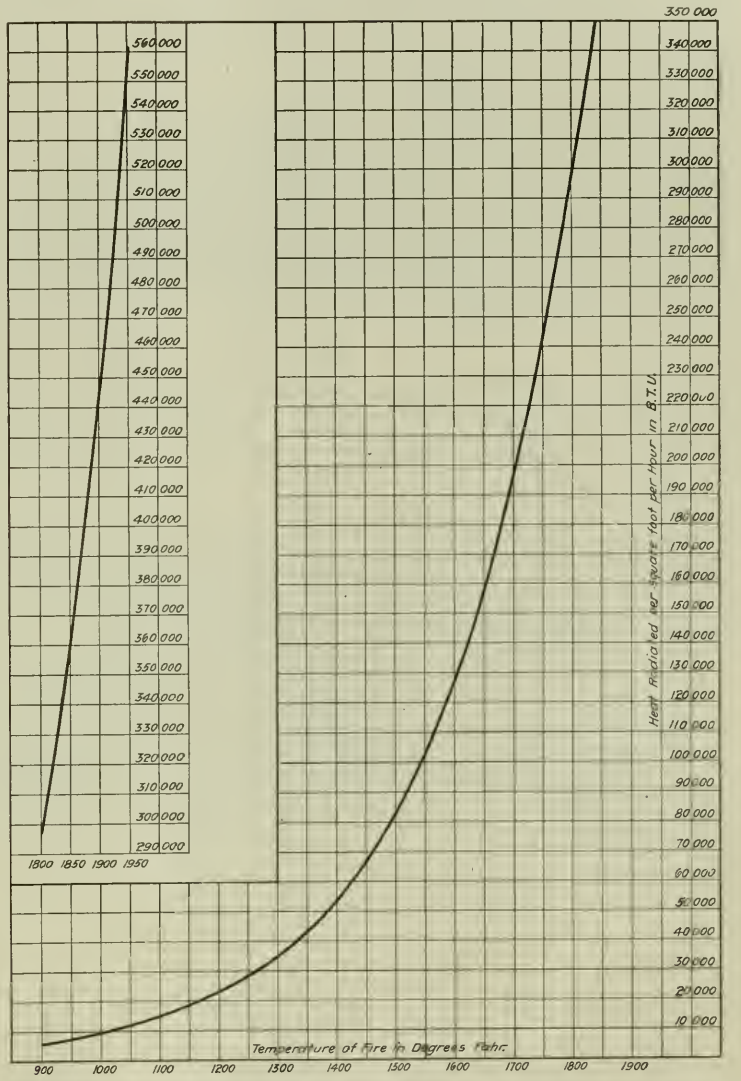



Fig. 3.—Diagram of Peclet's Formula for Quantity of Heat Radiated From Fire.

ashes, and outside radiation, and producing 19 pounds of gas per pound of coal. The heat at the grate will be 1,476,000 B. T. U. per square foot, or sufficient to produce 1,268 pounds of steam per hour. The fire temperature will be about 1,894 degrees, and of the heat produced about 29.8 per cent. will be radiated and about 70.2 per cent. carried off by the gases. The evaporation formula will be

$$V = 378\,G + 57.8\,\sqrt{S.G} \quad ....(2).$$

It will be noticed that in substituting excellent coal for that of medium quality the increase in evaporation is gained chiefly in that portion due to the radiant heat. The first term of the formula, which is that giving the evaporation due to the radiated heat, is practically doubled, while the second term, which gives the evaporation from the gas-carried heat, is only increased about 10 per cent. With a boiler of the proportions of the Purdue boiler the total evaporation is increased about 35.6 per cent. by using the better quality coal, while the actual heat at the grate is only increased 26.8 per cent.

The two formulæ (1) and (2) give evaporative results, respectively, too low and too high to represent general conditions, and a mean between the two will probably give results which more nearly represent average working conditions, as, say,

$$V = 280\,G + 55\,\sqrt{S.G} \quad ....(3).$$

Now to consider the foregoing in relation to tests to be made. The action of the radiant heat as covered by the first term of the evaporation formula is based on Peclet's work, which appears to be reliable. The second term of the formula is based on the curves in Figs. 2 and 3. These curves should be confirmed or replaced by curves plotted from temperature measurements on boilers in service. It is probable that while the general shape of the curves will be sustained, there will be some change in the proportions. The curves are calculated on the assumption that the rate of transfer of heat from gas to water is proportional to the difference in temperature between gas and water. Now it is certain that through the metal of the tube the

rate of transmission of heat is proportional to the difference in temperature between the two sides of the metal, but in the transfer of heat from the gases to the tube, and from the metal to the water, the relation between the rate of transfer and the temperature is not so well determined. It is probable that the rate of transfer of heat from tube to water is dependent on the rate of circulation of the water about the tube, as well as on the temperature, and that, consequently, the more rapid ebullition of the water about the fire-box and the fire-box end of the tubes, accelerates the transfer of heat and makes the part of the heating surface nearest the fire more efficient in reality than it is shown to be by the curves. If this is true a curve of fall of temperature plotted from experiments would drop more rapidly at the beginning than is the case with the curve in Fig. 1, and as a consequence, the actual curve of heat absorption would rise at the start more rapidly than the curve in Fig. 2.

The effect of various methods of feed water introduction could also be studied by comparing the curves showing the fall of temperature along the tubes. Any gain in evaporation would be accompanied by a corresponding lowering of the smoke-box temperature, and the differences in the shape of the curves would show just where the improvement was effected.

Formulæ (4) and (5), which are intended to give the evaporative power of a locomotive boiler, can be and should be checked in two ways. The first way, and one which lies readily to hand, is to compare the evaporation calculated by the formula with that actually obtained. The second and more far-reaching check is to carry out temperature measurements giving curves similar to those in Figs. 1 and 2, but plotted from actual observations. Then the principles on which the formulæ are grounded can be examined, and, if necessary, modified, and eventually a formula for the steam-producing power of a boiler can be built up by a logical process from observed facts.

APPENDIX.

*Combustion Conditions.*—The conditions of combustion chosen for the analysis of heat production and transference are those of test 23, reported by Prof. W. F. M. Goss, in his paper on "Tests of the Boiler of the Purdue Locomotive," presented at the New York meeting (December, 1900) of the American Society of Mechanical Engineers. (Trans., Vol. XXII., p. 453). To fully analyze the action of the fire it is necessary, in addition to the data given, to know the heat lost by ashes and cinders. This is therefore assumed to be 22 per cent. of the total heating value of the coal. Professor Goss gives the heating value as approximately 13,000 B. T. U. per pound of dry coal, and this figure is used for present purposes. The outside radiation from the boiler is assumed to be 1 per cent. of the total heating value of the coal.

On each square foot of grate 116.3 pounds of coal are burned per hour, producing 1,512,000 B. T. U. per hour. The total heat effective in evaporation, as reported in Professor Goss's paper (col. 35, p. 468), is 220,000 B. T. U. per minute, that is, 765,000 B. T. U. per square foot of grate per hour. Consequently, the difference (747,000 B. T. U. per square foot of grate per hour) is lost, and this lost heat is divided as follows:

| | Per Hour. |
|---|---|
| Total heat lost per sq. ft. per hour..... | 747,000 |
| Heat lost in ashes and cinders (22 per cent. of total)..... | 333,000 |
| Heat lost by outside radiation (1 per cent. of total)..... | 15,000 |
| | 348,000 |
| Remainder ..... | 399,000 |

This remainder is the amount of heat carried to the smoke-box by the products of combustion from each square foot of grate. As the smoke-box temperature is 724 deg. F., and the specific heat of the products of combustion is 0.24, the weight of gases passing through the smoke-box per hour must be 2,300 pounds per square foot of grate, or 19.75 pounds for each pound of coal burned. From this information and Peclet's formula the temperature of the fire can be calculated as explained below.

The following results are obtained:

| | B. T. U. Per Hour. |
|---|---|
| Total heat of coal per sq. ft. of grate.. | 1,512,000 |
| Losses by ashes and cinders..... | 333,000 |
| Heat produced at grate..... | 1,179,000 |

The fire temperature is found to be 1,732 degrees F., the heat being carried away as follows:

| | B. T. U |
|---|---|
| Heat radiated from each sq. ft. of grate. | 223,000 |
| Heat carried by gases from each sq. ft. of grate ..... | 956,000 |
| Total heat from each sq. ft. of grate.. | 1,170,000 |

Of the 956,000 B. T. U. of heat carried by the gases, 399,000 B. T. U. are lost in the smoke-box, leaving 557,000 B. T. U. to be absorbed by the heating surface. The total heat absorbed by the boiler is therefore 780,000 B. T. U., and 15,000 B. T. U. being lost by outside radiation, leaves 765,000 B. T. U. effective for evaporation. If the outside evaporation loss is divided proportionately between the radiated and the gas-carried heat, the amount of effective heat absorbed from the gases is 546,000 B. T. U., while the effective heat radiated from the fire is 219,000 B. T. U. These results are summarized in the table in the body of the article.

*Radiated Heat.*—Peclet's formula as given by D. K. Clark in the *Steam Engine*, gives a means of calculating the amount of heat radiated per hour from each square foot of a coal or coke fire, the temperature of the fire being known. The formula is:

$$R = 144\ a^t\ (a^d - 1)$$

where R is heat radiated per hour in B. T. U., t is temperature of enclosure in degrees F., d is difference between temperatures of fire and enclosure in degrees F., and a = 1.00425. Then if the boiler pressure is 180 lbs. per sq. in. and (T) is the fire temperature t = 380 deg. F. and d = T — 380. On this basis the curve in Fig. 1 has been constructed showing the rate of radiation for all fire temperatures between 900 deg. and 1,900 deg. F. It will be seen that with increasing temperature the rate of radiation increases very rapidly. In giving the above formula Clark explains fully the method of applying it to the calculation of fire temperatures. The weight of gases passing each square foot of grate being known, the amount of heat carried by the gases at any temperature of the fire is known. Then by trial a temperature is found at which the heat carried by the gases, together with the heat radiated, just amounts to the total heat produced at the grate.

*Temperature Lost by Gases in Passing Over Heating Surface.*—Assume that the rate of transfer of heat from the gases in the boiler tubes to the water in the interior of the boiler, is proportional to the difference of temperature between the two points. This is in accordance with Rankine's work, and gives a point from which to start.

Let S = the heating surface in square feet;
h = the time in hours;
w = the weight of gas in pounds per square of grate per hour;
G = the grate area in square feet;
r = the specific heat of the gases;
m = the number of B.T.U. transmitted through each square foot of heating surface for each degree of temperature difference;
T = the temperature of the gases in deg. F.;
$T_b$ = the temperature of the water and steam in deg. F.;
t = $T - T_b$ the difference of temperature in deg. F.

Then the heat transferred through the element of heating surface $\triangle S$ in the element of time $\triangle h$ is (m) (t) ($\triangle S$) ($\triangle h$). The gas passing in this time is (w) (G) ($\triangle h$), and in consequence of the above heat transference the temperature loss is $-\triangle t$; then the heat lost by the gas is $-(\triangle t)$ (r) (w) (G) ($\triangle h$), and equating the heat transferred and the heat lost by the gas:

$$(m)\ (t)\ (\triangle S)\ (\triangle h) = -(\triangle t)\ (r)\ (w)\ (G)\ (\triangle h)$$

therefore, $\left(\frac{r\,wG}{m}\right)\left(\frac{\triangle t}{t}\right) = -\triangle S$

Now if a steady rate of combustion is maintained $\frac{r\,wG}{m}$ remains constant and may be replaced by the symbol (k). Then

$$k\,\frac{\triangle t}{t} = -\triangle S$$

and reducing the differences to their limiting values

$$k\,\frac{dt}{t} = -dS;$$

hence $k\int \frac{dt}{t} = -\int dS$

or, integrating to limits as shown,

$$k\left[\log_e t\right]_t^{t_o} = -\left[S\right]_s^o$$

hence $k\,(\log_e t_o - \log_e t) = S$

Here ($t_o$) is the initial temperature of the gases on leaving the fire and the logarithms are to the base (e). By substituting $K = \frac{k}{2.303}$ for (k) the logarithms are transformed to the usual base 10 and the expression becomes:

$$K \log\left(\frac{t_o}{t}\right) = S \quad \ldots (4)$$

The Purdue test analyzed above affords an opportunity for determining the value of the constant K in a particular case. The heating surface is 1,347 sq. ft., the steam pressure is 122.5 lbs. per sq. in. corresponding to a boiler temperature of say 352 deg. The fire temperature is 1,732 deg. and the smoke-box temperature is 724 deg. Hence K log $\frac{1380}{372}$ = 1347 and K = 2360. On this basis the curve in Fig. 2 is plotted.

The flues are 11.5 ft. long and have 1,204 sq. ft. of heating surface, so that if the fire-box heating surface be treated as though it were an extension of the flues the total heating surface of 1,347 sq. ft. will have a representative length of 12.8 ft. The curve in Fig. 1 shows how the temperature falls from an initial temperature of 1,732 deg. to a temperature of 724 deg. after passing over 12.8 lin. ft., or 1,347 sq. ft. of heating surface. If the tubes were extended, other conditions remaining the same, the temperature would fall as shown, up to a flue length of 30 ft.

In equation (4) the constant includes the area of the grate since $K = \frac{P\,wG}{2.303m}$. This is eliminated by writing $K_1 = \frac{P\,w}{2.303m}$, so that equation 4 becomes:

$$K_1 \log\left(\frac{t_o}{t}\right) = \frac{S}{G} \quad \ldots (5)$$

This gives the smoke-box temperature (t) in terms of the initial temperature ($t_o$) and the ratio of grate to heating surface $\left(\frac{S}{G}\right)$. This equation, with $K_1$ having the value obtained from the Purdue test, is plotted in the curve in Fig. 3.

## Railroad Shop Tools.

AXLE LATHES (*Continued*).

The double end axle lathe shown in Fig. 1 is made by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio. This machine embodies several novel features. The bed is of an entirely new and massive design. It is provided with separate ways for the carriages and tailstocks, the ways for the latter being in the form of a dovetail inclined at an angle. The base of the tail-stock engages directly into the dovetail and the upthrust of the cutting tool is taken directly by the casting instead of on clamping bolts. Throughout the entire length of the bed are four vertical beams, or webs, so placed that the strains on the tail-stock act up through the two rear webs, while the two front webs come directly under the carriage and receive the entire downward pressure of the cutting tool.

The driving mechanism consists of a three-step cone running between self-oiling bearings and having diameters of 20 in., 25 in. and 30 in. by 6½-in. face. The inner end of the cone shaft is connected through two changes of gearing directly to a short driving shaft at the back of the lathe. This driving shaft is geared into a central driving gear 30 in. in diameter by 4 in. face, mounted between bearings at the center of the bed. An equalizing driving plate having a 15 in. opening in its center transfers the power to the axle. The ratios of gearing between the cone-pulley-shaft and central driving gear are 6.1:1 and 20.9:1, which, with the three changes on the cone-pulley, gives six cutting speeds. A hand-wheel and shaft near the cone-pulley provide means of changing from one gear to the other.

The carriages are arranged to take one or more tools. The feed instead of being obtained by a rack and pinion is got by a bronze nut 14 in. long, which encircles the stationary lead screw. This screw is cut with a double thread having a 1 in. lead. With this arrangement, it is claimed that a more powerful feed is obtained, and also greater wearing qualities. The nut is revolved for the regular feed by a feed rod driven by gears from the cone pulley shaft.

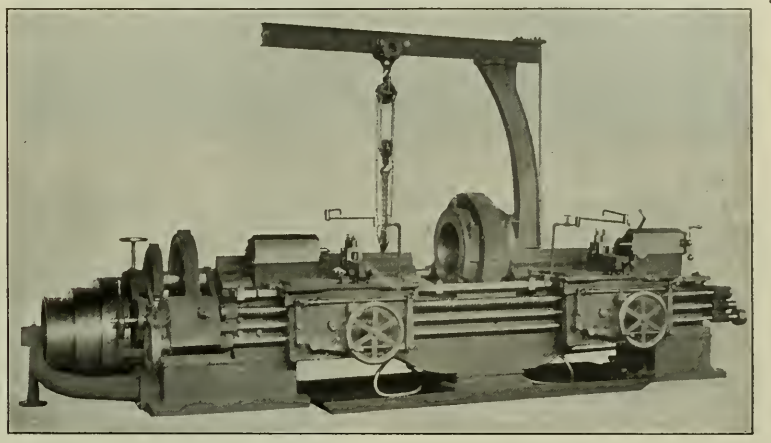


Fig. 1—The Lodge and Shipley Double Axle Lathe.

Another feed rod directly under this, driven by an independent belt, runs constantly at a high speed and affords a means of moving the carriage rapidly in either direction. At the front of the apron are three levers. The one at the left starts or stops the feed; the lever at the bottom is for reversing, and that at the right applies the quick movement to the carriage. A safety device in the apron prevents the feed for turning and the feed for the quick movement being engaged at the same time. The hand wheel movement can always be used. Automatic stops in both directions for each carriage are provided and calipering stops can be applied to each tool for duplicating diameters. Shear wipers keep the ways free from dirt and grit.

The tail-stocks are shaped to allow the carriage to pass when starting a cut at the end of the axle. A rack and pinion movement facilitates the movement of both tail-stocks to accommodate different lengths of axles. A pawl in the rear of each tail-stock engaging in this rack forms a positive lock against end movement. The tail-stock spindle instead of being round is a dovetail with a gib at the bottom for taking up the wear.

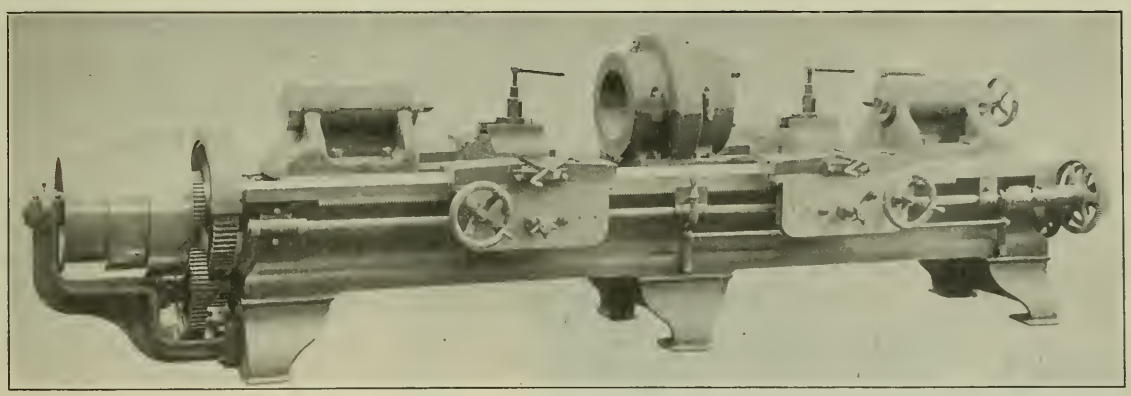


Fig. 2—The Bridgeford Double Axle Lathe.

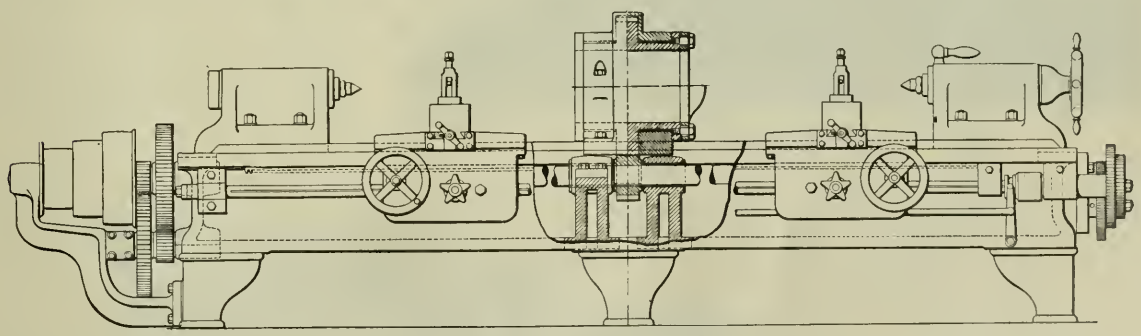


Fig. 3—The Bridgeford Double Axle Lathe.

The feeds obtainable on this lathe are six in number—3-5-8-11-16 and 32 to an inch—any of which can be obtained while the machine is running, by a movement of a lever shown at the head of the lathe. The complete weight of this axle lathe with countershaft, oil pump and pan is 19,000 lbs.

The double end axle lathe shown in Figs.

Locomotive No. 303 Before Rebuilding.

## Rebuilding Locomotives—Philadelphia & Reading.

BY S. F. PRINCE, JR.

The examples of rebuilding shown herewith are the outcome in one case of frequent breaking of frames and cylinders and in the other of an effort to increase the adhesion of an engine in order to handle trains when running in average or in pooled service. The first case is that of a Columbia or 2-4-2 type of engine which was frequently shopped on account of broken frames and cylinders. In rebuilding it was desirable, if possible, to make it a more efficient engine. With that in view it was decided to replace the trailing wheels with driving wheels, thus making it of the mogul type (2-6-0) and suitable for heavy passenger service. The photographs of engine 303 will clearly show the design before and after rebuilding. The pony or engine truck is not equalized with the drivers, the weight going to the truck being directly transmitted to it through a solid, cast-iron bed plate or frame filling-casting which is bolted between the front frames and has a center plate cast thereon. The only change made in the boiler was to remove the combustion chamber and to substitute shaking for water-bar grates.

Locomotive No. 303 After Rebuilding.

Placing 78 in. driving wheels under the wide fire-box necessitated raising the boiler up for clearance, and this required that the pops and whistle be removed from the dome on account of overhead clearance and placed on a turret on the back of the boiler. The ash-pan is provided with side pans equipped with adjustable side registers for draft regulation. The frames, guide yoke and tail piece are cast steel, the latter being held in place by bolts and vertical wedges.

In the case of engine 317, originally having a single pair of drivers (4-2-2 type), it was found to be practically impossible to find a service for which this type of engine was adapted. It might have a suitable train one way over the road but on the return trip the load or number of stops would almost invariably render schedule time an impossibility. Also when shortage of power

Locomotive No. 317 Before Rebuilding.

Locomotive No. 317 After Rebuilding.

2 and 3 is built by Charles Bridgeford, Rochester, N. Y., and is designed to meet modern tool steel requirements. The main driving spindle is crucible steel 3 15/16 in. in diameter, and runs the entire length of the lathe in six brass boxes. The spindle is connected to the driving head by a heavy steel pinion 8½ in. in diameter with a 4 in. face, which runs between two heavy brass bearings 9 in. long. The driving head is fitted with two brass liners each 6 in. wide and 15½ in. in diameter, in which the steel driving gear revolves. The driving head has an opening of 13 in. for the axle to pass through, and has a double self-centering steel driver. The axle revolving on dead centers is turned and finished complete at each end without reversing. The cone has three steps for a 6 in. belt, the largest step being 24 in. in diameter and the smallest being 18 in. The cone is fitted with brass bushings. There are two independent carriages, each having a bearing on the ways of 30 in. The carriages are driven by a spline in the feed shaft with rack and pinion.

There are four changes of feed, which are connected to the main driving spindle by gearing, and are so arranged that two different feeds can be had for each change of gear on the feed shaft. The feeds are arranged so that the roughing cuts can be instantly changed to finishing cuts, or vice versa, by shifting the lever at the front of the machine. The tail-stocks are 24 in. long and 19 in. wide, and are secured to the bed with four bolts and heavy binders. The left-hand tail-stock is split and is adjustable. The spindle in the right-hand tail-stock is adjusted by a steel screw and hand wheel, and in both tailstocks the spindle can be clamped with split binders. The centers are tool steel 2 in. in diameter The feed shaft is steel 1 15/16 in. in diameter. All pinions, large and small, are steel. Pulleys on the countershaft are 18 in. in diameter by 7¼ in. face, fitted with brass bushings. The bushings and the hangers are self-oiling. The maximum distance between centers is 7 ft. 8 in.; the swing over the ways is 27 in., and the swing over the carriage is 14 in. The bed is 28½ in. wide and 18 in. deep, reinforced with heavy box cross-ties. The weight of this lathe is 15,000 lbs. net.

*(To be continued.)*

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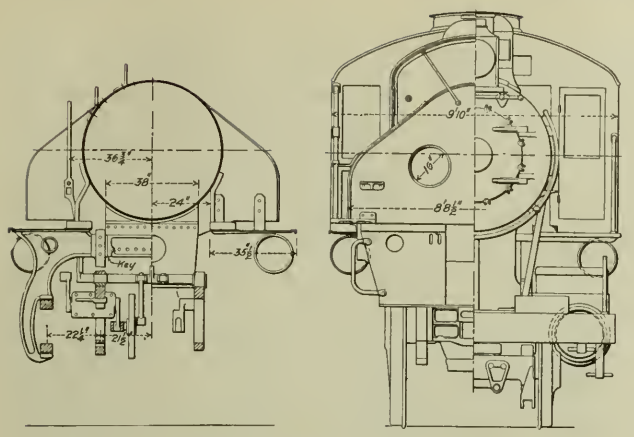
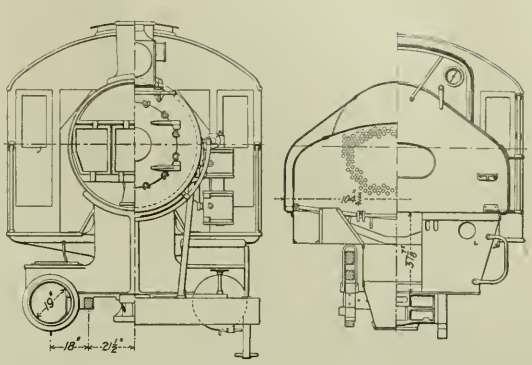
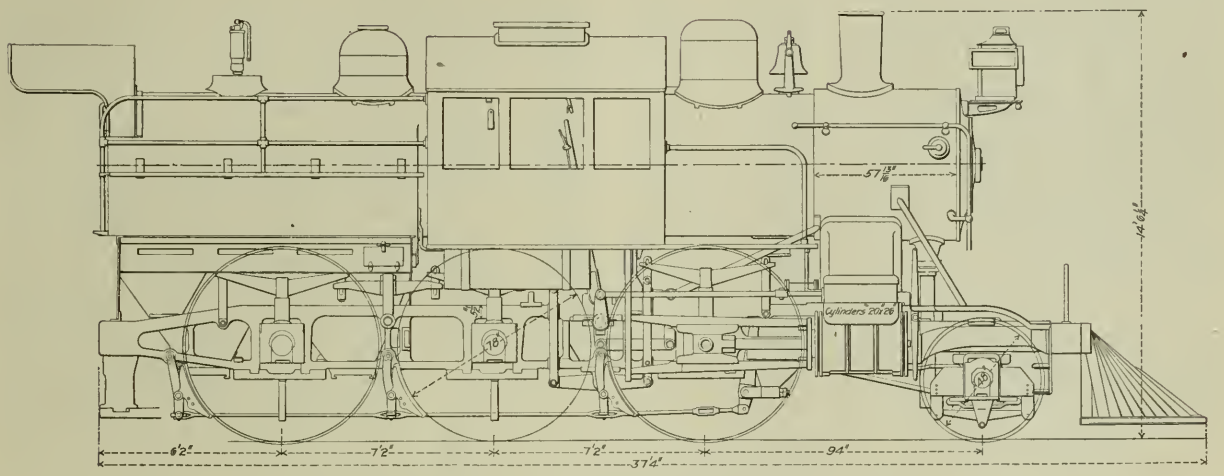
The travel on the city elevated railroads in Vienna, which have been opened only a few years, decreased about 5½ per cent. in 1903, and the working expenses were 110 per cent. of the earnings in 1903, against 109 per cent. the year before. When the road was built it seemed very much needed; but the street horse railroads have been changed to electric lines since. The elevated is still worked by steam, but there is talk of changing to electricity.



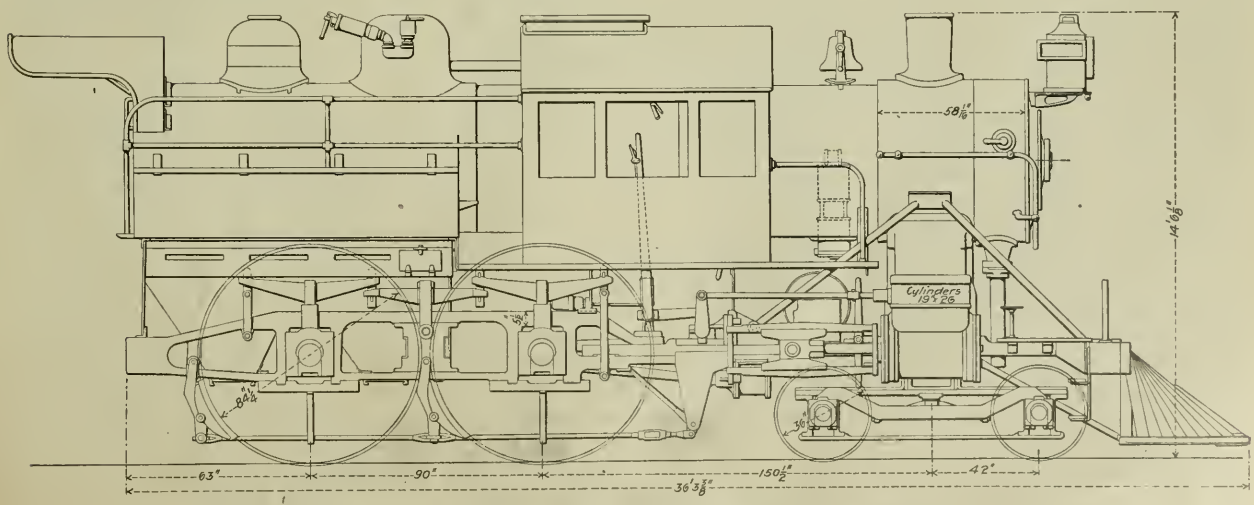

Rebuilt Locomotive No. 303.




Rebuilt Locomotive No. 317.




Locomotive No. 303 After Rebuilding—Philadelphia & Reading.




Locomotive No. 317 After Rebuilding—Philadelphia & Reading.

exists (a chronic condition in American railroad service) and the engine pool is resorted to, an engine of this type is utterly unfitted for the service. The pioneer engine of this type built in 1880 with a traction increaser failed to overcome the above objections, and the tendency to slip required frequent shopping of engine for tire turning. In the rebuilding, another pair of driving wheels of the same size (84¼ in.) were placed under the engine, and changes in the boiler similar to those made on the Columbia type were made. Seventeen engines with 78 in. driving wheels and two engines with 84¼ in. wheels are now in service. The accompanying table gives the principal dimensions of both classes of engines before and after rebuilding.

Rebuilding Locomotives.

| Engine number | 317. | | 303. | |
|---|---|---|---|---|
| | Original. | Rebuilt. | Original. | Rebuilt. |
| Type | 4-2-2 | 4-4-0 | 2-4-2 | 2-6-0 |
| Simple or compound | Compound | Simple | Compound | Simple |
| Cylinder diameter, h. p., in. | 13 | 19 | 13 | 20 |
| Cylinder diameter, l. p., in. | 22 | .. | 22 | .. |
| Piston stroke, in. | 26 | 26 | 24 | 26 |
| Type of valve | Piston | Rich. Bal. | Piston | Rich. Bal. |
| Diameter of valve, in. | 11½ | .. | 10½ | .. |
| Lap of valve, h. p., in | ⅞ | 1¼ | ⅞ | 1¼ |
| Lap of valve, l. p., in | ⅝ | .. | ⅝ | .. |
| Exhaust clearance, in. | ⅛ | ⅛ | 0 | ⅛ |
| Travel of valve, in. | 5⅝ | 7 | 5 | 7 1-32 |
| Lead of valve, in. | 1-10 | 1-10 | 1-10 | 1-10 |
| Steam port length, in. | 27 | 19 | 27 | 19 |
| Steam port, width, in. | 1½ | 1⅝ | 1½ | 1⅝ |
| Exhaust port length, in. | 27 | 19 | 27 | 19 |
| Exhaust port width, in. | 4½ | 3 | 4½ | 3 |
| Diam. of boiler (front), in. | 58¾ | 58¾ | 57½ | 57¼ |
| Number of flues | 373 | 279 | 324 | 285 |
| Diam. of flues, in. | 1½ | 1¾ | 1½ | 1½ |
| Length of flues (over sheets), ft. and in. | 10 3 | 13 7⅜ | 10 0 | 13 4⅜ |
| Combustion chamber | With | Without | With | Without |
| Grate, length, ft. and in. | 9 6 | 9 6 | 9 6 | 9 6 |
| Grate, width, ft. | 8 | 8 | 8 | 8 |
| Grate, area, sq. ft. | 76 | 76 | 76 | 76 |
| Height from rail to center of boiler, ft. | 8 9¼ | 9 9 | 8 4 | 9 4 |
| Heating surface, flues, sq. ft. | 1.489 | 1,730 | 1,261 | 1,628 |
| Heating surface, furnace, sq. ft. | 175 | 137 | 168 | 137 |
| Heating surface, total, sq. ft. | 1,664 | 1,867 | 1,429 | 1,765 |
| Steam pressure, lbs. | 200 | 200 | 175 | 175 |
| Wheel base (driving), ft. and in. | .. | 7 6 | 13 10 | 14 4 |
| Wheel base (total), ft. and in. | 22 9 | 23 6½ | 23 4 | 23 8 |
| Wheel diameter (drivers), in. | 84¼ | 84¼ | 78 | 78 |
| Wheel diameter (truck), in. | 36 | 36 | 48 | 48 |
| Wheel diameter (trailers), in. | 54 | .. | 48 | |
| Weight on drivers, lbs. | 53,200 | 100,800 | 73,300 | 131,400 |
| Weight on truck, lbs. | 43,900 | 46,700 | 32,400 | 27,900 |
| Weight on trailers, lbs. | 29,500 | ..... | 34,300 | ..... |
| Weight, total, lbs. | 126,600 | 147,500 | 140,000 | 159,300 |

## Heating Surface and Boiler Power.

BY L. B. JONES.

The question has already been asked whether large heating surface pays, or whether it is necessary. The present fad, if such we may call it, for excessive heating surface had its origin at the same time grate areas were increased, and at that time it seemed to be the logical course. The result was a better steaming engine, but was the improvement due to the increase in heating surface, or to the larger grate? In connection with this question the accompanying speed diagram of a performance by one of the Pennsylvania $E_2$ engines is interesting. As is well known to the readers of the *Railroad Gazette*, the fastest train service in the world is maintained between Camden, N. J., and Atlantic City by the Pennsylvania and the Philadelphia & Reading railroads. The schedule of both roads calls for a 60-minute trip from the Philadelphia wharf to Atlantic City, including the ferry across the Delaware River and the transfer of passengers. By the Pennsylvania route the ferry and transfer requires at least six minutes, so that the 58.3 miles from Camden to Atlantic City must be regularly run in 54 minutes and often in a considerably shorter time. By the Reading route the ferry is longer and the railroad somewhat shorter, but the speed diagrams of the two runs and the profiles of the roads are very similar. The accompanying speed diagram was taken on Pennsylvania train 269 on Sept. 18, 1903, leaving Market St. wharf at 5:00 p. m. and due in Atlantic City at 6:00 p. m. The times given were taken by two observers and are substantially correct, the speed diagram having been plotted by noting the time at each mile post.

| | Hrs. | Mins. | Sec. |
|---|---|---|---|
| Leave Camden | 5 | 6 | 38 |
| Pass Winslow Junction | 5 | 33 | 36 |
| Pass Drawbridge | 5 | 56 | 25 |
| Arrive Atlantic City | 5 | 59 | 6 |

The distance from Winslow Junction to Drawbridge on this run was covered in 22 minutes 49 seconds, or 80.5 miles per hour for 30.6 miles.

The train consisted of a locomotive and seven cars, as follows:

| | Weight, Lbs. |
|---|---|
| 5 Penn. R. R. "Pk." coaches | 295,000 |
| 1 Penn. R. R. "Cb" parlor car | 68,800 |
| 1 Penn. R. R. "club car" (est.) | 50,000 |
| Locomotive 6065 | 176,600 |
| Tender one-half loaded | 104,000 |
| 350 Passengers (est.) | 52,500 |
| Total, engine and train | 746,900 |

The 6065 was built in 1901 and is one of the earlier $E_2$ engines. All the engines of this class built since June, 1902, have been designated Class $E_{2a}$ and have a Belpaire boiler and more weight on drivers than class $E_2$, which has a straight top boiler and radial stays. The principal dimensions of the 6065 are as follows:

| | |
|---|---|
| Wheel arrangement | 4-4-2 |
| Total weight in working order, lbs. | 176,600 |
| Weight on drivers, lbs. | 109,033 |
| Cylinders, in. | 20½x26 |
| Diameter of driving wheels, in. | 80 |
| Type of boiler | Straight radial stay |
| Grate area, sq. ft. | 55.5 |
| Length of tubes, ft. | 15 |
| Heating surface, total, sq. ft. | 2,640 |
| Heating surface, fire-box, sq. ft. | 166 |
| Working steam pressure, lbs. | 205 |
| Ratio of heating to grate surface | 47.56 |

The practice in making up trains for this run is to place about a dozen cars on the stub track and unlock the coaches as the forward ones fill up, so that the train load is never heavier than necessary and the seats are always well filled.

This is very fast running, but this particular run is in no way unusual—the service is maintained all the year round by one train each day, and during the busy summer season three 60-minute trains are run by each road. The train load is often heavier than seven cars, and the schedule is easily made with 10 cars, or a total weight of train of 946,400 lbs. The profile shows that there are no grades steeper than 30 ft. per mile, and outside of the Camden City limits there are no curves as sharp as 2 degs. The line between Winslow Junction and Absecon is a tangent with a total fall in favor of the locomotive of about 3.5 feet per mile—too small to be considered at a speed of 80 miles per hour. Water was taken from the track tanks just before passing Winslow Junction, and from this point to Drawbridge the average speed was 80.5 miles per hour.

There are undoubtedly many special runs and runs to make up time on record which exceed this performance in point of speed, but the writer believes that there is only one other place in this country where a speed of 80 miles per hour is attained in regular daily running, and there only for a few miles.

The various formulæ for train resistance are widely at variance for high speeds, so that any attempt to compute the power developed is more or less unsatisfactory; but for purposes of comparison the method used by Mr. E. L. Coster in a letter to the *Engineer*, of London, of Nov. 13, 1903, furnished some interesting data. Mr. Coster describes a performance by Atlantic-type locomotive 483 on the Michigan Central, in which a train of 16 cars weighing 605.57 tons was hauled 118.22 miles in 127 minutes, or a speed of 55.8 miles per hour. The rolling resistance of the train was taken from the *Engineering News* formula, the wind resistance was computed from the formula by Prof. Goss, and 10 per cent. was added to the total cylinder tractive effort for engine friction; the results showing a drawbar horse-power of 1597.37, a total horse-power of 2123.38, and a total water consumption, at the rate of 27 lbs. per i.h.p. per hour, of 57,331 lbs. per hour. The locomotive has a large heating surface (3,505 sq. ft.), so that the evaporation per sq. ft. of heating surface per hour was only 16.28 lbs., but the grate area, 50.3 sq. ft., is practically the same as that of the 6065, which is 55.5 sq. ft.

Applying these calculations to train 269 of the Pennsylvania, we obtain the following results:

For the internal tractive resistance of the train, from the *Engineering News* formula:

$$R = 2 + \frac{V}{4} = 2 + \frac{80.5}{4} = 22.1,$$

where R is the resistance in lbs. per ton of 2,000 lbs. For the wind resistance of the train Prof. Goss' formula gives:

$$R_a = (.016 + .02C)V^2,$$

and for the engine and train

$$R'_a = (.13 + .02C)V^2,$$

where $R_a$ is the total wind resistance in lbs., C is the number of cars in the train, and V is the speed in miles per hour. Substituting in the above, C = 7 and V = 80.5, we have

$$R_a = .156\,V^2 = 1011 \text{ lbs},$$

and $R'_a = .27\,V^2 = 1750$ lbs.

The drawbar tractive effort for the train of 233 tons then becomes:

$$T'_d = 233 \times 22.1 + 1011 = 6160 \text{ lbs.}$$

The total cylinder tractive effort for the entire train of 373.5 tons, adding 10 per cent. for engine friction, will be:

$$T = 373.5 \times 22.1 \times 1.1 + 1750 = 10{,}830 \text{ lbs.}$$

The horse-power developed is found from the formula:

$$\text{H.P.} = \frac{\text{Trac. effort} \times \text{speed in miles per hr.}}{375}$$

The drawbar h.p. then becomes:

$$\frac{6160 \times 80.5}{375} = 1322,$$

and the total indicated h.p.:

$$\frac{10{,}830 \times 80.5}{375} = 2325.$$

Mr. Coster assumes a steam consumption of 27 lbs. per i.h.p. per hour, and at this rate the Pennsylvania engine would require 2325 × 27, or very nearly 63,000 lbs. of water per hour. At this speed, however, it is reasonable to assume that the cylinders were using the steam economically, and if we assume a consumption of 24 lbs. per i.h.p. hour we have a total consumption of 55,800 lbs. per hour, or an evaporation of 21.1 lbs. per sq. ft. of heating surface per hour.

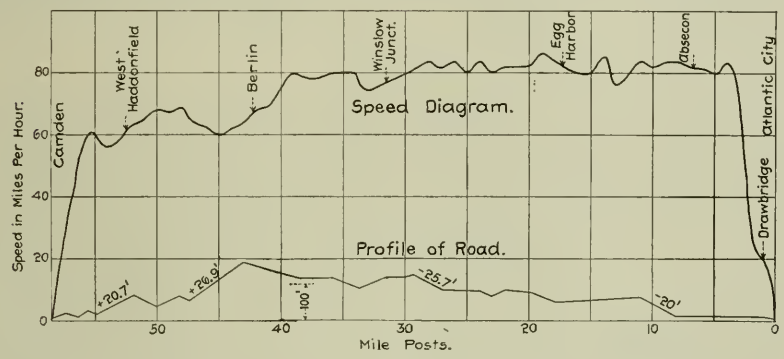
These figures are, perhaps, too high, but they afford an excellent basis for a comparison. We do not know whether the Michigan Central locomotive was forced to the limit of its boiler, but we know that the Pennsylvania engine was not forced to its full capacity because all the conditions were the best and the train was not heavy. Tests have been made which indicate that the maximum evaporation of a boiler is about 15 lbs. per sq. ft. of heating surface per hour, and in view of this fact the above figure of 21.1 lbs. seems large. This may be the case, but we know that in the recent high-speed trials at Zossen in Germany a horse-power of 1800 is reported for a train of 250 short tons at a speed of 79.5 miles per hour.

The confusion among the train resistance formulæ is shown by the following table for 80 miles per hour, the resistance being given in lbs. per ton of 2,000 lbs.:

| Formula. | Conditions. | Resistance, Lbs. |
|---|---|---|
| Wellington | Engine and train | 39.3 |
| Baldwin | (47 to 77 miles per hr). | 17.5 |
| Barbier | Bogie coaches | 18.5 |
| Barbier | Engine and tender | 38.6 |
| Sinclair | | 18.9 |
| Aspinall | Bogie coaches | 25 |
| Barnes | Engine and train | 13.5 |
| Meth. used above | Engine and train | 29 |

So far as the cylinders are concerned, the above steam consumption is quite possible. The Class $E_2$ engines cut-off in the running position at 6⅜ in., and the weight of dry steam required by the displacement to cut-off, at 160 lbs. pressure, is 38,700 lbs. per hour at 338 r.p.m., or 80.5 miles per hour. If we add to this 30 per cent. of the total water consumption for extra losses, such as initial condensation, we have a cylinder consumption of 55,300 lbs. per hour.

The point of chief interest is that the boiler with 2,640 sq. ft. of heating surface can maintain an output equal to the one with 3,505 sq. ft. as shown by the above comparison. The most striking feature of the Pennsylvania boiler is the liberal water space around the fire-box and the wide throat, insuring ample circulation around by far the most valuable heating surface in the boiler. Another peculiarity of the design which may or may not affect the circulation is the placing of the injectors on the back-head and carrying the feed-water well to the front by pipes running inside the barrel. There is no ground for the assertion that a big heating surface is useless, but there is ground for question whether it is necessary, and whether the maintenance of a large number of tubes does not offset the advantage. This is very clearly stated in Mr. Vaughan's paper* on the "Value of Heating Surface," and his deductions show that the evaporation of a boiler per lb. of coal was not decreased by stopping up half the flues. The limit to the capacity of a boiler on a fast passenger locomotive is the grate area; and granting that the all-important draft arrangements are properly designed, and that there is ample fire-area through the tubes, the locomotive with a large grate and liberal circulation will prove itself a free steamer without much consideration as to its heating surface. The Class $E_2$ engines with their large grates are doing in the Atlantic City service what Class $D_{16}$, which has only 33 sq. ft. of grate, failed to do. Class $D_{16}$ did, of course, good work in less severe service.




Speed Diagram—Atlantic City Division of the Pennsylvania.

The cry has been raised for something definite in ratios for boiler design. The chief value of ratios in locomotive design is to serve as a check on the work. A complete outfit of perfect ratios will not make a free steaming engine when the fundamental consideration of circulation is overlooked, and the engine has cracked side-sheets and other fire-box difficulties.

## Alloy Steels.†

The term "alloy steels" is used chiefly to distinguish steels containing influencing quantities of metals other than iron, from the ordinary steel of commerce known as carbon steel, in which, iron and carbon are the influencing elements for use, other elements being considered more as impurities than as useful ingredients. There are three kinds of carbon steel, namely: crucible, bessemer and open hearth. They contain small quantities of phosphorus, sulphur, silicon and manganese, as well as oxygen, nitrogen and hydrogen. Copper and arsenic are present sometimes but not generally in large quantity. Small percentages of silicon and manganese are often regarded as useful for special purposes but they do not give a specific name to the steel. From time to time we have had upon the market silicon steel, phosphorus steel, chrome steel, aluminum steel, but none have been permanent. Nickel steel, manganese steel, self-hardening or air-hardening steel and high-speed steel are permanent alloy steels.

Nickel steel containing small parts of nickel is used chiefly for structural purposes, and gives strength and toughness. It has been used mostly for armor plates and gun parts, and lately it is being tested in rails.

Hadfield's manganese steel is unique, hard, tough, non-magnetic, non-hardening by quenching, non-annealable by any known method, and practically unmachineable. There is nothing to compare it to, nor to test it by. It is finding large use for a number of special purposes.

Self-hardening or air-hardening steel derives its name from the fact that when it is heated to an orange color and allowed to cool slowly in the air it becomes exceedingly hard. Some years ago it was known generally as Mushet steel, from the fact that the first development was due to the distinguished metallurgist whose name it bore. The usual composition of this steel is about 2 to 3 per cent. manganese, 4 to 6 per cent. tungsten and carbon high. The distinctive, persistent hardness of manganese steel indicates that it is manganese that gives this steel its so-called self-hardening property. This was confirmed many years ago by Langley, who found that steel high in carbon, containing about 4 per cent. tungsten and minute quantities of manganese had no self-hardening property, and that the same steel remelted so as to contain 3 per cent. manganese became an excellent self-hardening steel. Langley next showed by his emery wheel test that tungsten is the element that acts as a mordant to hold the carbon in solution at a high temperature, giving this steel its most valuable property, namely, that of remaining hard at a comparatively high temperature, so that a tool made of it could be used for cutting metals at a hign speed.

Air-hardened steel, as a rule, is not tough; that is to say, if it is made tough it will not be very hard, and the edge of a tool will flow. When it is so hard that it will not flow then it is so brittle that it will crumble easily. A few years ago at the Bethlehem Steel Works, some person (whether he was a blunderer or a genius history does not say) revolutionized the whole machine business. Either by design or accident he heated a tool made of air-hardening steel until it was nearly melted, and according to the traditions and teaching of the ages the tool was ruined utterly. Again, either by accident or design this ruined tool was put into service, and it did an unheard of amount of work. This led to further experiments and tests, and the Taylor-White process was developed. This process consisted in heating a tool excessively hot and cooling it by successive stages, thus producing a tool that would cut at enormous speed for metal work, and take off chips that developed enough heat to blue them.

The process seems to have been uncertain, and the potentialities were so great that nearly all of the leading steel makers in the world attacked the problem. Manganese has reduced from 3 to 4 per cent. to 0.30 per cent to traces, tungsten has been increased to 10 to 20 per cent. instead of the usual 4 to 6 per cent., and the carbon is generally less than 1.00 per cent.

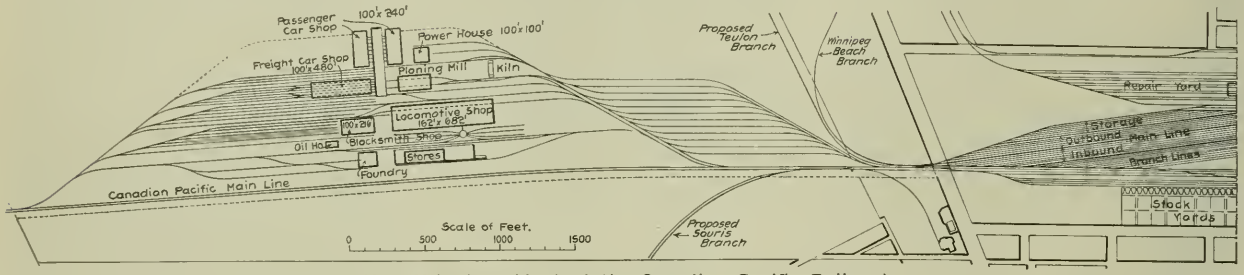
The best methods of hardening may not have been found. It seems that for very high-speed work it is necessary to nearly melt the point of a tool and quench it in a strong air blast, and then grind it to shape. This would not do for threading dies, milling cutters, etc., for the heat would destroy the tools. High-speed steel can be annealed as nicely as carbon steel, differing in this respect from air-hardening steel. The finished tools are heated in a lead bath to 1,800 degrees to 2,000 degrees, and are quenched quickly in ordinary tempering oil, which

*See *Railroad Gazette*, April 22, 1904.

†Extract from a paper read by Wm. Metcalf at the Atlantic City Convention of the American Society for Testing Materials.

must be kept cool by a coil containing circulating cold water. They are then tempered in a bath of heavy oil heated to about 450 degrees. The tools come out bright and clean.

The steel maker has the most to learn; he must find out why there is such a great difference in the work the steel will do, when there is so little difference in compositions. He must find the composition, or mixture, that will come nearest to meeting all of the requirements. As far as we know at present the steel users have not succeeded in making tools that are satisfactory for finishing, and for this purpose they use carbon steel tools. This difficulty may be overcome by proper methods of hardening and tempering or the steel makers may find a composition that will make a tool that is as good for finishing as for roughing.

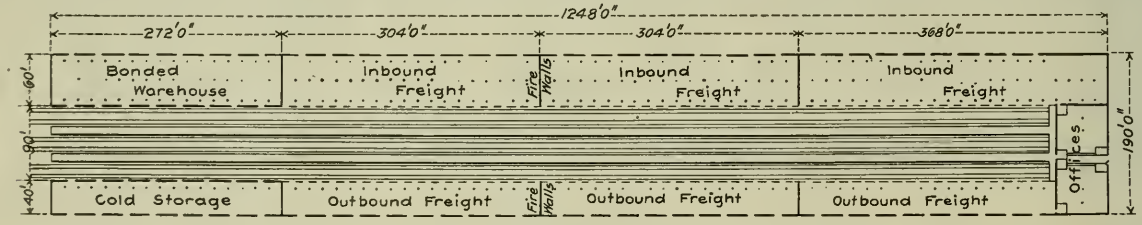



New Winnipeg Yard of the Canadian Pacific Railroad.

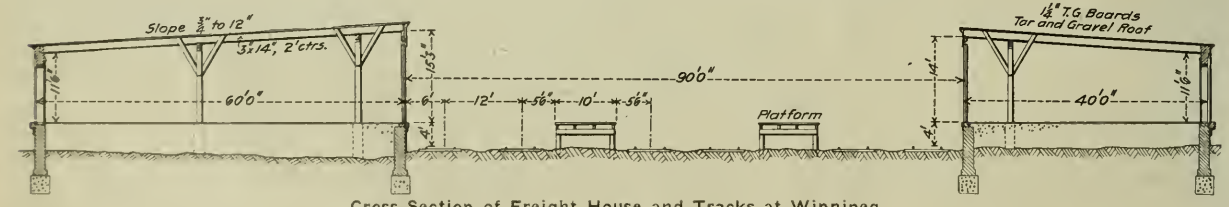
## Yard, Shop and Terminal Improvements of the Canadian Pacific at Winnipeg.

The improvements now being made at Winnipeg by the Canadian Pacific Railroad consist of extensive changes in the main yard, including the building of a number of new shops, a terminal station and hotel and the erection of an eight-track viaduct 140 ft. wide over Main street. In order to provide for the yard changes, the company purchased, in the early part of 1903, about 350 acres of land west of the present yard site. The improvements now being made in the yard are of a radical nature as the general layout has been entirely changed with the exception of the main tracks and a few of the branch-line tracks serving the industries surrounding the yard. The plans provide for two combination receiving and classification yards for branch and main-line traffic which are connected by means of two "hump" tracks. Each yard contains six in-bound and six out-bound main tracks, nine branch-line tracks, six storage tracks and three independent running tracks. The yard is arranged with the engine shed, stand pipe, coal chutes and ash pit in the middle, and all freight is classified over the hump tracks. This system of having all the facilities convenient to the point where the engines are engaged will save a large amount of time and money. Other interesting and economical features are the arrangement of the weigh scales, which are on a descending grade, thus allowing cars to be separated and weighed by gravity without rehandling, and an elevated caboose track situated so as to be convenient to the outlet of the classification yard, so that cabooses can be attached to out-going trains with little delay. The accompanying yard plan shows how both the local and main line traffic may easily be classified. The arrangement of the eastbound and westbound main tracks has not been changed and they run directly through the lower part of the yard. The junction of the tracks of the branch lines to Souris, Toulon, Selkirk and Winnipeg Beach has, however, been moved further west between the main yard and the new car and locomotive shops. According to the new arrangement, all the eastbound trains of both branch and main lines will pull directly into the west receiving yard. The cars are weighed in passing over the hump and are then classified on the main and branch line tracks in the eastern half of the yard. The same operation reversed will take place with the trains from the east, which are classified in the western half of the yard. In connection with these yard changes, new car, locomotive and other shops are being built to the west of the main yard. The new buildings include two passenger shops 100 ft. x 240 ft., freight-car shop 100 ft. x 408 ft., planing mill 100 ft. x 216 ft., power house 100 ft. x 100 ft., locomotive shop 162 ft. x 680 ft., blacksmith shop 100 ft. x 216 ft., foundry 100 ft. x 100 ft., and a stores building 85 ft. x 260 ft. with a 200-ft. platform and offices above. Some of these buildings are nearly finished and all are under construction.

In the main yard proper, a new engine house and freight sheds are now being built. The engine house is of fireproof construction throughout, with walls of masonry, brick and concrete and with roofs of concrete and steel supported on steel posts encased in concrete. It contains 42 stalls divided into four sections by brick fire walls. The turntable pit is 71 ft. 6 in. in diameter, and the inner wall is 95 ft. 2½ in. from the center of the pit. The depth of the roundhouse is 80 ft. The outer door and roof supports are made of steel and are 13 ft. 7 in. from center to center at the front circle, diverging to 25 ft. at the outside walls. The pits are 58 ft. long and 4 ft. wide. The walls and footings are of concrete and the floor is paved with hard burnt brick on an arched bed of well-puddled sand. They are from 2 ft. 4 in. to 2 ft. 8 in. deep, and a catch water basin is built at the end of each pit. These basins are connected with 10-in. drain pipes graded to run to the main outlet. An easy inspection is obtained by this method and any blocking of drains can be remedied without




General Layout of Freight House at Winnipeg—Canadian Pacific.




Cross Section of Freight House and Tracks at Winnipeg.

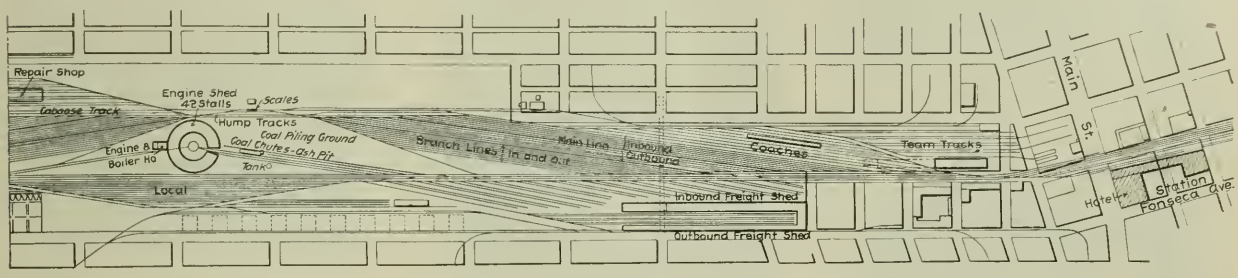
digging or taking up the pipes. The track rails are bolted to the pit walls by wrought iron angle-shaped plate anchors placed in the concrete when the wall is built. The drop pit is built between and connects two pits and is 7 ft. wide. At the engine pits, the opening is spanned by steel I-beams so arranged that they can be removed to facilitate the handling of driving wheels. The pit is 5 ft. 2 in. deep to the first floor level and has a car track 2 ft. in gage. Under the track is an opening 1 ft. 5 in. wide and 5 ft. deep for the pneumatic jack. The roof is of concrete and steel construction and the main beams over the posts are of steel. The cross beams are built of steel rods and con-

crete. The posts are steel I-beams encased in concrete with a metal mesh close to the outer faces. Between the cross beams, a 3-in. slab of reinforced concrete carries the roof and a 2-in. slab forms the ceiling, the air space between serving to prevent condensation. The longest spans for the reinforced concrete beams are 24 ft. An extension is being built at the rear of the house for the engine and boiler rooms independent of the roundhouse. The engine room contains a fan engine and blower for heating purposes.

carried on four rows of reinforced concrete columns. The two street railway tracks are provided for in the center archway with a clear headway of 14 ft. over the center of each track, while the side roadway arches are intended for vehicles. The roadway will have a grade of one in 20 in the approaches and will be paved with wooden blocks laid diagonally from center to sides across the street and resting on 6 in. of concrete. Sidewalks will be Granolithic 3 ft. 6 in. above the roadway and laid

rails and rods. The platforms are 6-in. concrete slabs reinforced with expanded metal through which skylights are provided over each roadway and sidewalk. These skylights are removable to allow of snow being deposited and distributed on the roadways below so that sleighing will not be interfered with in winter time.

Work has not yet been begun on the combined hotel and passenger station, although the contract has been awarded to Peter Lyall & Sons, of Montreal. There will be



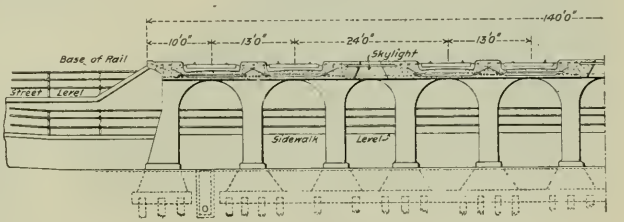

New Winnipeg Yard of the Canadian Pacific Railroad.

The houses are heated by hot air which is conducted through concrete and tile pipe ducts to the pits. The floor of the engine house is composed of brick with sand grout resting on a bed of well-puddled sand. The pipes from the boiler house consist of a 3-in. exhaust steam pipe with attachments to connect with the steam domes of locomotives. Exhaust steam is used for heating purposes, a 4-in. wrought-iron pipe serving for hot and cold water, and a 1¼-in. pipe being used for compressed air. Attachments and valves are provided between each pair of pits. The houses are wired for electric light and have three 16-candle power droplights per pit which are hung over the main beams between pits. Sockets for connecting handlights are provided in a convenient position on each post.

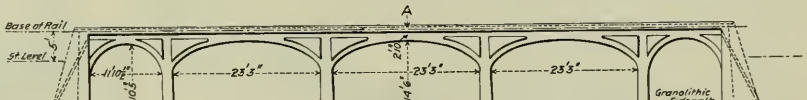
The freight houses now building consist of a two-story office 60 ft. x 120 ft., an out-bound shed 40 ft. x 1,242 ft., an in-bound shed 60 ft. x 1,242 ft. with six tracks and two transfer platforms between them. The west end of the in-bound shed is to be used as a bonded warehouse, and the west end of the out-bound shed is a cold-storage building to be equipped with a refrigerating plant. The method of construction is shown by the accompanying plan. The distance between the two sheds is 90 ft. and the width of each of the two transfer platforms is 10 ft. The height of the out-bound freight shed at the rear wall is 11 ft. 6 in., and at the platform is 14 ft., and the height of the in-bound freight shed is 11 ft. 6 in. at the rear and 15 ft. 3 in. at the front. The principal features are the long span roof beams which are cantilevered 8 ft. over the posts to carry the continuous doors. The rafters are covered with 1¼ in. boards and tar and gravel roof. The posts are supported on stone footings, and the concrete floor is laid on a prepared bed of well puddled sand.

The contract for building the Main street subway has just been let to Deeks & Deeks, Winnipeg, and work on this has been begun. The tracks of the Canadian Pacific (eight in number) will be carried across Main street on a reinforced concrete groined arched structure at an elevation of 5 ft. above the present level of the street. The total length of subway and approaches is 646 ft. 8 in. and the total width over sidewalks 100 ft. The arch structure has a width of 140 ft. over copings. There are three main elliptical roadway arches of 23 ft. 3 in. clear span and two semi-circular sidewalk arches of 11 ft. 10½ in. clear span

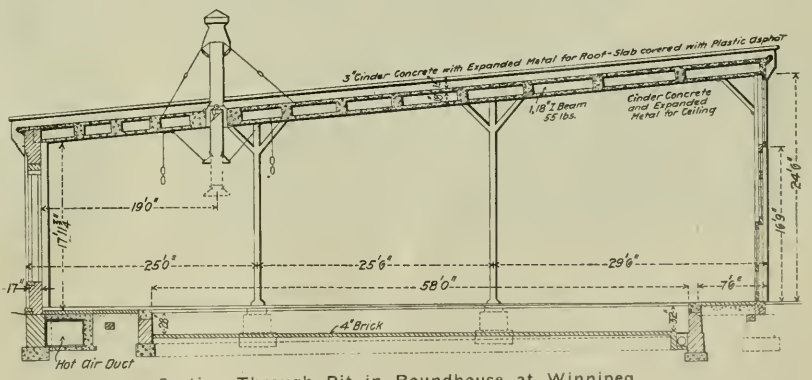
to same grade. The railroad tracks, which cross Main street on a skew of 86 deg. 4 min., are laid in depressed ballast troughs, the base of rail being 5 in. below the tops of platforms and beams. The main longitudinal beams terminate in buttresses and are reinforced with old rails latticed together, making continuous trusses between the buttresses of retaining walls. In addition to these rail trusses, other loose rails are provided on tops of beams over columns and bottom of beams in center of spans, all of which are




General Plan of Main Street Subway at Winnipeg.




Cross Section of Main Street Subway at Winnipeg.




Section Through Pit in Roundhouse at Winnipeg.

joined together by additional shear bars hooked through holes punched in rail webs. The load is transferred to these beams by a solid concrete floor reinforced with rails and rods, the latter bent up and hooked in concrete beams at ends. The columns and footings are also reinforced with

ing room in the station will be three stories high, with a glass roof. The building will be built mostly of stone and terra-cotta.

We are indebted to former Chief Engineer E. H. McHenry and to F. P. Gutelius, Engineer of Maintenance of Way, for the above information and drawings.

## Notes from the Union Pacific Shops at Omaha.

The new locomotive shops of the Union Pacific at Omaha were put in operation in the fall of 1902. The machine tools are driven by direct-current motors and more than 60 per cent. of the tools are new. Good results were obtained, but it was realized a year or more ago that possibilities for a considerable improvement in efficiency existed. It was decided to put the matter into the hands of one man who would devote his entire attention to bringing each important tool up to its maximum service. In some cases the output of a single tool has been so greatly increased that extra tools, previously needed, have been withdrawn from service. A few of the more notable and interesting records are given in the following:

Three pairs of 50-in. Midvale tires, which were badly worn, required two roughing cuts and were finished in 4 hours and 4 minutes, the first pair taking 1 hour and 40 minutes, the second pair 1 hour and 37 minutes and the third pair 1 hour and 27 minutes. This includes all work from the time the wheels were taken off of the floor until they were put back again. The machine used was a 90-in. Pond lathe driven by a 15-h.p. motor. The average surface speed was 23 f.p.m., using a 3/16-in. cut and feed. The maximum power demand on the motor was 7 h.p., and the average horse-power was 4½. On the basis of these tests the horse-power of the driving motor could be reduced about one-third and still have enough power to do the work.

On this same lathe 84-in. drivers having Standard tires were turned at a peripheral speed of 28½ f.p.m. using a 5/16-in. cut and 3/16-in. feed. With these heavy cuts and feeds and high cutting speeds, a tendency to excessive vibration is developed in the machine due to the dogs being too light and the shaft too small, and an uneven chattering motion given by the large gears. Larger dogs have been designed at the shops for the purpose of reducing the trouble. It has been suggested that these difficulties can be overcome by doing away with the driving shaft, which is subjected to considerable torsional stress, and drive each face plate independently with a worm.

Before high-speed steels were introduced into the shops car-wheel tires required 5 hours for turning. This time has now been reduced to 55 minutes, the machine having been speeded up to a cutting speed of 28 f.p.m., as against 6 ft. formerly. The feeds and depth of cut have, of course, been increased correspondingly. The lathes proved to be too light in some respects for this heavier service, and they were strengthened by replacing the cast-iron pinions with soft steel.

Extended piston rods are finished from the rough forging in 7 hours. The former time was 14 hours. The average roughing speed is 5 f.p.m., with ¼-in. cut and a 3/16-in. feed. This work is done on an old New Haven 36-in. lathe that has been in service 30 years. The finishing is done on a new 38-in. Pond lathe at 90 f.p.m.

The time on piston valves has been reduced from 14 hours to 3 hours. This includes centering and turning valves of medium hard cast iron 12 in. in diameter. The work is done on a Lodge & Shipley 36-in. lathe. Roughing is done at 38 f.p.m. with a ⅜-in. cut and a ¼-in. feed. Finishing and grooving is done at 45 f.p.m.

Low-pressure cylinder bushings 30 in. in diameter are turned in 1 hour and 40 minutes on a 42-in. Pond lathe. A year ago this job took 12 hours. The speed is 32 f.p.m. with a ½-in. cut and a ¼-in. feed. The finishing cut is at 48 f.p.m. with a 1-in. feed. This includes turning and facing complete, "floor to floor."

The record for drilling flue sheets has been increased from 30 to 110 holes an hour. This has been accomplished by means of the cutter shown in the accompanying sketch, Fig. 1, which was designed at the shops.

The tool used for turning and flanging locomotive and car-wheel tires is shown in Fig. 2. It consists of a soft-steel holder having at one end the roughing tool and at the other the flanging tool, both being made of high-speed steel.

The details of an air hoist for placing air drums on locomotives are shown by Fig. 3. It consists of a 5-in. air cylinder supported upright in a framework on three wheels, provided with a tongue. The upper end of the piston rod is shouldered and threaded and carries a cradle in which the drums are placed. The rod carries a split collar which rests on the upper head of the cylinder, which is used to secure the rod at any height. A drum held in position by this hoist is shown in Fig. 4.

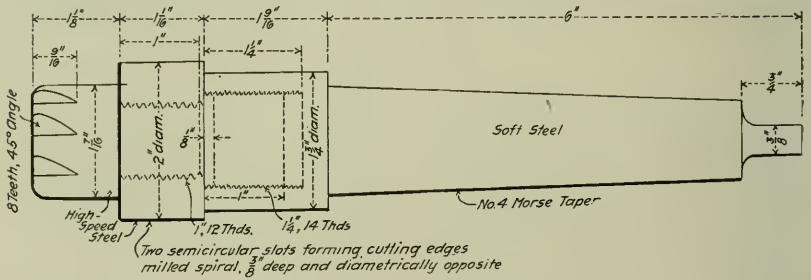

8 Teeth, 45° Angle
2" diam.
Soft Steel
No 4 Morse Taper
High-Speed Steel
1", 12 Thds.
1¼", 14 Thds
Two semicircular slots forming cutting edges milled spiral, ⅜" deep and diametrically opposite

Fig. 1—Flue Hole Cutter.

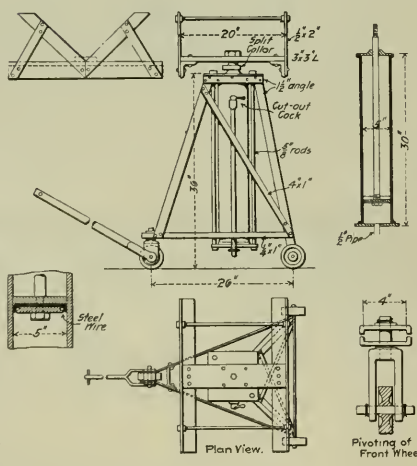



Fig. 3—Details of Air-Drum Hoist.

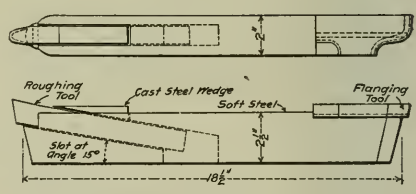



Fig. 2—Tool for Turning Tires.

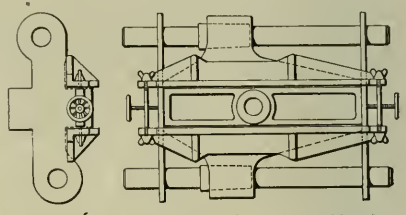


Fig. 5—Jig for Babbitting Cross-Heads.

To overcome the necessity of machining the sliding surfaces of the cross-heads of the Vauclain compounds a cast-iron jig (Fig. 5) is used. It consists of two end-plates made of boiler plate, which are supported by two soft-steel mandrels, each having a taper part to fit the piston rod fit of the cross-head. The end plates support four cast-iron angle face-plates in the same position relative to the cross-head as the guides. The top and bottom angle-plates on each side are clamped together and hand wheels with threaded stems, inserted through the clamps, bear against the end-plates, holding the angle-plates rigid longitudinally. The cross-head is heated in a molten babbitt bath contained in a cast-iron box, and the end-plates and mandrels are heated to a uniform temperature. The resulting babbitted surfaces are of such smoothness that after a short time in service their condition is as satisfactory as if they had been milled or planed, while the time for this latter operation, amounting to 1½ hours per cross-head, is entirely saved.

The method of milling ports in piston valve bushings for compound engines is shown in Fig. 6. This is done with a specially designed fixture, which mills four ports at once.

By the use of knuckle pin reamers the time for reaming rods has been reduced from 2 hours to 15 minutes. In connection with the reamers is a set of templates which have been reamed out, hardened and ground, to which the reamers have been sized. The different shops along the line have been supplied with reamers, but the templates are kept in the Omaha shop, each hole having a symbol number corresponding to the reamer that has been fitted to this hole. All knuckle pins are made at Omaha, and any point along the line wanting a certain pin simply gives the symbol number.

Twenty triple valves are completely overhauled in a day of nine hours by one man and an apprentice. Fig. 7 is a corner of the brass room where triple valve work is done, showing the rack for testing the valves. One man grinds seven angle-cocks in 35 minutes. This is done on a special grinding machine (Fig. 8) that has been built up out of a nut tapper rescued from the scrap bin.

All shoes and wedges for the entire system (about 3,600 per year) are planed on the machine of Fig. 9. The time is 30 minutes per shoe or wedge, planing the surface on five sides. A special chuck was devised for this work. Fig. 10 shows an adjustable chuck that is used in planing the box face of the shoe or wedge. With a special adjustable chuck, driving box brasses are turned to fit the box (for a 9-in. journal) in 15 to 20

minutes. The former time was one hour.

Eccentrics, cast-iron, in two halves are planed up with a special jig for clamping them on the planer, at the rate of six halves an hour. The former time was two halves an hour. They are turned on a special mandrel holding four at one time (Fig. 11) at the rate of one hour each. The former time was two hours each.

The former record for boring cast-iron car wheels was 50 in nine hours by one man. There is now a record of boring 90 wheels for a 5½-in. fit in this same time, by one man, on two boring mills, using high-speed steel cutters. With a double angle-iron for clamping, and a double tool holder, eight new driving boxes have been planed up complete in 14 hours. The time with old methods was five hours per box.

One specially belted planer, to plane steel rods, runs 52 f.p.m. and removes, on actual test, 846 lbs. of metal per hour. Eighty-two-in. steel tires are bored and faced (¼ in. stock removed) in 35 minutes. The old time with the old steel was three hours. On a Gisholt lathe, fitted up with high-speed cutters, 40 4-in. cast-iron piston rod glands have been fitted up in nine hours. On a new 24-in. Pond lathe, 60 13-in. valve packing rings have been bored, faced and cut off in six hours. A special double tool holder for slotter work enables the operator to slot out a large steel driving box complete for brass and collar fit, in 1½ hours; old time, three hours. A special revolving angle-iron chuck, with which the brass needs but one cutting, enables the operator to plane for the rod fit a large back-end main rod brass in 2½ hours. The time by the old method was five hours.

Other aids to rapid handling of work are the regulation of the crane service, and the narrow-gage track system. For instance, there is used with the crane a form of tackle which permits of four driver boxes being picked up and carried with safety at one time. Material is stored in special places on the platforms, and all refuse, chips, scrap, etc., are placed in bins provided for each, these bins being emptied periodically. The narrow-gage road for the most part runs by a time-table.

The present efficient condition of these shops has been brought about under the supervision of W. R. McKeen, Jr., Superintendent of Motive Power and Machinery, to whose suggestions many of the special methods and devices in use are due. H. W. Jacobs,

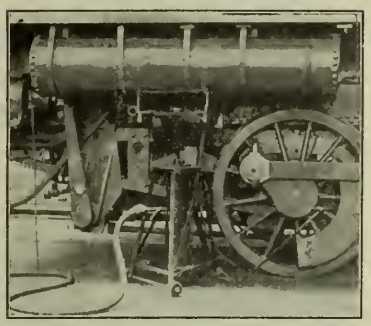


Fig. 4—Air Hoist for Air-Drums.

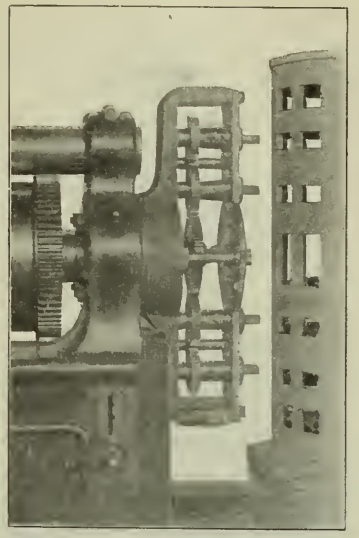


Fig. 6—Milling Ports in Bushings.

Fig. 10—Chuck for Planing Box-Faces.

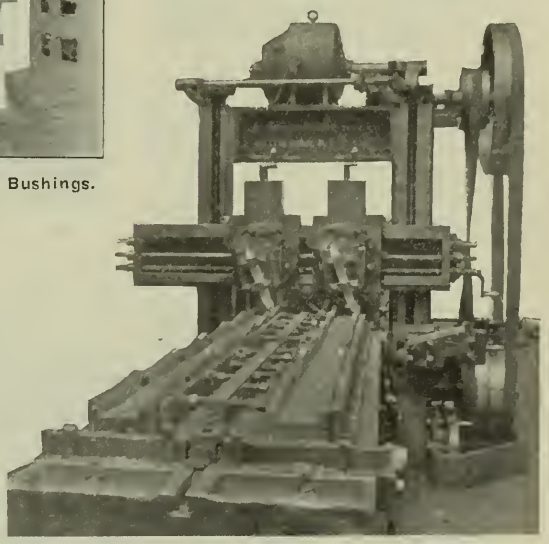


Fig. 9—Planing Shoes and Wedges.

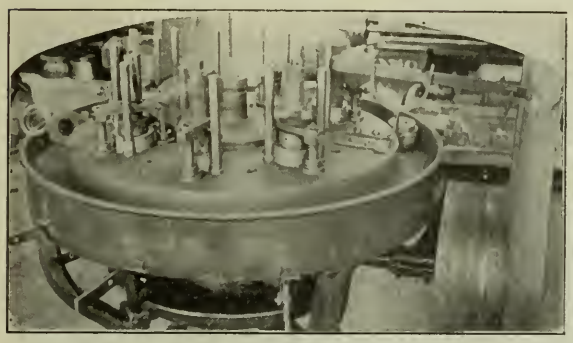


Fig. 8—Grinding Machine for Angle-Cocks.

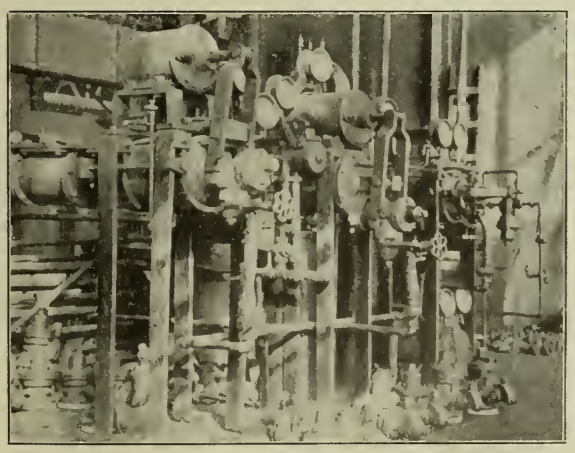


Fig. 7—Rack for Testing Triple-Valves.

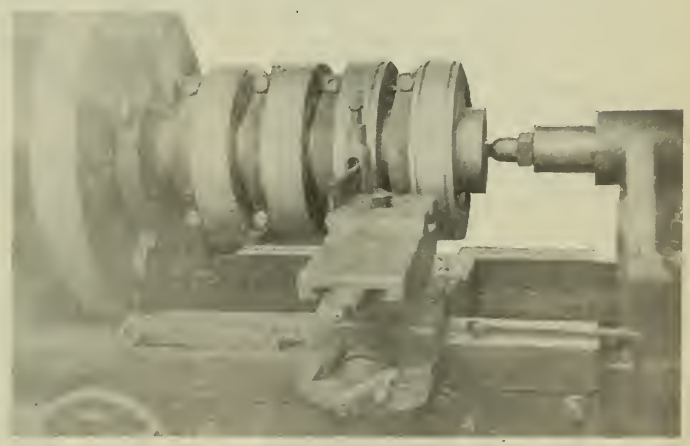


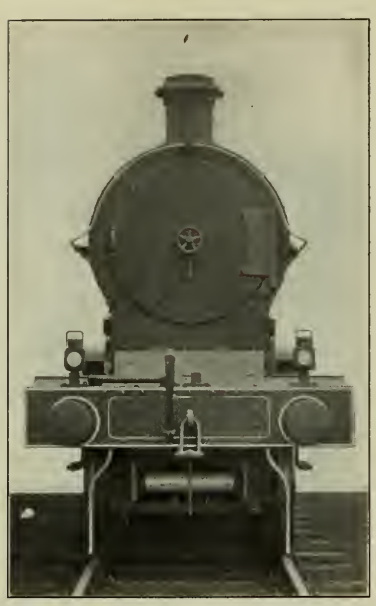
Fig. 11—Turning Eccentrics on Special Mandrel.

General Shop Demonstrator for the Union Pacific System, has been directly in charge of the work, developing many of the details of Mr. McKeen's suggestions. He also devised the cutter of Fig. 1 and the tool-holder of Fig. 2.

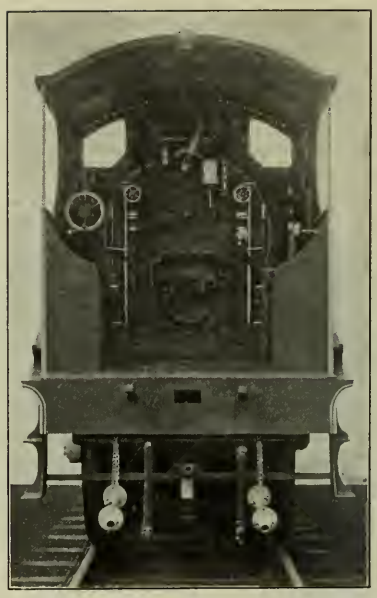
### Eight-Wheel Passenger Locomotive for the London & North-Western.

The illustrations herewith show a new fast passenger locomotive designed by Mr. George Whale, Chief Mechanical Engineer of the London & North-Western. The engine was built at the Crewe works of the company. It has been designed to meet the requirements necessary for hauling the heavy and fast express trains between London, Manchester and Liverpool, and at the same time to have a reserve power to meet increased weight or speed which may be required in the future.

The cylinders are 19 in. x 26 in. and the drivers are 81 in. in diameter. With 85 per cent. of the boiler pressure of 175 lbs. available as mean effective pressure at starting, the maximum tractive effort is 17,200 lbs. The total heating surface is 2,009.7 sq. ft., with 161.3 sq. ft. in the fire-box. The grate area is 22.4 sq. ft. The leading truck is the

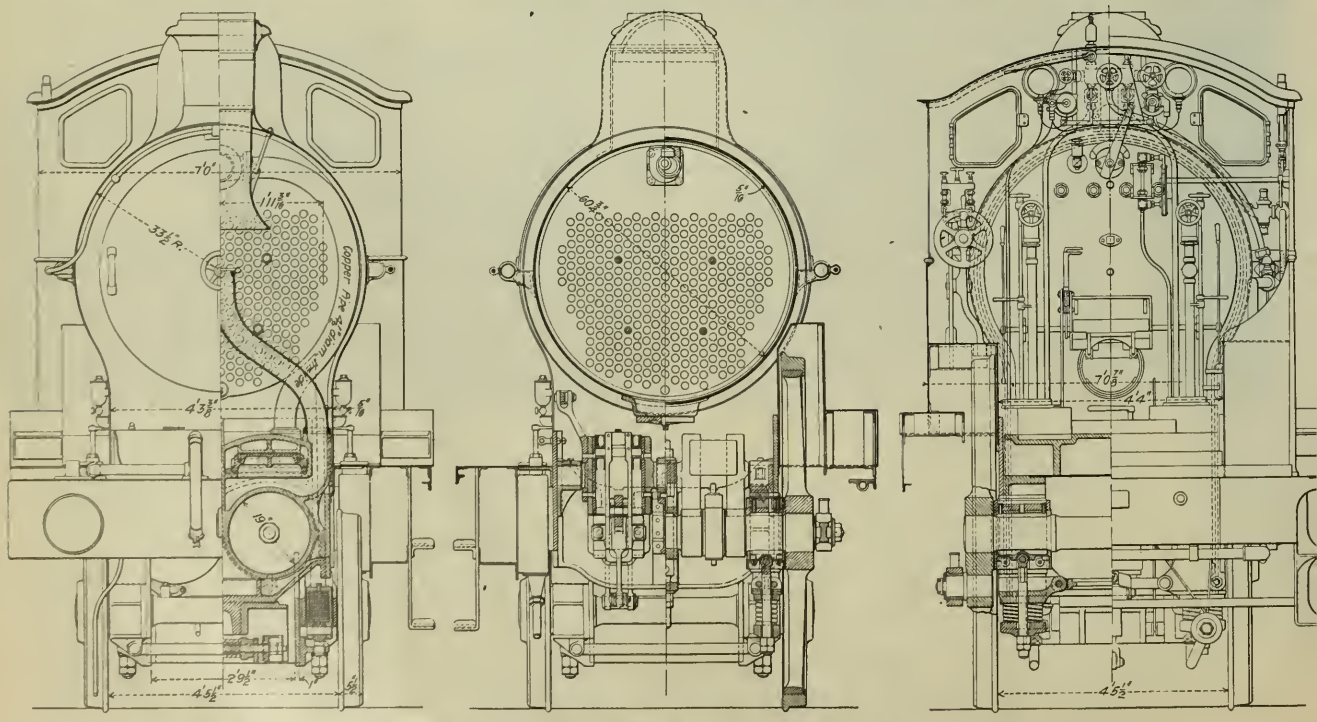


London & North-Western Locomotive.

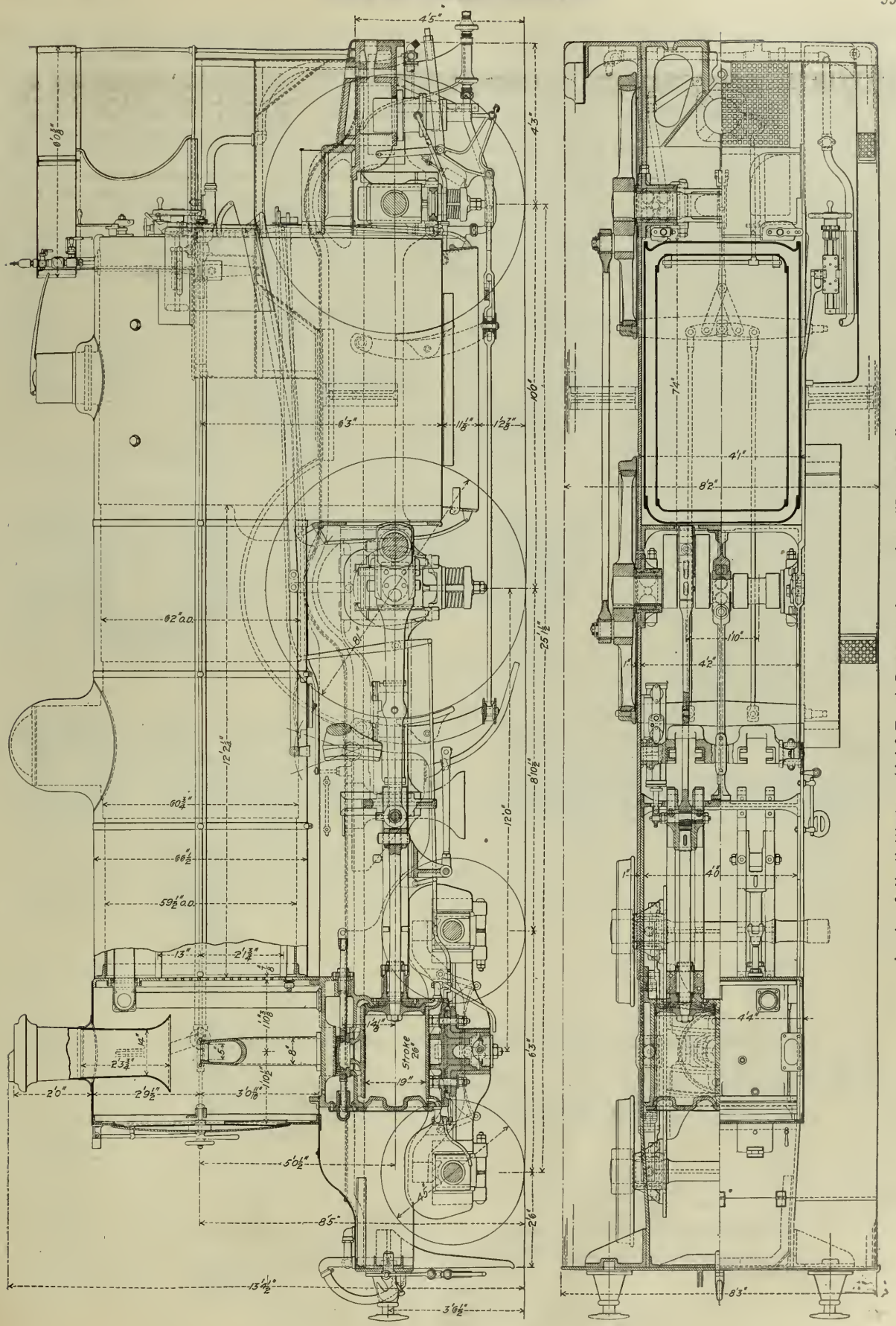


London & North-Western Locomotive.

London & North-Western 4-4-0 Type Passenger Locomotive




London & North-Western Locomotive "Precursor."




London & North-Western (4-4-0 Type) Passenger Locomotive "Precursor."

double radial type fitted at the center with a radial axle-bar, and side controlling springs. The cylinders are between the frames and have balanced rectangular valves operated by Joy's valve gear. The tender of the locomotive is made entirely of steel, which is a departure from usual practice on the L. & N.-W. The tank capacity is 3,600 gallons and the coal capacity is 6.7 tons. The tender is fitted with a water scoop operated by a hand wheel and screw. The engine weighs 133,660 lbs.

Some trial runs were made between Crewe and Rugby, and Rugby and Crewe. The train behind the tender consisted of 15 passenger cars each 50 ft. long weighing about 407 tons, and a dynamometer car weighing about 12.3 tons. The tender weighed 41.4 tons, which together with the engine gives a gross weight of about 528 tons. The trip from Crewe to Rugby (a distance of about 75.5 miles) was made in 86 minutes, and from Rugby to Crewe the time was 83 minutes, or at the rate of 54.5 miles an hour. The maximum speed attained was 75 miles an hour, but this was maintained but a short time on a 1 in 250 down grade near Crewe. The maximum tractive effort indicated by the dynamometer car was 15,948 lbs. in starting from Rugby.

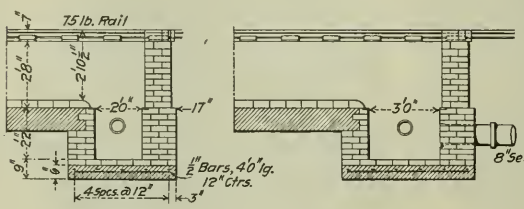
We are indebted to Mr. Whale for the drawings, photographs and details.

## Reinforced Concrete Roundhouse for the C., M. & St. P.

The Chicago, Milwaukee & St. Paul has begun the erection at Galewood, Ill.—a suburb of Chicago—of a roundhouse having reinforced concrete pits and lower walls. Resort to a special design was necessitated by the soil conditions of the site, which is on made ground of a depth of about 15 ft.; the alternative to the course adopted being a liberal use of piling.

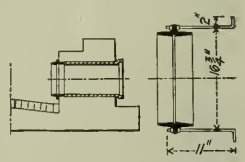
The house will contain 36 stalls and is built on a radius for the inside circle of 86 ft. 10 in., and a stall depth of 84 ft. It is separated into three equal sections by transverse fire walls. The outside wall and all transverse walls are reinforced concrete up to the window line, and are brick above this point. The house is polygonal, with sides 26 ft. 8¼ in. long. A beam design is used for the reinforced concrete, the beams resting upon footings 1 ft. 3 in. deep and 2 ft. 6 in. wide, on creosoted piling, 30 ft. long. There are three piles under each angle, and a single pile under each of the two intermediate points. The transverse walls have single piles spaced at intervals varying from 6 ft. to 8 ft., except at their inner ends, where the distance is reduced to 3 ft. 7½ in.

The beams are 7 ft. 7 in. deep and 15 in. thick. Their lengths vary from 6 ft. in the transverse walls to 9 ft. 6 in. in the outside wall. They are reinforced by a double row of ½-in. corrugated steel bars, placed 3 in. in from the outside and spaced 13 in. apart. There are two additional bars at the top and one at the bottom, and a single bar 3 in. from the lower edge in the middle of the beam, giving altogether 20 continuous bars. Wherever a joint occurs in construction, 12 additional bars 6 ft. long will be used, the manner of their insertion being shown in the typical sections of walls. Between sup-

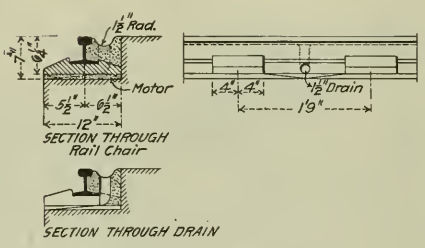



Section of 2-Ft. Catch Basin E.

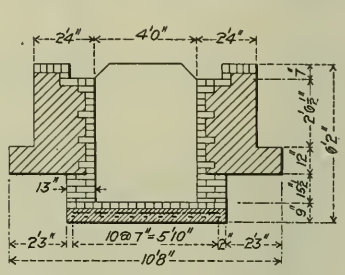
Section of 3-Ft. Catch Basin F.



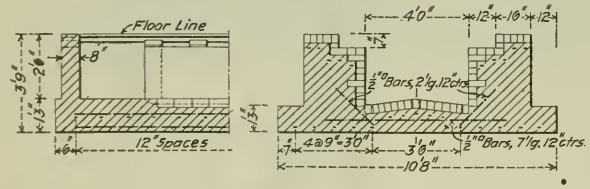
Section of Pit Showing Blast Gate and Hot-Air Pit.



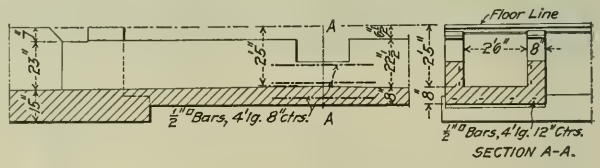

Detail of Rail Chair Setting.



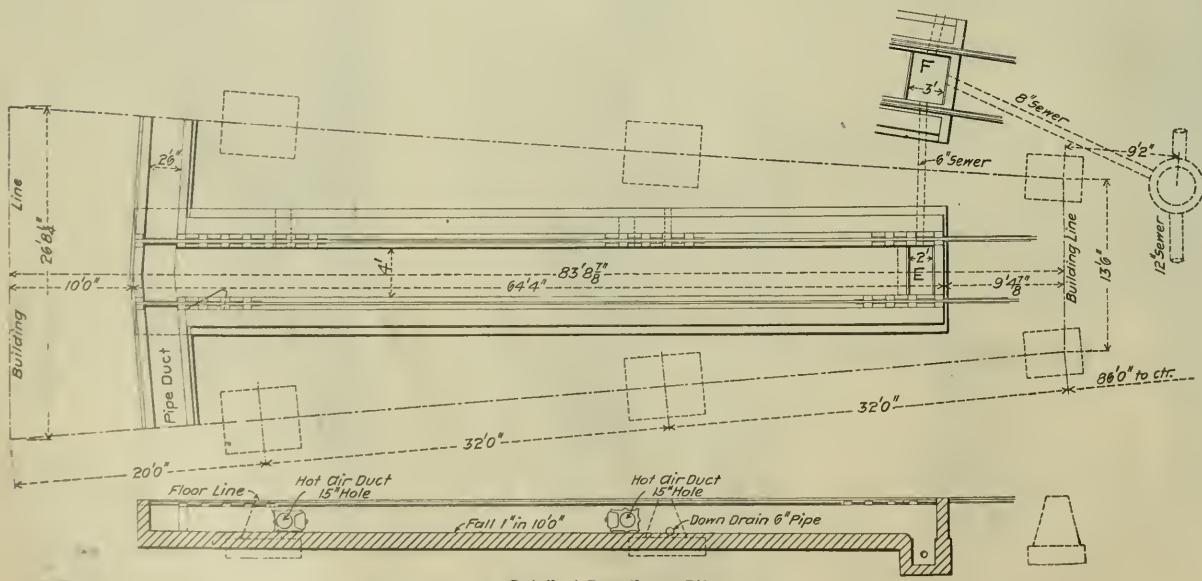

Section Through Catch Basin.




Section Through Pit.




Section Through Pipe Duct.




Detail of Roundhouse Pit.

Reinforced Concrete Roundhouse for the C., M. & St. P.

ports the bottoms of the walls are beveled at an angle of 45 deg. to a width of 3 in., the object being to reduce resistance in the event of heaving of the ground from frost. The cross-section shows a new idea in roof arrangement, there being three inclinations. The two inner ones have each a skylight to give light over the rear and middle parts of the locomotive. The ventilators have louvres and pivoted doors on each side opposite the smoke-jacks, the sides between being covered with drop siding. The smoke-jacks are tile.

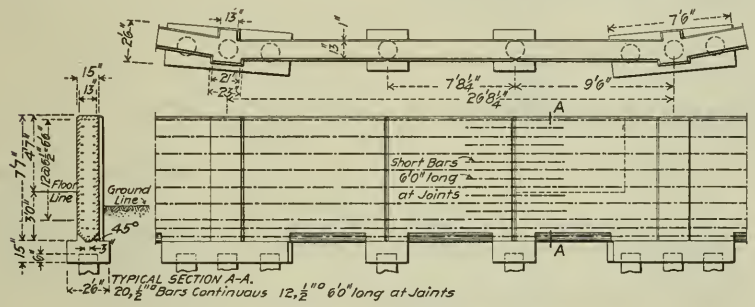
The pit design is novel. A broad base is provided to avoid the use of piling, this dimension being 10 ft. 8 in. The depth below the floor line is 3 ft. 9 in., and the thickness of wall is 2 ft. 4 in. The pit and tops of walls are lined with brick. This is due to a well founded belief that the locomotive lubricating oils would have a bad effect on the concrete. A hard-burned paving brick will be used.

The reinforcing bars of the pit concrete are clearly indicated in the drawings. At the bottom, beginning 7 in. from each edge, there are two sets of five longitudinal bars, 1½ in. in from the lower surface, spaced 9 in. apart. There is also one set of five directly under the pit bottom, spaced 6 in. apart, and a set of five at the top of each wall. Transverse reinforcement is obtained by 7-ft. lengths spaced 12 in. centers, and the lower corners of the pit are strengthened by 2-in. lengths, placed at 45 deg. and spaced 12 in. centers. The walls of the catch-basins at the inner ends of the pits are brick. The bottoms are concrete, reinforced longitudinally and transversely as shown. The pipe duct is also of reinforced concrete. The rail chair setting, a detail of which is shown, is the standard of the C., M. & St. P. The pits have a fall toward the inner end, draining into the catch-basins. They are divided into sets of three, the one on each side draining to the center one and the latter to the sewer.

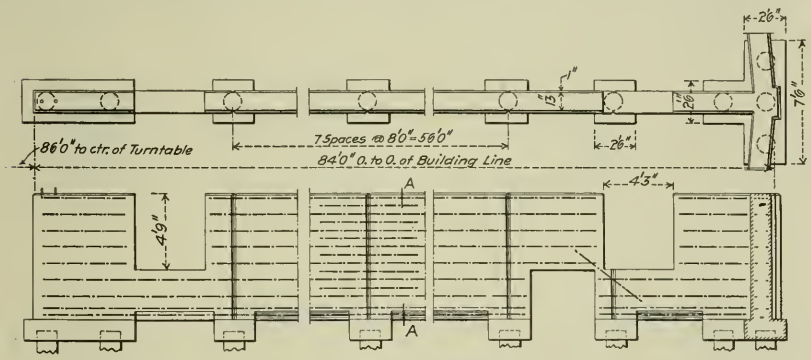
The house will be heated by the hot-blast system. The distribution will be overhead, with branches dropping down the posts to ducts running beneath tthe floor to the pits. The two outlets for each pit are placed on one side.

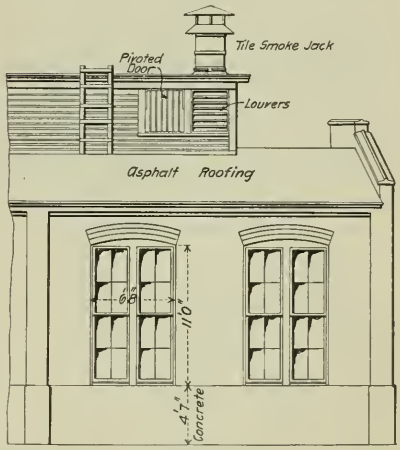
The estimated cost of the Galewood house, for the building alone, is $80,000. A 30-stall house of the same design will be built at West Milwaukee, at a cost of $65,000, and the Franklin Boulevard (Chicago) house will be enlarged by 19 stalls, also using the reinforced concrete construction. These were designed under the supervision of Mr. C. F. Loweth, Engineer and Superintendent of Bridges and Buildings. The design of the reinforced concrete work was directly in charge of Mr. J. J. Harding, Assistant Engineer. Above the concrete work the design was in charge of Mr. J. U. Nettenstrom, Architect for the company.

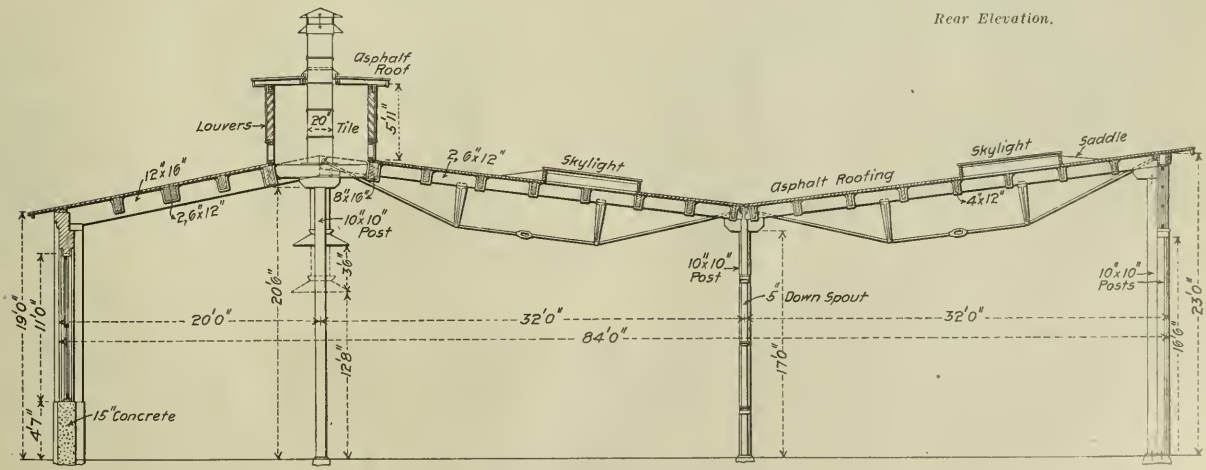
A large increase in the wages of the employes of the Chinese Eastern Railroad has been made, to last during the war. Married employes whose salary is $450 a year or less get an advance of 50 per cent., but not more than $180; salaries of $450 to $900 are advanced 40 per cent. till the advance reaches $270; from $900 to $1,800 the advance is 30 per cent. till it reaches $450, etc. Unmarried employes receive one-half of these advances. Free passes are granted to wives and children of employes who wish to return to Europe. This means that supplies are scarce and high in Manchuria. The military traffic being almost entirely eastward, passengers can be carried westward with scarcely any additional cost.




*Typical Section of Outside Wall.*




Reinforced Concrete Roundhouse for the C., M. & St. P.

### Shop Notes from Elizabethport.

The principal repair shops of the Central Railroad of New Jersey are at Elizabethport, N. J. These shops were completed in 1901 and were described in the *Railroad Gazette* Dec. 27, 1901, and Jan. 3, 1902. The shops are modern in design and in equipment, but in addition to this, the efficiency of the shops has been greatly increased by the close attention paid to special devices for facilitating many of the operations necessary in repairing locomotives and cars. We are indebted to W. McIntosh, Superintendent of Motive Power; G. L. Van Doren, Superintendent of Shops, and others, for assistance in obtaining the details for the following descriptions:

MACHINING DRIVING BOX SHOES AND WEDGES.

Driving box-shoes and wedges are machined on a 36 in. x 10 in. double-head Pond planer, driven by a 10 h.p. motor. The chuck used for planing the inside bearing surfaces of the shoes and wedges is shown in detail in Fig. 1. The chuck is 8 ft. long and 13 in. wide over all. On the bottom of the chuck a rib is cast. This rib fits into the slot on the planer bed and prevents any lateral movement of the chuck. Two of these chucks are bolted side by side on the planer bed. Five shoes are placed in each chuck, and are held in position by ⅞ in. set screws in the chucks, as shown.

The first operation is to plane the inside faces of the shoes, shown by the dotted lines and marked "A." Both heads of the planer are used, one head on each set of five shoes, thus planing 10 shoes at one time. The second operation consists of planing the vertical sides of the shoes marked "B." Both sides are planed at the same time by using the tool "A" shown in Fig. 2. The shoes are then bolted on a planing bar, shown by Fig. 3. A parallel block is placed under each end of this bar, and the bar with the shoes attached is bolted to the planer bed. The faces of the shoes or wedges, as the case may be, marked c-c, are then planed. By using a double tool, "B" shown in Fig. 2, both of these faces are planed at one time. When these faces are planed the bar is turned over. The bar is turned by means of a crane and tackle which passes over the planer. The tackle is hooked to the planing blocks. These blocks are placed in the ends of the bar and are shown at A in Fig. 3. The faces of the shoes or wedges d-d are then planed in a similar manner to the faces c-c.

The shoes and wedges are now ready to be placed in their respective pedestal jaws to have the box faces, or face, "E" located. When the proper positions of the box faces have been found and marked, the shoes and wedges are taken to the planer and planed in the chuck shown in Fig. 4. This chuck also has a rib cast on its under side, and is secured to the planer in the same way as shown. In a day of 10 hours one man using this method can plane from 18 to 20 shoes and wedges. This system, tools and chucks, was designed by Mr. G. L. Van Doren, Superintendent of the Elizabethport shops.

CHUCK AND MANDREL FOR BORING AND TURNING ECCENTRICS.

The chuck used for boring and facing eccentrics is shown by Fig. 5. The lug on the bottom of the chuck is finished to fit the pocket of the boring mill. Bolts passing through the flange of the chuck hold it in position on the bed. The eccentric casting is dropped into the chuck, and is adjusted and held in its proper position by means of four set screws passing through the chuck, as shown. This device is particularly useful and economical when a number of eccentrics of the same size are to be bored. Before this chuck was used it cost about 45 cents to set up, bore and face one eccentric. By using this chuck, an eccentric can be bored and faced in 45 minutes at a cost of 25 cents. After the eccentrics have been bored and faced the key-ways are cut. They are then keyed on a mandrel, shown by Fig. 6. The method of securing this mandrel to the bed of the boring mill is the same as that used in securing the boring chuck. Two eccentrics are turned up at the same time, both heads of the boring machine being used, the chuck shown in Fig. 1. This chuck is made up of three pieces; the wedge "A," the base casting "B," and an upper hinged casting "C." The shoes, or wedges, as the case may be, are secured to the upper hinged casting, and are adjusted to the proper position for planing by means of the wedge "A." This wedge can be shifted to any desired position by means of the adjusting screws

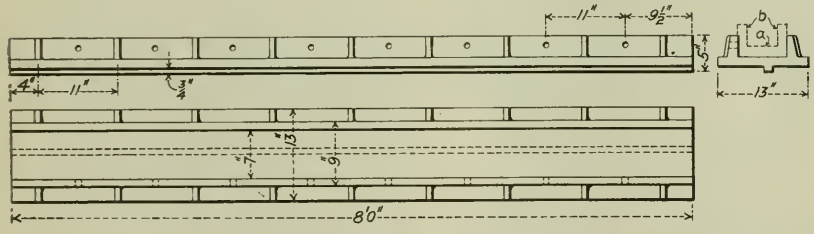



Fig. 1—Chuck for Planing Shoes and Wedges.

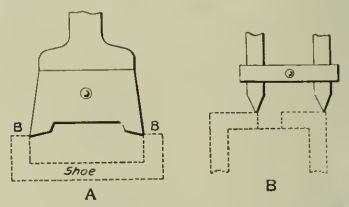



Fig. 2—Tools for Planing Shoes and Wedges.

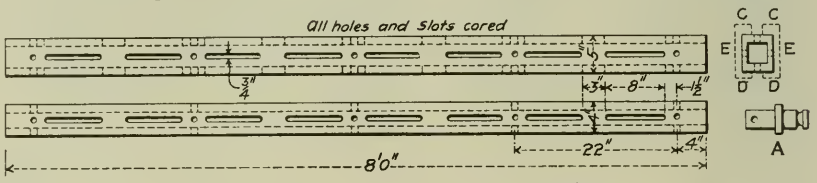
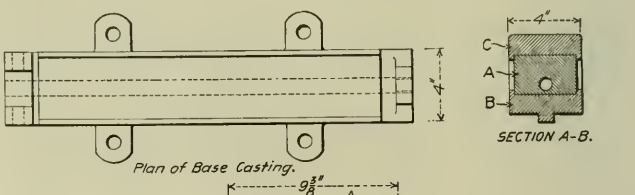



Fig. 3—Bar for Planing Shoes and Wedges.



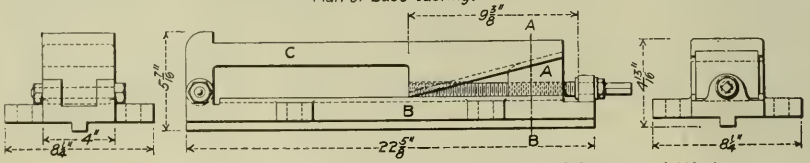




Fig. 4—Chuck for Planing Box-Faces of Shoes and Wedges.

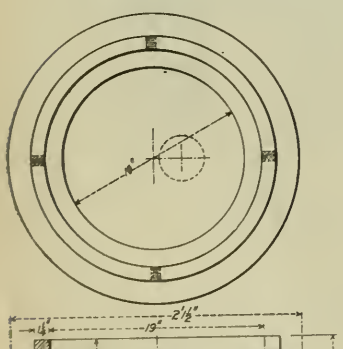



Fig. 5.

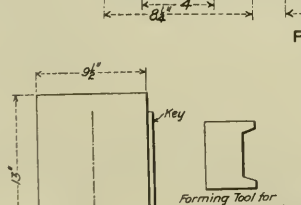



Fig. 6.

Chuck and Mandrel for Machining Eccentrics.

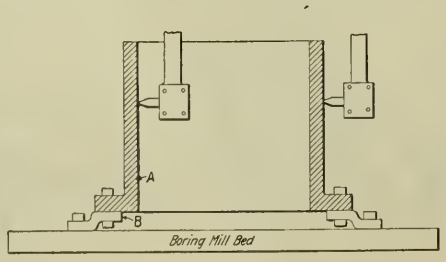



Fig. 7.

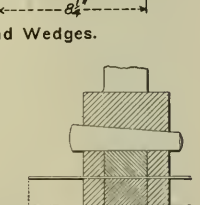


Fig. 8.

Tools for Machining Packing-Rings.

one on each eccentric. First they are roughed out with one cut by means of a round-nose tool. The finishing cut is then taken with a forming tool, like that shown in the illustration. By using this mandrel in connection with a boring mill two eccentrics can be turned up in one hour.

SPECIAL TOOLS FOR MAKING PACKING RINGS.

A cheap and rapid process for making cast-iron packing rings is shown in the accompanying illustrations. The first operation is shown by Fig. 7. The packing ring casting "A" is centered on the bed of a double head boring mill and rests on four wrought iron dogs "B," which provide clearance for the

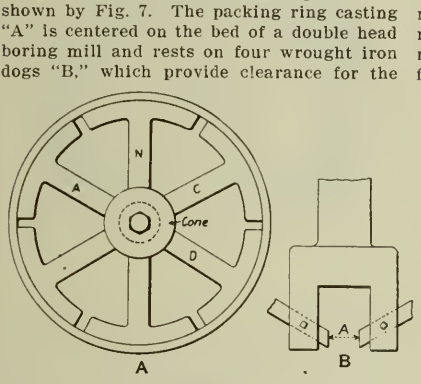



Fig. 9—Tools for Machining Packing-Rings.

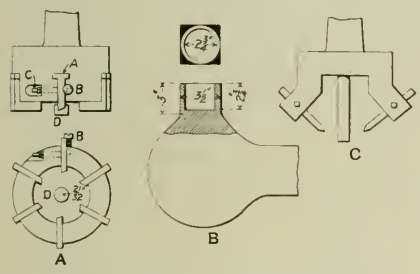



Fig. 11—Tools for Turning Oil-Cups.

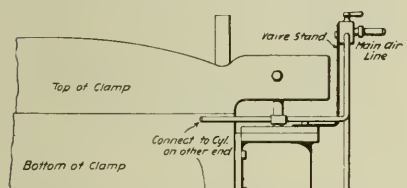



Fig. 14—Attaching Air Cylinders to Boiler Clamps.

tool posts at the bottom of the casting. The casting is turned up on both sides at the same time. The cutting-off tool, Fig. 8, is then placed in the tool post. This tool is made up of four parting tools, spaced so that the rings when cut off are $^1/_{16}$ in. wider than the finished size. The cutting edges of the parting tools are stepped so that each upper tool leads each lower tool by ⅛ in. This arrangement of the cutting edges allows a clean cut through each ring and also leaves enough uncut stock in the lower rings to prevent them from breaking off before the upper rings have been cut.

Each ring is then finished in a special chuck, which is attached directly to a lathe spindle. A view of the face of the chuck is shown at "A" by Fig. 9. This chuck is made up of six segments, a, b, c, d, etc., which are expanded by a conical center. The packing ring is placed around the chuck and the segments are forced out and hold the ring in position for turning. The combination tool "B," Fig. 9, finishes both sides of the ring at the same time. The distance "A" between the edges of the cutters gives the exact finished width of the ring.

CHUCK FOR TURNING DUNBAR CYLINDER-PACKING.

Dunbar packing is extensively used on the locomotives of the Central of New Jersey. To facilitate fitting this packing to the pistons, the shops and roundhouses are provided with a chuck, shown in the accompanying illustration (Fig. 10). These chucks are made in two sizes; one size for fitting 17 in. and 19 in. rings, and another size for fitting 18 in. and 20 in. rings. The Dunbar packing rings are all made and assembled at the main shops at Elizabethport, N. J. The rings are all made ½ in. larger than the finished size. The method of chucking the

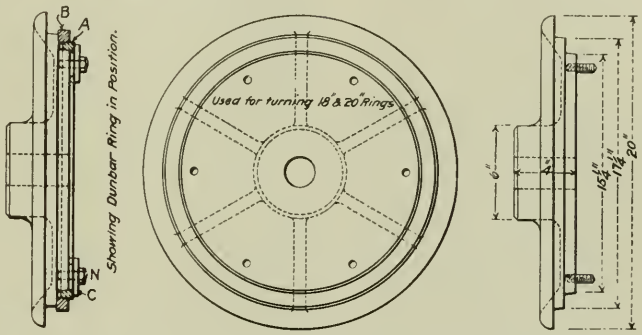



Fig. 10—Chuck for Turning Dunbar Packing-Rings.

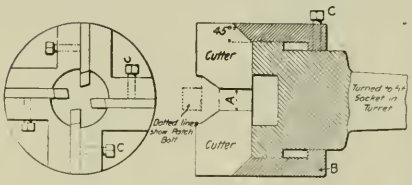



Fig. 12—Cutter Head for Patch-Bolts.

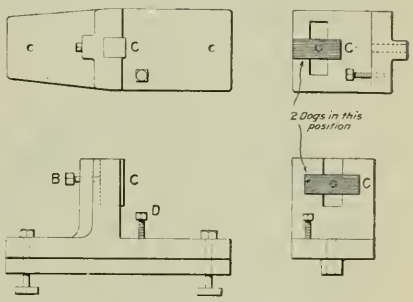



Fig. 13—Jaws for Turning Tires.

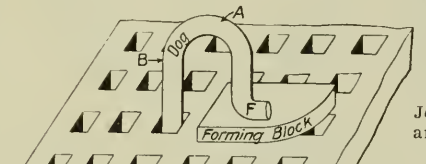



Fig. 15—Boiler Shop Block and Dog.

Dunbar ring is as follows. The wedge-shaped cast-iron ring "A" is placed in the position shown. The Dunbar ring "B" is then placed around the ring "A." The nuts "N" on the studs are then turned down, which, in turn, brings the wrought iron clamps "C" against the wedge-shaped ring. This wedge-shaped ring is split, and when the clamps are pulled down they cause the ring to expand and bear against the Dunbar ring and securely clamp it in position for turning.

TURNING OIL-CUPS ON SOLID-END RODS.

The six cutters in the box tool "A," Fig. 11, are made of ⅜ in. x 2 in. tool steel and fit into the slots "A." The cutting edges are adjusted by the screws "B" and the cutters are held in place by the set screws "C." The center guide "D" is $^{31}/_{32}$ in. in diameter. This fits into a 1 in. hole drilled in the center of the solid oil cup forging "B." The oil cups are turned and bored on a boring mill, and the stock which this tool cuts away is shown by the dark shading. By using the tool the oil-cups are turned in one-third to one-quarter the time formerly needed by the old tool, shown at "C," Fig. 11. The holes in the cups are bored out by a three cutter spiral counterbore.

A CUTTER HEAD FOR MAKING PATCH-BOLTS.

An adjustable cutter head for making patch-bolts is shown in Fig. 12. The cutters are adjusted to the diameter "A" of the bolt by the adjustable collar "B." This collar is threaded to the shank of the tool. When the cutters are set to the desired position they are held in place by the set screws "C." The patch-bolt forgings are held in the chuck by the square heads. The cutter head is then brought up and with one cut finishes them the exact size. By using this tool and a screw cutting die head in the turret of a Jones & Lamsen turret lathe, 22 patch-bolts are turned and threaded in one hour.

CHUCK-JAWS FOR TURNING WHEEL TIRES.

The chuck-jaws shown in Fig. 13 are used on a 90 in. Pond double-head boring mill. There are four of these jaws in a set and they are used for chucking wheel tires. The dogs are made of tool steel. Two of these are placed in a vertical position in the jaws to prevent the tires from turning, and the other two are placed in a horizontal position to prevent the tires from rising. On the bottom of the jaws a rib is cast which fits into the radial slots in the bed of the boring mill. The jaws are secured to the bed by the bolts "A." The finer adjustment and holding of the tire is done by the set screws "B," which bear on the steel dogs "C." The tires rest on the adjusting screws "D," which also serve to adjust the tire to the proper level.

PNEUMATIC FLANGING-CLAMPS.

A pair of flanging-clamps (Fig. 14) used in the boiler shop were designed by Mr. W. McIntosh, Superintendent Motive Power. They are fitted up with a pair of old air pump cylinders. These work in unison and are so connected as to be operated by one valve. With this arrangement the clamps can be opened and closed very quickly, practically giving the sheet no time to cool. One man can operate these clamps in a better manner than two men formerly operated the old screw clamps.

A BLOCK AND DOG FOR BOILER SHOPS.

An effective block and dog (Fig. 15) was

designed by Mr. Craig, Foreman Boiler Maker of the Elizabethport shops. The block is about 4 ft. square by 2½ in. thick. It has a series of 1½ in. square holes cast through it, which are about 2¾ in. center to center. The dogs are made of 1¼ in. round iron, shaped as shown. To secure a piece of work, the dogs are placed in the holes, the foot "F" is put into any desired position on the forming block, or piece to be held, and a couple of sharp blows struck on the dog at "A" holds the piece firmly to the block. It is surprising how securely the work can be held with such a simple device. A blow struck at "B" releases the dog.

## Shapes of Ties.*

In seeking for new shapes of ties the first consideration should be to secure at least the same bearing surface on the ballast which the present ties have, and preferably very much more. It is believed by the writer that the present thickness of ties is one which will probably not be increased to any extent even with an increased load, and the same may be asserted of the length. Any changes which may be made will probably be in the two bearing surfaces, namely, the one under the rail and the one on the ballast. With light rails, the present bearing surface of 8 to 9 in. under the rail is necessary where ties are used without tie-plates. The broad tie gives greater bearing surface to the base of the rail, and greater safety to the track.

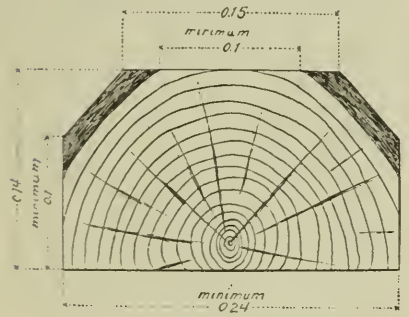



Fig. 1.

Standard tie, Bavarian State railways, suggested for use in the United States. (Measurements given are in fractions of meter.)

The heavier rails now coming into general use, because of their increased stiffness, no longer require the same amount of bearing surface on the tie as the lighter rails. It is generally agreed that a reduction in the bearing surface of the rail on the tie may be effected with safety, provided the same kinds of timbers are used as in the past. The only point which has been questioned is whether the softer timbers which are now coming to be employed—that is timbers like red oak, loblolly pine, etc., in which the sapwood is utilized (it being taken for granted that all of these ties are treated), could be used safely with any bearing surface less than the customary 8 or 9 in. It has been generally conceded that these timbers could not be used safely without some form of tie-plate, and at the present time most of the roads which have taken up the softer timbers are actually using tie-plates of one kind or another.

While it is probable that stiffer rails will reduce the cutting action of the rail on the tie to a minimum, there seems to be no doubt that some form of tie-plate will be necessary with soft woods, even when a stiff rail is used. By using the stiffer rail, which has a broad base, the tie-plate no longer need distribute the weight, as with the lighter rails, or at least that is a minor function. Its chief function on the soft wood tie with stiff rails will be to prevent wear, and for this purpose some form of plate, either of iron or of wood, will be indispensable.

Keeping in mind the desirability of an increased bearing surface on the ballast, and the fact that the top bearing surface need be only 5 in. when a tie-plate is used, it is suggested that a type of tie with a top-bearing surface of about 6 in. and a base bearing surface of anywhere from 8 to 12 in. will not only give a sufficient bearing surface for the rail, but will also give a very much more stable tie on the ballast. Such a tie would correspond to the type shown in Fig. 1, to which may be given the name of the half-round tie. It is evident that the lines of force here have a very much greater extent on the base, and that nothing has been lost in the amount of bearing surface which the rail has on the top of the tie. This form would not only give a greater bearing surface at the base, thereby making the tie more stable, but would also permit of laying fewer ties per mile. (See Fig. 2.)

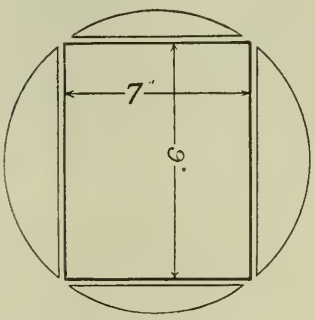



Fig. 3.

Manner of making one 7x9-inch tie from a log 11½ inches in diameter.

It has been admitted that with the increased stiffness of the rail it might be possible to increase the spacing between the centers of bearing of neighboring ties. If this is true, ties such as the one indicated in Fig. 1, with a top bearing surface of 6 in. and a base of 12 in., could be spaced so that the distance between the bases of two neighboring ties would be the same as for a 7 by 9 in. tie. This would, of course, increase the distance between the bearing centers on the top of the ties (Fig. 2.) It is necessary to space ties so as to get the same number per rail length and avoid joints. This for a 7 x 9 in. tie is about 18 per 30-ft. rail, with a space 11 in. wide between the two ties, or 20 in. between bearing centers. To avoid joints it will be necessary to space the new form so as to make either more or less than 11 in. between the extreme base joints, and, in the comparison which follows, the spacing will be assumed as 10½ in. per 30-ft. rail. (See Fig. 2.) It is by no means meant to imply, however, that such would be the actual distance in practice. It is extremely probable that 10½ in. would be too close together to allow of a proper use of the shovel or other tool employed in tamping the tie, a point which deserves considerable attention when the question of tie spacing is being considered. It is extremely probable that the increased stiffness of the rail will permit of a spacing, with a tie of the form proposed, very much greater than is possible with the present tie.

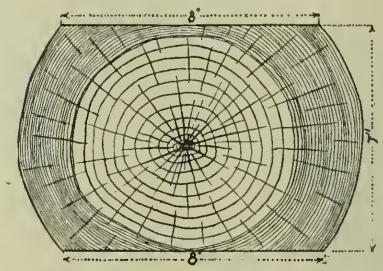


Fig. 5.

Pole Tie.

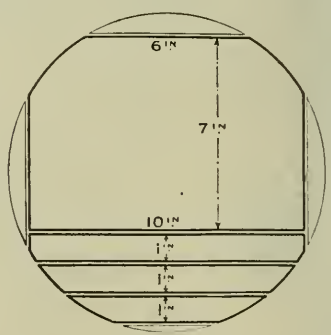



Fig. 4.

Manner of cutting one 6-inch face tie, with a 10-inch bearing surface and 7-inch thickness, and several boards from a log 11½ inches in diameter.

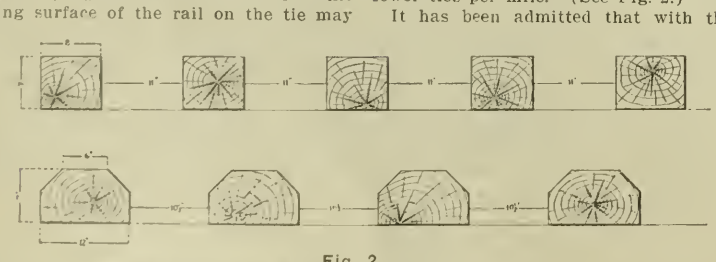


Fig. 2.

Manner of spacing 7x8-inch ties and half round ties.

The comparative showing of rectangular 7 x 8 in. and 7 x 9 in. ties and of ties with a 6-in. top and 12-in. base, spaced respectively at 11 and 10½ in., is as follows:

| | Rectangular tie. 7 in. x 8 in. | Rectangular tie. 7 in. x 9 in. | New tie. 6-in. top 12-in. base. |
|---|---|---|---|
| Distance between bearing centers, on both top and base of tie, in. | 19 | 20 | 22.5 |
| Increase in distance between bearing centers by use of ties of the new form, in. | 3.5 | 2.5 | ... |
| Total number of ties per mile | 3,242 | 3,168 | 2,816 |
| Number of ties per mile saved by use of new form | 426 | 352 | ... |
| Total linear bearing on ballast per mile, ft. | 2,161 | 2,376 | 2,816 |
| Bearing surface on ballast per mile, with 8-in. length, sq. ft. | 17,290 | 19,008 | 22,528 |
| Gain in bearing surface by use of tie of the new form, sq. ft. | 5,238 | 3,520 | ... |

*From Hermann von Schrenk's report to U. S. Department of Agriculture, Bulletin No. 50.

According to this table the number of ties of the new form required per mile is 352 less than with the 7 x 9 in. tie, and 426 less than with the 7 x 8 in. tie, while the amount of bearing surface obtained is greater by 3,520 sq. ft. than that obtained by the 7 x 9 in. tie—an increase in bearing surface of over one-sixth. At the same time there would seem at first sight to be a considerable saving from the smaller number of ties,

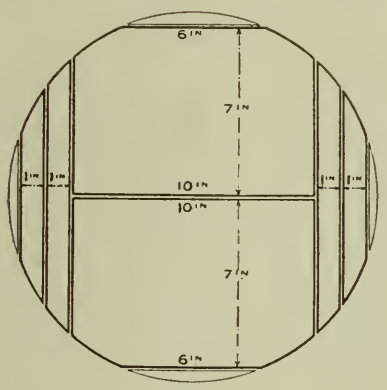



Fig. 6.

Manner of cutting two ties, with 6-inch face, 7-inch thickness and 10-inch base, as well as several boards from a log 15½ inches in diameter.

but in reality there is little difference in expense because of the larger number of feet, board measure, in the new tie.

Having shown that a tie with a smaller bearing surface at the top and a larger one at the base is a better one from a mechanical standpoint, it now becomes necessary to consider the changed tie form from a lumber standpoint. The question is, Will it be more economical to cut ties of the form just indicated than the present rectangular tie? It ought to be stated that the suggestion for the adoption of the form above specified is by no means meant to exclude the rectangular tie now used. Whenever it will pay to purchase square ties with a bearing surface of 10, 11 or 12 in., such ties will serve for all practical purposes as well as the one in which the bearing surface has been reduced to 6 in.

Ties are now being cut from trees of all diameters from 9 in. upward. If cut but one from a cross section, they are usually termed pole ties.

Most of these are rounded at the edge and squared on two sides (Fig. 3), with a required bearing surface of 6 to 8 in. Pole ties are now cut from trees as large as 17 in. in diameter. Most of them are hewn, and in the hewing much of the outer portion of the tree is wasted. In larger trees also a great deal of timber is wasted, even when ties are split in the most economical fashion. In the majority of instances no wane is admitted for a first class tie, so that logs less than 10 in. in diameter will not make ties of this class. This means that a great many tops are now left in the woods because they are too small. By adopting the tie classification suggested above (and here again emphasis ought to be laid upon the fact that ties cut according to this shape will all be treated) it will be possible to utilize a great many logs which now do not make ties, and also to cut a good many more ties out of the same amount of timber than under the present specifications. This will appear from the diagrams (Figs. 4 to 8). Fig. 8 shows a tree 11½ in. in diameter. Such a tree will make one 7 x 9 in. tie, or it will make a tie with a 6-in. bearing surface, 7 in. thick, and a 10-in. base, and a number of boards in addition, as shown in Fig. 9. A log 15½ in. in diameter (Fig. 6) will make only one 7 x 9 in. tie, but it will make two of the suggested form (Fig. 1), while from a log 19.8 in. in diameter, which will make but two 7 x 9 in. ties, three ties, two 7 x 9 in. and one of the suggested form, can be cut (Fig. 7.)

The cutting of ties of this new form will be essentially a saw mill proposition. Where now there is a great deal of waste in hewing, if the log were sawed it would mean the obtaining of several boards on the side, as indicated in Figs. 5 and 6. The number of boards to be sawed from a tree 16 in. in diameter, making two ties, will depend largely upon the value of the timber from which the ties are made. For instance, it will pay to make as many boards as possible out of a 16-in., two-tie log of red oak or gum, while with timber like loblolly pine, the lumber of which has a low value, it will at present not pay to cut off many boards. In the case of such timber an extreme form of the half-round tie will be applicable (Fig. 8.)

The influence which the new tie form will have upon the size of trees cut for tie purposes ought to be a marked one. It certainly would discourage the cutting of pole ties to a very considerable extent. It would not pay to make a tie out of a small tree when by leaving it for a few years two ties could be made from the same tree. In other

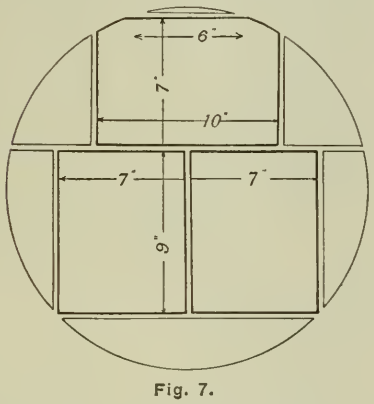



Fig. 7.

Manner of cutting ties from a 20-inch log.

words, the present policy of cutting trees 11 or 12 in. in diameter would be found less profitable than cutting trees 16 or 17 in. in diameter. There is probably no other branch of the lumber industry in which so many small trees are annually destroyed and the possible regrowth of forests retarded to such an extent as in the manufacture of ties. The practice of sawing ties from logs is going to be more and more prevalent as the old feeling that a sawed tie is not worth having disappears. This feeling is already rapidly disappearing. It certainly will disappear entirely when railroad men realize that with a chemically treated tie it makes no difference whether it be sawed or hewn. With increasing permanency in the source of supply it will pay more and more to put up small sawmills, which will saw ties and such lumber as may incidentally come to them. This will be particularly true in regions where there are rapidly growing tree species, such, for instance, as loblolly pine. The cutting of these trees will, moreover, make possible the use of large quantities of timber which now is practically wasted and from which the lumberman has no return. This is particularly true of tops.

Fig. 6 shows the manner of sawing two half-round ties from a log 15.3 in. in diameter. Such a log will make only one 7 x 9 in. tie, but it will make two of the 6 x 7 x 10 in. ties. The 7 x 9 in. tie measures 42 board ft., and the boards on the side 55 ft., a total of 97 board ft. for a 15.3-in. log when sawed into a tie of the present standard shape. The same log will make two 6 x 7 x 10 in. ties equal to 84 ft. b.m. and boards equal to 17 ft. b.m., a total of 101 ft. b.m.; that is, 4 board ft. in favor of cutting the half-round ties. It must be remembered, however, that only in the rarest instances will it be possible to realize the full number of boards estimated for the ideal round tree; hence the difference between the two methods of cutting will probably be very small.

SUMMARY.

From the foregoing discussion we may make the following generalizations:

First.—It is not desirable to continue the present method of classifying ties as first class, second class, etc., and culls. Instead, an alternative classification is proposed, which substitutes a division into grades A, B, C, etc., each standing for a certain definite size. Such a classification would throw out the cull tie entirely.

Second.—It is not desirable to decrease the number of ties of the present breadth now laid per rail length, for the reason that even with an increased stiffness of rail a reduction in the bearing surface on the ballast is not warranted, in view of the fact that a larger bearing surface on the ballast is continually being sought for. In this connection it must be remembered that closer spacing of ties will not be possible, since a certain minimum space must be maintained to permit proper track work. In other words, increasing the breadth of the tie will necessarily mean a reduction in number per rail length.

Third.—Triangular ties are not desirable and ought not to be used, because they give less bearing surface on the ballast rather than more.

Fourth.—Assuming that tie-plates are to to be used on treated timbers of inferior grade, it is a waste of timber to require an 8-in. top bearing surface. It is therefore proposed that the present requirement be modified so as to admit timbers having a minimum of 6-in. top bearing surface. At the same time it is proposed that the bearing surface on the ballast be increased above 9 in. to such an extent as may prove ad-

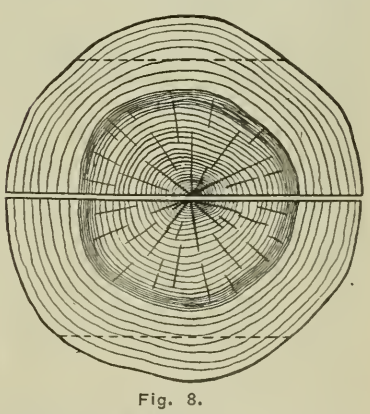


Fig. 8.

Extreme form of half-round ties cut from log of inferior lumber value.

vantageous, depending upon the class of timber from which the ties are made. This would make a "half-round tie" (Fig. 1) of the following dimensions: Top bearing surface, minimum breadth, 6 in.; bearing surface on the ballast, 10-12 in.; thickness, 7 in.; length, 8 ft. or more.

Fifth.—The half-round tie is advantageous from a mechanical standpoint, because it gives greater bearing surface per mile and

a correspondingly more stable track when spaced at approximately the same distance now used with 7 x 9 in. ties.

Sixth.—The half-round tie is good for the lumberman, because in numerous instances it will make two ties where it would have been possible to make only one of the rectangular form.

Seventh.—The half-round tie is good for the forest, because it will encourage the cutting of large trees and the saving of small ones and, further, will prevent the waste due to leaving many tops in the woods.

Eighth.—Taking all these matters into consideration, it would appear that the half-round tie is worthy of trial. Experiments are now under way to test the practicability of sawing large numbers of these ties. These experiments are being made in co-operation with the New York Central in the Adirondacks, with beech and birch, with the Santa Fé in Texas and Arizona with various pines, and with the St. Louis & San Francisco Railroad in Missouri and Arkansas and the Northern Pacific in Montana and Washington with red fir and lodgepole pine.

## Programme of the Master Mechanics' Convention.

The American Railway Master Mechanics' Association will hold its 37th annual convention at Saratoga Springs, N. Y., June 27, 28 and 29. Headquarters will be at the Grand Union Hotel and the meetings will be held in the ballroom, which has been remodeled to give good acoustic properties. The following programme has been arranged:

OPENING SESSION.

First Meeting.

*Monday, June 27, 1904—9:30 a. m. to 1:30 p. m.*

| | |
|---|---|
| Opening Exercises: Prayer, President's address. | 9.30 a. m. to 10.00 a. m. |
| Intermission | 10.00 a. m. to 10.05 a. m. |
| Those wishing to retire may do so, but all are requested to remain. | |
| Action on minutes of last meeting | 10.05 a. m. to 10.10 a. m. |
| Report of secretary and treasurer | 10.10 a. m. to 10.25 a. m. |
| Assessment and announcement of annual dues | 10.25 a. m. to 10.30 a. m. |
| Election of auditing committee | 10.30 a. m. to 10.35 a. m. |
| Unfinished business | 10.35 a. m. to 10.40 a. m. |
| New business—consideration of matters affecting the conduct of the affairs of the association: appointment of committees on correspondence, resolutions, obituaries, nominations, etc., and such other matters as may properly come under this order of business | 10.40 a. m. to 11.00 a. m. |
| Discussion of report on ton-mile statistics | 11.00 a. m. to 11.30 a. m. |
| Discussion of individual paper on grates for bituminous coal, by J. A. Carney, M. M., C. B. & Q. R. R. | 11.30 a. m. to 12.00 m. |
| Discussion of reports on: Coal consumption on locomotives | 12.00 m. to 12.45 p. m. |
| Locomotive front ends | 12.45 p. m. to 1.30 p. m. |
| Adjournment. | |

Second Meeting.

*Monday, June 27, 1904—7:30 p. m. to 9:30 p. m.*

Topical Discussions

| | |
|---|---|
| 1. For lubricating main, side rods and driving box bearings, which is the better practice, grease or oil? To be opened by Mr. T. S. Lloyd | 7.30 p. m. to 8.00 p. m. |
| 2. With the large modern engines equipped with power brakes, is not screw reverse mechanism preferable to present hand lever arrangement, and is quick reversal a vital consideration? To be opened by Mr. Jas. McNaughton | 8.00 p. m. to 8.30 p. m. |
| 3. What is the best practice with reference to providing air spaces under locomotive grates, especially with wide fire-box locomotives? To be opened by Mr. F. J. Cole | 8.30 p. m. to 9.00 p. m. |
| 4. What is the best method of caring for exterior of locomotive front ends from the standpoint of cost and appearance? To be opened by Mr. W. O. Thompson | 9.00 p. m. to 9.30 p. m. |
| Adjournment. | |

MIDDLE SESSION.

First Meeting.

*Tuesday, June 28, 1904—9:30 a. m. to 1:30 p. m.*

| | |
|---|---|
| Discussion of reports on: Locomotive driving and truck axles and locomotive forgings | 9.30 a. m. to 10.00 a. m. |
| Boiler design | 10.00 a. m. to 10.30 a. m. |
| Revision of standards | 10.30 a. m. to 11.00 a. m. |
| Air-brake and signal instructions | 11.00 a. m. to 11.30 a. m. |
| Piston valves | 11.30 a. m. to 12.00 m. |
| Individual paper on machine tools. By Mr. H. H. Vaughan | 12.00 m. to 12.30 p. m. |
| Individual paper on technical school graduates. By Mr. R. D. Smith | 12.30 p. m. to 1.00 p. m. |
| Individual paper on terminals for locomotives. By Mr. R. Quayle | 1.00 p. m. to 1.30 p. m. |
| Adjournment. | |

Second Meeting.

*Tuesday, June 28, 1904—3:00 p. m. to 5:00 p. m.*

| | |
|---|---|
| Topical discussions: Packing for air pumps for high speed brakes. To be opened by Mr. A. J. Cota | 3.00 p. m. to 3.30 p. m. |
| The advisability of reducing the diameter of stay bolts and shortening the space between the stay proportionately. To be opened by Mr. G. R. Henderson | 3.30 p. m. to 4.00 p. m. |
| Leaky flues in wide fire-boxes. To be opened by Mr. M. K. Barnum | 4.00 p. m. to 4.30 p. m. |
| Limit of width of soft coal burning fire-boxes, with reference to high evaporation efficiency. To be opened by Mr. S. M. Vauclain. | 4.30 p. m. to 5.00 p. m. |
| Adjournment. | |

CLOSING SESSION.

Wednesday, June 29, 1904.—9.30 a.m. to 1.30 p.m.

| | |
|---|---|
| Discussion of: Individual paper, by Mr. W. R. McKeen, Jr., on tool steel | 9.30 a. m. to 10.00 a. m. |
| Report of Master Car and Locomotive Painters' Association on painting locomotives | 10.00 a. m. to 10.15 a. m. |
| Individual paper, by Mr. C. A. Seley, on variable motors | 10.15 a. m. to 10.45 a. m. |
| Report on: Automatic stokers | 10.45 a. m. to 11.00 a. m. |
| Locomotive frames | 11.00 a. m. to 11.30 a. m. |
| Cost of locomotive repair shops | 11.30 a. m. to 12.00 m. |
| Safety appliances for locomotive front-ends | 12.00 m. to 12.30 p. m. |
| Subjects | 12.30 p. m. to 12.45 p. m. |
| Correspondence and resolutions | 12.45 p. m. to 1.00 p. m. |
| Election of officers | 1.00 p. m. to 1.30 p. m. |
| Adjournment. | |

## Water Softening on the Union Pacific.

BY A. K. SHURTLEFF.*

During the progress of the improvement work on the Wyoming division of the Union Pacific Railroad, particular attention was directed toward the improvement of the locomotive water supply, both as to quality and quantity. The conditions on the district from Rawlins to Green River demanded very careful consideration. The entire supply for the district was obtained from deep wells except at Green River and Rock Springs. These two stations were supplied by water pumped from the Green River, which is a fair boiler water. At Rawlins the water was very high in both incrusting and foaming solids, and the supply was insufficient for the needs of the company. At Point of Rocks the water was high in incrusting solids, but appeared susceptible to treatment. At the other stations the supply was limited, and while low in incrusting solids was very high in sodium salts.

After thorough investigation it was decided to build pumping stations and a pipe line from the North Platte River at Fort Steele to Rawlins. In this manner an abundant supply of water was obtained for Rawlins, carrying in solution about 6 gr. of incrusting solids and 8 gr. total solids per gallon, and varying but little from this throughout the year. To improve the quality of the water at Point of Rocks, a Kennicott water softener of 8,000 gals. per hour capacity was erected, and when placed in operation reduced the incrusting solids in this water from about 18 gr. to about 5 gr. per gallon, as shown in the table herewith. The only satisfactory method of obtaining a better supply at the Riner and Bitter Creek stations was to haul water to these points from Rawlins and Point of Rocks respectively, and this method was adopted. By thus obtaining the better quality of water at Rawlins and Riner, and treating the water for Bitter Creek and Point of Rocks at the latter point, the amount of incrusting solids going into boilers daily on this engine district was reduced about 500 lbs. Owing to the fact that the new line from Rawlins to Tipton was placed in use only five months prior to the first use of this better water, a comparison of statistics is necessarily confined to a limited time and cannot show full value on many points. A study of freight train statistics before and after the improved conditions in water supply show the following:

| | Per Cent. |
|---|---|
| Increase in average monthly engine mileage | 27 |
| Increase in gross ton miles per lb. of coal | 7½ |
| Decrease in repairs of locomotives per engine mile | 34 |

The increase in gross ton miles per pound of coal and decrease in locomotive repairs is directly due to the better water supply, and the increase in the monthly engine mileage is largely due to the same thing, but cannot be entirely attributed to this one cause. As only five months' time has been considered, the true benefits in repairs of locomotives, and possibly in reduction of locomotive fuel, are not shown in this statement.

A better idea of the reduction in expense in locomotive repairs may be obtained from the following. The length of this district is 134 miles. There are assigned to this district about eight passenger and 20 freight locomotives.

| Locomotive washed out— | Before. | After. |
|---|---|---|
| Passenger | Each trip. | "Limited," each trip; others, round trip. |
| Freight | Round trip. | Round trip. |

*Assistant Engineer, Union Pacific R. R.

Water changed in boilers—
3 to 4 changes, blown through boiler each trip. Each trip.
Average life of set of flues—
Passenger .....6 months....2½ years
Freight .....10 to 12 months....2½ years

Before the change in water, a great deal of trouble and expense was incurred because of tube sheets cracking between the holes, and occasionally a crown-sheet was mud-

The stations selected for the installation of these plants were those where the greatest amount of incrusting matter could be removed daily, based on the amount of water used in locomotives and the guarantee that the incrusting solids could be reduced to 5 gr. or less per gallon. These points are shown in the Table 1. Only about one-third of the water treated at Cheyenne is used by

TABLE 1.—NEBRASKA DIVISION—MAIN LINE WATER STATIONS.

| Station. | Gallons water used per day. | Incrusting solids in one day's supply, lbs. | Capacity of softener gals. per hour. | Date softener installed. |
|---|---|---|---|---|
| Council Bluffs | 130,000 | 706 | 15,000 | May 29, 1903 |
| Millard | 30,000 | 82 | .... | ..... |
| Valley | 89,000 | 152 | 8,000 | Dec. 20, 1902 |
| Fremont | 60,000 | 143 | .... | ..... |
| North Bend | 13,000 | 27 | .... | ..... |
| Schuyler | 30,000 | 116 | .... | ..... |
| Columbus | 150,000 | 528 | 10,000 | Apr. 18, 1903 |
| Silver Creek | 12,000 | 30 | .... | ..... |
| Clarks | 16,000 | 43 | .... | ..... |
| Central City | 34,000 | 64 | .... | ..... |
| Grand Island | 180,000 | 293 | 10,000 | Mar. 28, 1903 |
| Wood River | 17,000 | 41 | .... | ..... |
| Gibbon | 19,000 | 49 | .... | ..... |
| Kearney | 72,000 | 168 | 8,000 | Mar. 23, 1903 |
| Elm Creek | 10,000 | 36 | .... | ..... |
| Lexington | 75,000 | 168 | 10,000 | Jun. 7, 1903 |
| Willow Island | 13,000 | 27 | .... | ..... |
| Brady Island | 37,000 | 61 | .... | ..... |
| North Platte | 180,000 | 497 | 15,000 | Apr. 27, 1903 |
| Hershey | 13,000 | 45 | .... | ..... |
| Paxton | 37,000 | 196 | .... | ..... |
| Ogallala | 57,000 | 94 | .... | ..... |
| Big Springs | 11,000 | 16 | .... | ..... |
| Julesburg | 122,000 | 309 | 8,000 | Jan. 29, 1903 |
| Chappell | 10,000 | 18 | .... | ..... |
| Lodge Pole | 16,000 | 30 | .... | ..... |
| Sidney | 140,000 | 301 | 10,000 | Mar. 16, 1905 |
| Potter | 21,000 | 38 | .... | ..... |
| Kimball | 38,000 | 99 | .... | ..... |
| Bushnell | 4,000 | 7 | .... | ..... |
| Pine Bluffs | 38,000 | 84 | .... | ..... |
| Egbert | 6,000 | 11 | .... | ..... |
| Hillsdale | 18,000 | 42 | .... | ..... |
| Durham | 5,000 | 9 | .... | ..... |
| Cheyenne | 270,000 | 203 | 20,000 | Aug. 18, 1903 |
| Totals | 1,973,000 | 4,733 | | |

TABLE 2.

*Results obtained at water softening plant in operation March 1, 1904, with actual costs of chemicals used, based on cost at Omaha, Neb., of lime at 90c. per barrel and soda ash at $1.07¼ per cwt.*

| Division and Station. | Gallons water treated daily. | Solids in solution per U. S. gal. Before treatment. Incrusting. | Before treatment. Total. | After treatment. Incrusting. | After treatment. Total. | Cost of chemicals for treating. Cents per 1,000 gals. | Cost of chemicals for treating. Per day for water used. | Lbs. Incrusting solids removed per day. |
|---|---|---|---|---|---|---|---|---|
| Nebraska Division— | | | | | | | | |
| Council Bluffs | 130,000 | 38.00 | 47.00 | 4.91 | 34.28 | 2.55 | $3.32 | 615 |
| Valley | 89,000 | 11.98 | 15.72 | 4.34 | 9.72 | 1.34 | 1.19 | 96 |
| Fremont | 60,000 | 16.70 | 20.52 | 4.84 | 17.37 | 1.05 | .63 | 101 |
| Schuyler | 30,000 | 27.16 | 29.84 | 5.18 | 22.36 | 2.26 | .68 | 94 |
| Columbus | 150,000 | 24.62 | 30.74 | 4.94 | 20.55 | 1.50 | 2.25 | 422 |
| Grand Island | 180,000 | 11.41 | 13.51 | 4.77 | 12.65 | 1.00 | 1.80 | 171 |
| Kearney | 72,000 | 16.35 | 21.68 | 4.74 | 15.02 | 1.07 | .77 | 120 |
| Lexington | 75,000 | 15.69 | 21.07 | 4.91 | 12.87 | 1.42 | 1.06 | 115 |
| North Platte | 180,000 | 19.37 | 28.49 | 5.33 | 25.22 | 1.47 | 2.65 | 361 |
| Paxton | 37,000 | 37.10 | 57.17 | 10.95 | 51.19 | 2.55 | .94 | 139 |
| Julesburg | 122,000 | 17.74 | 25.26 | 4.86 | 18.79 | 1.46 | 1.78 | 224 |
| Sidney | 140,000 | 15.03 | 16.81 | 4.93 | 15.40 | .90 | 1.26 | 202 |
| Wyoming Division— | | | | | | | | |
| Cheyenne | 270,000 | 14.19 | 16.65 | 4.56 | 8.47 | .63 | 1.70 | 372 |
| Cooper's Lake | 47,000 | 20.12 | 28.18 | 4.65 | 17.54 | 1.50 | .71 | 104 |
| Rock River | 90,000 | 16.81 | 20.63 | 4.99 | 16.15 | 1.00 | .90 | 152 |
| Hanna | 45,000 | 14.80 | 15.80 | 4.67 | 8.71 | 1.35 | .61 | 65 |
| Dana | 35,000 | 14.04 | 14.52 | 4.62 | 10.24 | 1.35 | .47 | 47 |
| Point of Rocks | 144,000 | 18.05 | 41.79 | 4.26 | 31.52 | 1.50 | 2.16 | 284 |
| Rock Springs | 70,000 | 14.27 | 18.33 | 5.15 | 15.42 | 1.02 | .71 | 91 |
| Kansas Division— | | | | | | | | |
| Lawrence | 70,000 | 23.59 | 33.38 | 5.01 | 20.32 | 1.22 | .85 | 185 |
| Wamego | 44,000 | 28.89 | 42.83 | 4.87 | 24.05 | 2.18 | .96 | 151 |
| Junction City | 89,000 | 19.31 | 21.38 | 4.11 | 11.95 | 0.85 | .76 | 193 |
| Total per day | 2,169,000 | | | | | | $28.16 | 4,304 |

Average cost for chemicals per 1,000 gals. water treated, 1.3 cents.

burned. No troubles of this nature have occurred since using the better water at these four points.

While treated water is used at only two of the stations on this district, the low amount of incrusting solids in the North Platte River water makes this water the equivalent of treated water so far as incrusting water is concerned. The beneficial effects resulting from the use of water containing about 5 gr. incrusting solids to the gallon at these four stations and the absolute proof that water containing the carbonates and sulphates of lime and magnesia could be treated at a very moderate cost, resulted in an order to place ten water softeners on the Nebraska division between Council Bluffs, Iowa, and Cheyenne, Wyo. Nebraska division locomotives, the balance being used on the Wyoming and Colorado divisions. By treating the water at the ten stations shown in the Nebraska division table, the total amount of incrusting matter going into boilers daily on this division was reduced about 53 per cent., or 2,450 lbs., as shown in Table 2.

As the last of these plants was established in August, 1903, and three additional plants have been established on the division on a new contract during the last three months of 1903, sufficient time has not elapsed to estimate properly the full benefits of these plants. A comparison of freight train statistics for the six months ending Jan. 31, 1904, with the first six months of 1902 shows an increase of 17 per cent. in average monthly mileage of freight locomotives which is largely due to better boiler water. The locomotives spend less time in shops for repairs and in the house for washing out. The number of men at work on boiler repairs has been reduced. One motive power official, who has followed the matter closely, estimates that boiler repairs on this division have been reduced at least one-half, but it will take months and possibly years to realize fully the extent of the reduction in boiler repairs. Locomotives, which under the old conditions would have required an entire change of flues several months ago, are still running and doing good service. During the progress of the installation of these softeners close account has been kept of boiler washings. After several plants were installed it was noted that the treated water had a tendency to loosen the old scale, causing foaming at times, and at first the boilers required as frequent washing as before; but finally the monthly reports began to show a continual decrease from month to month in the number of engines washed out and a steady increase in the average mileage of engines between washouts. During the last seven months of 1903 the average mileage of locomotives on the Nebraska division between boiler washings was doubled. This means a considerable reduction in labor and cost of water for washing out, as well as increased life of boilers owing to the fact that they are less frequently subjected to the deteriorating effects of cooling caused by washing out.

In March, 1903, an order was placed for 25 additional softeners, 16 to be of 10,000 gals. and the balance 15,000 gals. an hour capacity. Five of these softeners were for the Nebraska, seven for the Wyoming, eight for the Kansas and five for the Colorado division. Of these plants, 11 are in use and the balance under construction. Table (2) shows the results being obtained from the operation of the 22 plants installed prior to March 1, 1904, and the costs of chemicals for treating the water, deduced from the actual quantities and cost of chemicals used. The last column shows the average quantity of incrusting solids removed daily in treating the amount of water used at each plant. As most of the waters on the Union Pacific carry from 2 to 3 gr. of silica per gallon in solution, no particular effort is made to reduce the incrusting solids below 5 gr. per gallon. Where soda ash is used to reduce the sulphates of lime and magnesia, the sodium sulphate in the water is increased slightly more than grain for grain of the incrusting sulphates. This means an increased tendency toward foaming. At Paxton, Neb., the water is already high in the foaming solids, hence in treating this water the carbonates of lime and magnesia are reduced to the minimum, but only enough soda ash is used to partiallly treat the sulphates of lime and magnesia so as not to unduly raise the foaming solids.

In order to get satisfactory results in the softening of water it is absolutely necessary that particular attention be given to the care of the plants and that instructions regarding their operation be carefully followed. It is necessary that frequent tests be made of the treated and untreated waters so as to keep check on the attendant and on the liability of the natural water to change. It has been necessary to use discipline at times in order to get results, as no machine can soften water without proper attention.

At a few stations where a windmill was in use in addition to the steam or gasoline pumping plants, the use of the windmill has been discontinued as it could not furnish sufficient water to properly operate the plant and thoroughly treat the water. At such stations the average cost of pumping water

has been slightly increased. In a few of the cities objection has been made to having the sewer of the softener connect into city sewers. This has caused the construction of an independent sewer, and where but light fall can be obtained a considerable expense is incurred in keeping the manholes cleaned out and the sewers flushed. At points where good fall and a discharge into a regular waterway can be obtained, the expense of caring for sludge is very little.

The cost of chemicals to treat the waters varies. Each water has to be considered separately and the cost of chemicals depends on the amount and kind of reagents required for proper treatment. Common lime is used as a reagent for the carbonates of lime and magnesia, while soda ash is used as the reagent for the sulphates of lime and magnesia. As soda ash is the most expensive, water containing the sulphates of lime and magnesia is more expensive to treat than water containing about the same quantity of carbonates of lime and magnesia. Particular care is taken in the purchase of lime, and only that which is well burned and having the highest percentage of calcium oxide with the lowest amount of silica is used.

Other expense in the operation of the softeners is the labor of preparing the solutions and additional expense incurred by the testing department. At most of the plants now in operation no additional expense is incurred in preparing the solutions. This work requires not to exceed half an hour of time for each six hours of operation, and the pumpers are enabled to look after this without stopping their pumps or interfering with their other duties. At busy terminals and at points where water is obtained from city mains or by gravity, it has been necessary to make it part of the duty of some employee to prepare these solutions. In such case a proportion of his wages is charged to the operation of the plant.

At present two traveling assistants to the chemist are employed to inspect the plants and see that pumpers follow the instructions given them in regard to preparing solutions One additional laboratory assistant is required to make weekly analyses of the water from each plant. When the entire 36 plants are in operation, the only further expense to this department will be one more traveling assistant and the additional expense for chemicals in making the analyses. At present, with 22 plants in operation, the additional expense attending softeners is $370 per month. The additional expense incurred by the testing department is $330 per month. While these are not dependent upon the amount of water treated, the cost per thousand gallons for 22 plants in operation for attendance and testing department expense is only 1.08 cents. As consumption increases at these plants this amount will be reduced. No additional expense for labor and fuel in pumping water is required, as the water is handled only once in these plants. In Nebraska and Wyoming it has been found advisable to install small heating stoves in the upper housing of the softeners to keep the plants from freezing when not in operation, during the colder part of the year.

Depreciation and repairs is an important item and was duly considered. The materials used in construction are concrete for foundations and iron and steel for the balance of the plant with the exception of the housing at the top of softeners, and a small frame building to store a month's supply of lime and soda ash at each plant. The machinery is slow and steady-moving, without jar to the structure. With these points in view the charges for depreciation and repairs will probably represent but a very low percentage of the original investment.

With the entire 36 plants in operation, having a total hourly capacity of 417,000 gals., the Union Pacific will be softening an average of 3,000,000 gals. of water per day, removing therefrom over three tons of incrusting solids. Excluding interest on investment and charges for depreciation and repairs, the entire additional expense incurred by the operation of these softeners will be equivalent to an additional charge to water supply of 2.32 cents per thousand gallons of water treated. As the consumption increases this cost will decrease somewhat, owing to the fact that some of the charges depend more directly on the number of plants in operation than on the amount of water treated. On the Nebraska division alone a reduction of 3½ per cent. in fuel used would compensate for this additional cost for treating water, and the increased monthly mileage of locomotives will more than compensate for the interest on the investment. The reduction in cost of maintenance of locomotives, less the cost of maintenance of the softening plants, is a clear saving to the railroad company.

## Mr. Moseley and the Master Car Builders.*

Mr. Moseley spoke of the pleasant relations existing between the inspectors of the commission and men in the car departments of the railroads throughout the country. The recommended standards of the association are carefully followed by the commission in its criticisms of defective cars. He hoped there would be a permanent committee for conference between the association and the representatives of the government. The committee recently appointed by the Master Mechanics' Association to confer with them in the matter of handholds and steps on the front ends of locomotives settled a troublesome matter and the conference resulted in the adoption of a standard that is meeting with no serious opposition. It is possible that a similar conference ought to be held regarding a standard of construction for handholds on the roofs of freight cars. Mr. Moseley reminded the Master Car Builders that the association's standards ought to be more thoroughly promulgated, as railroad officers are sometimes found to be ignorant of them.

The law which went into effect last September requiring not less than 50 per cent. of the cars of a train to be air-braked had greatly bettered conditions. On many roads the improvement is striking. The need of high braking power is a question requiring earnest attention. The use of two air pumps on each engine hauling a long train is also an important desideratum. Cars are often cut out simply on account of insufficient air. Again, two pumps would give a feeling of security against disaster from the failure of a pump. The speaker commended the introduction of automatic hose couplings, which he had observed on some roads.

The government inspectors uniformly report that railroad officers treat them well. On the Baltimore & Ohio recently there was an extended joint inspection by two of the commission's men and one representing the railroad company. The commission desires to extend this method of inspection. It has been suggested that the government inspectors ought to mark the cars which they examine, but Mr. Moseley does not wish to thus shift the burden of responsibility from the railroad to the government. The government inspection is not for the purpose of correcting individual defects, but is for the purpose of making reports to railroad managers which will indicate general conditions.

To bring about an ideal state of equipment it is necessary to have the means for maintenance; a watchful operating department; an efficient mechanical department, and employees (trainmen) who will intelligently observe and report failures and defects. The work of trainmen and switchmen is now less hazardous than formerly, but, on the other hand, appliances are more complicated and the men need higher intelligence; a course of persistent admonition and training is necessary; the men should be able to detect defects and to repair minor ones.

The M. C. B. coupler gage can be used only when cars are separated one from another. A gage which can be used on cars that are coupled together is needed. The speaker spoke of the well-known difficulties in connection with uncoupling mechanism, and in discussing the duty of settling this complicated problem, reminded his hearers that on some roads the conditions are found to be much better than on others, where the difficulties are no less. The inspectors also find that roads usually treat their own cars better than foreign cars.

The commission has instituted suits against a number of roads for non-compliance with the law, but practically all have been settled without going through a complete trial. The commission has no desire to oppress the roads in the slightest degree, but the president and the attorney general are determined that the laws shall be enforced. The speaker referred to the Johnson case, which was decided in the Circuit Court of Appeals, affecting uniformity and interchangeability, and to the Voelker case, both of which have been reported in the *Railroad Gazette*. In conclusion Mr. Moseley said:

A matter of great importance, and one that has been brought to the attention of the whole country by the disastrous wreck which occurred on an eastern trunk line, is that of rules governing the loading of long materials. While, properly speaking, this is perhaps outside the province of the Commission, it is of such great national importance that I feel warranted in calling attention to it, and promise the aid of the Commission in securing the proper observance of any rules which may be adopted by this Association to govern the matter.

It might seem to a casual observer that the duties of your Association would decrease with the more general adoption of standards, but changing conditions indicate that your duties are to be still further increased, as new problems are constantly arising; and in this connection it has been suggested to me that some roads on which the car departments are operated entirely separate from what is known as the mechanical department are perhaps showing better results than are those roads where the two departments are operated by one superintendent. It would seem that the increased problems to which I have alluded are proving too complicated for the proper grasp of their details by any one official.

Public sentiment is rapidly becoming crystallized with regard to proper remedies for the prevention of railroad accidents, and it may be that within a measurable period of time Congress will be approached with a view to the creation of a board of experts to investigate and report on the causes of accidents, something after the plan in vogue in Great Britain. Whether this would be a desirable thing or not is not for me to say, but if it is to be avoided it can only be by associations similar to yours adopting standards which shall be followed, and using their utmost efforts to ascertain the causes of and remedies for defects in equipment.

*Abstract of an address delivered at the convention of the Master Car Builders' Association, at Saratoga, June 22, by Edward A. Moseley, Secretary of the Interstate Commerce Commission.

## Cars for the Chicago Subway.

Reference has already been made in these columns (Aug. 7, 1903) to the tunnel system in Chicago of the Illinois Tunnel Company, formerly the Illinois Telephone & Telegraph Company. The latter company began the construction of these tunnels for the purpose of installing a new telephone system, but the idea was later conceived of enlarging the scheme to include an underground traction system, and accordingly last year the city passed an ordinance giving the company the right to conduct in its tunnels a freight parcels handling business, including mails, newspapers, merchandise, coal, etc. It is understood that the latter commodity will be the first to receive attention, it being estimated that the manufacturing establishments, office buildings and other consumers in the downtown district will give opportunity for carrying 4,000,000 tons of coal annually. This business will also probably include the removal of ashes from the engine rooms of these same customers. The company also expects to obtain a good part of the trucking traffic between the depots and the large wholesale and retail establishments, estimated at 125,000 tons daily.

The Morgan third-rail traction system will be used. The locomotives are a mining type, 24 in. gage, and have gears engaging a rack-rail which is laid between the track rails and is also the conductor rail. It is made of perforated metal plate ½ in. thick and 4 in. wide, and is laid between two timber stringers which support and protect it. The locomotives will weigh three tons with one motor and five tons with two motors. One advantage claimed for these locomotives is ability to haul heavy loads around sharp curves, the sharpest in these tunnels being 16 ft. radius. The Morgan Electric Machine Company, East Chicago, Ind., is the maker.

The cars to be used in this service were designed by Mr. W. P. Bettendorf. Several engravings from photographs are shown herewith, which illustrate the adaptability of the design to the different classes of service in which the cars will be engaged. The upper view shows the car complete for mail and for package delivery. Its contents may be completely enclosed and locked up. The hood is in halves, hinged to the sides, and can be removed without having to take out any bolts or nuts. Removal of the hood converts the car into a gondola. The sides are divided midway of their height, the

View in Tunnel, Showing Track.

*Fig. 1—Complete for Mail and Package Del'*

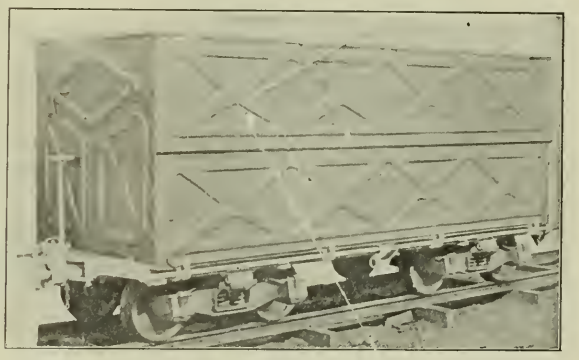


*Fig. 2—As a Gondola.*

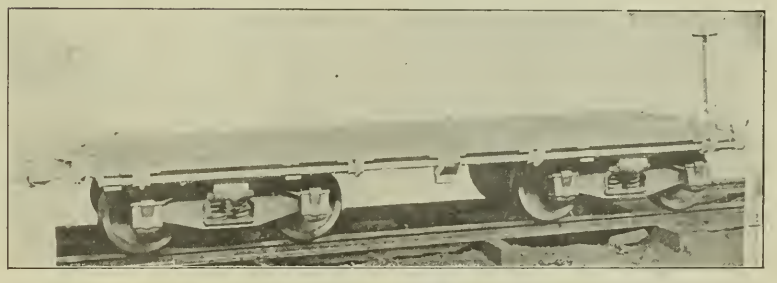


*Fig. 3—As a Flat Car.*

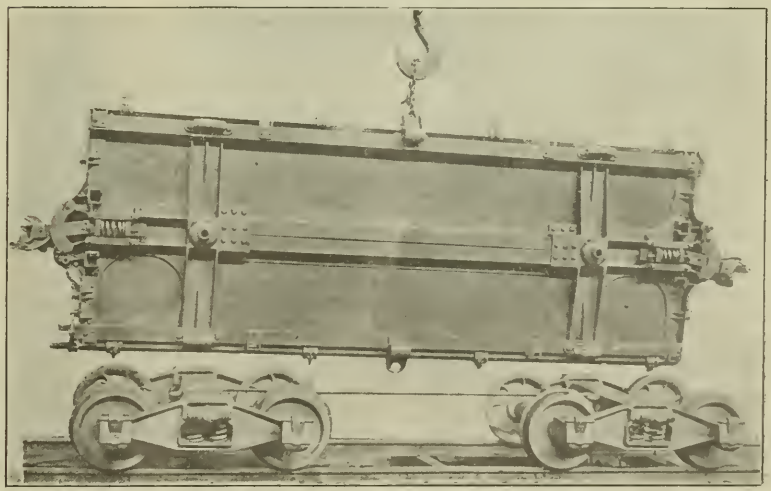


*Fig. 4—Bottom View, Raised from the Trucks.*

Four Views of Bettendorf Subway Car.

lower half being hinged at the top, enabling the contents to be discharged from either side. Conversion from a gondola to a flat can be accomplished in five minutes. Steel side stakes are provided for the flat cars when needed.

The cars are 10 ft. 6 in. long, 4 ft. wide, 5 ft. 1 in. from rail to top of side, and 6 ft. 7 in. to peak of hood. From the rail to the bottom of the floor is 16 in. and the height of side of the gondola is 45 in. The capacity is 30,000 lbs., and they are designed to go around curves of 15 ft. radius.

From the bottom view it will be seen that the body bolster and draft and end sills are combined in one casting. The center sills are two standard 4-in. Z bars, with their lower legs adjoining. They are riveted at their ends into pockets on the combination castings above mentioned. The side sills are also Z bars of the same size, with the lower leg extending inward. The floor is ¼-in. plate riveted to the sills and castings. The truck design is the same as that described in these columns two weeks ago, with slight modifications to adapt it to this particular service. There is no spring plank, and the truck side bearing is placed outside of the frame and is of such a form as to enable it to act both as a side bearing and a fulcrum in tipping the car body to unload it. The wheels are 14 in. in diameter and the journals 3 in. A distance rod attached to the two trucks retains them in their proper relation when the body is tipped or lifted off. To do this latter no bolts and nuts have to be removed. To provide for a condition where track cannot be laid to the unloading point, journals or lugs are cast on the end sills near their ends, to which chain bails may be attached and the entire body lifted by a hoist and run by a trolley to the desired point. In tipping for unloading, the outer lugs act as the fulcrum and form the axis about which the body rotates.

The sides are pressed steel, riveted to cast-steel stakes of T-shaped section. The cars have M. C. B. couplers and are equipped with hand brakes only. They are being built by the Bettendorf Axle Company, Davenport, Iowa, which is also building flat cars of similar design but 12 ft. 6 in. long, intended to carry the large rolls of paper used by newspapers.

## Water Softening on the Southern Pacific.

BY H. STILLMAN, ENGINEER OF TESTS.

Since the establishment in 1896 of the first plant for water treatment on the Southern Pacific the system has been extended, and the method improved, so as to obtain good results without unnecessary expense in placing apparatus. As far as possible, our standard apparatus is interchangeable and can be easily moved, or repaired. The first plant established at Port Los Angeles was described in my paper before the Am. Soc. M. E. in December, 1897. The object of this article is to give a mechanical description of the apparatus.

The elevation of the small chemical house with one settling tank, which is ordinarily sufficient at stations using 30,000 to 40,000 gallons per day, is shown by Fig. 1. The water main from the pump or gravity supply passes through the chemical house where it is intercepted by a motor furnishing power to drive the small chemical pumps, and stir the chemical mixture within the chemical tank when the plant is in operation. After passing through the apparatus within the chemical house, the water which contains precipitates from treatment, passes directly into the settling tank. The old principle of drawing the settled sludge at intervals by a system of pipes at the bottom (known as a "spider drain") has, however, been abandoned, as large open ended pipes become clogged up.

The system of having a false sloping bottom dropped into the ordinary form of tank, as shown in Fig. 1, with an 8-in. central drain pipe is ample and gives no trouble. Ordinarily, it is sufficient to clean out the sludge once a month by draining the tank as low as possible into the service tank. A couple of section men make a business of cleaning out. About two hours once a month is sufficient time for sludging out the settling tank. The tank shown is duplicated at large stations. At San Luis Obispo there are four tanks, connected together and worked in pairs, the amount of water required per 24 hours being from 125,000 to 150,000 gallons.

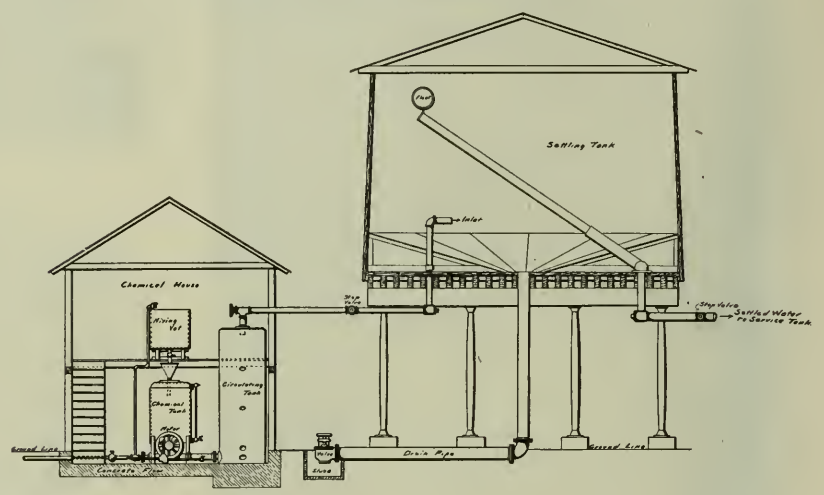



Fig. 1—General Arrangement of Water Treating Plant—Southern Pacific.

The softened water is allowed to remain in the settling tank as long as possible before the connection is opened to the service tank. The bottom of the settling tank is four feet higher than the bottom of service tank. It was formerly our practice, when possible, to treat the water directly in the service tank. This plan was abandoned, as service conditions often interfered with effectiveness of treatment. Unsettled water and sludge found their way into locomotive tenders so that independent settling tanks were found necessary. The apparatus within the chemical house is shown by Fig. 2. The chemical house also contains dry storage for chemicals. At some stations this apparatus is placed within the pump house, being arranged so that all apparatus is within easy reach of the pumps.

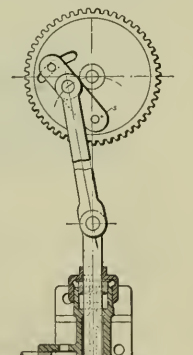


Fig. 3—Chemical Pump.

The water main is intercepted, first by the motor, which consists of an impulse wheel vertically placed within an enclosed case and driven by a nozzle at A. This nozzle can be adjusted through hand holes in the back of the motor case. On the outer projecting end of the motor shaft is a gear which drives the chemical pumps P.P.[1], and at the outer end is a sprocket wheel and chain, shown at S in the plan, for stirring the chemical mixture while feeding it from the chemical tank. In the installation shown, but one pump is used, the chemicals being mixed in one vat and fed from one chemical tank. This is at a station where temporary hardness only is to be reduced, or where the permanent hardness from sulphates, etc., requiring soda, is small. In such cases we use caustic soda* with the lime, the two oxides acting together, the caustic soda requiring less caustic lime in proportion to its affinity for carbonic acid.

Where much permanent hardness prevails, the system is made double, there being two chemical pumps, two vats and two chemical tanks. Soda ash, when thus used, is mixed in a separate vat alongside the vat shown which in this case is used for lime only. A second chemical tank is placed on the opposite side of the motor case without the stirring device which is not needed with soda solution. In some cases we have used the soda ash and lime together in one vat and found no variation in chemical results, the ultimate reactions on the raw water being the same. There are objections, however, to direct mixture in one vat of hydroxide of lime and carbonate of soda as much of carbonate of lime is directly produced, which is liable to clog the chemical pipes and pump and become hard in the chemical tank if the water is not continuously treated. We now use, therefore, a double system on bad waters.

From single or double chemical feeds, the necessary solutions enter the raw water at the cast iron box connection at B. This box has a cover for opening up the connection occasionally and removing the hard formation which will, in time, accumulate. The water now containing its necessary chemicals, passes on to the mixing tank. This tank contains no stirrer, but is arranged to stir its contents as a chemist stirs liquids in his laboratory, by using a stirring rod in the beaker of liquid and rotating the contents. This tank has four compartments, K L N and M. Compartment K is simply a sand box and receives the water directly from B. In each diaphragm which separates the tank into compartments are two

*The use of caustic soda in water treatment is quite fully discussed by Mr. H. Spencer Flynt in his article, "Some Sources of Error in Water Treatment," Engineering Magazine, Nov., 1903. Mr. Flynt advocates the use of caustic soda instead of lime where possible, on account of its being less liable to deterioration than commercial lime. We find this to be the case.

short nipples as shown. These nipples terminate in cast iron elbows or water guides which are set at an angle shown in plan, and serve to rotate the water in its upward passage through the compartment. At the second diaphragm the same water guides are set in reversed position so that the water passing M is reversed in the direction of the rotation. At the third diaphragm the water is again reversed in direction of rotation passing N.

Each compartment is provided with hand holes and the water guides of cast iron are readily detachable and removed when necessary to free them from any accumulation. Once a month this tank is drained and washed out or cleared of sludge if necessary. An extra set of water guides is at hand and inserted without delay, those removed being cleaned at leisure. With very hard waters there is a tendency for the formation of hard stony carbonate, where the caustic solutions first meet the raw water. We had some trouble with this at first, but since using the box B and removing water guides there is no trouble from this cause. After passing the circulating tank the treated and roily water passes on to the settling tank. The process described is automatic; the apparatus starting with the flow of water in the main and stopping when the flow ceases. A section of a chemical pump is shown by Fig. 3. Inverted ball valves are used in the pump to prevent sand working through with lime as is apt to occur with commercial lime.

Correct weights of lime or soda are added to the vats when the chemical tanks are filled for the day. The amount of each is suited to the mean rate of flow and the known capacities of the chemical vat and tank. At some points we have two of the automatic mixing or circulating tanks and the treatment is made strictly double, the chemical injection and mixing being separate as at Port Los Angeles. Our chemical solutions are used in condensed form, thus requiring smaller and less apparatus than usually employed in modern water treating systems that continue to use the old system proposed by Clark in England.

WATER SOFTENING ON THE SOUTHERN PACIFIC.

| Miles from San Francisco. | Stations. | Source. | Average Gallons Used Daily. | Grains Per Gallon. Non-Incrust. | Grains Per Gallon. Incrust. | Incrust. Matter After Treatment. | Cost of Treating for 1,000 Gallons (Cents.) |
|---|---|---|---|---|---|---|---|
| 253 | —S. Luis Obispo | Dug well, 30 ft. | 150,000 | 2.45 | 42.22 | 4.20 | 5.1 |
| 277.3 | —Guadalupe | Two wells, 100 and 130 ft. | 25,000 | 11.54 | 41.30 | 7.76 | 4.7 |
| 321.4 | —Jalama | Creek | 19,330 | 11.43 | 43.16 | 9.33 | 4.5 |
| 355.8 | —Naples | Dug well | 30,600 | 9.21 | 37.44 | 3.33 | 3.8 |
| 370.4 | —Santa Barbara | S. P. Co. well. | 20,000 | 12.02 | 26.24 | 9.74 | 3 1-3 |
| 382.5 | —Carpenteria | Artesian well, 125 ft. | 20,000 | 6.24 | 18.14 | 4.37 | 1 6-10 |
| 395.5 | —San B. Ventura | Ventura River | 36,000 | 8.40 | 28.21 | 12.14 | 3 1-3 |
| 416 | —Santa Paula | Santa Paula Creek | 24,000 | 7.64 | 20.18 | 5.53 | 4 |
| 450 | —Saugus | New well, 228 ft. | 36 000 | 5.43 | 19.18 | 5.77 | .. |

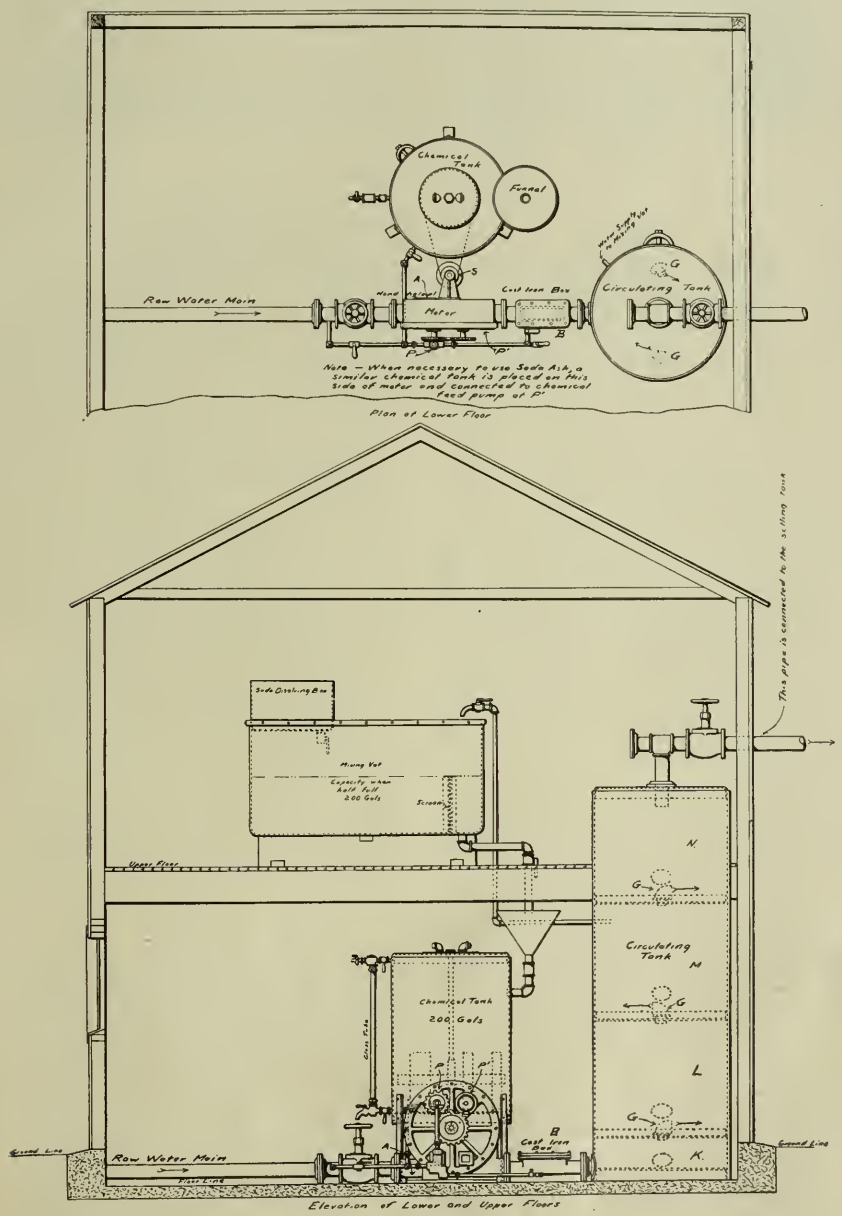



Fig. 2—Water Treating Plant—Southern Pacific.

Lime is weighed into its vat and slacked to thin white wash, which is as effective in absorbing carbonic acid as if in solution. The objection was raised when my process was first described that each particle of lime not in complete solution became coated with a carbonate, leaving an inner nucleus not carbonated. We have found by experiment that with a "half a chance" it is impossible to keep carbonic acid from combining with caustic lime or soda in the presence of water. With dry lime and carbonic acid gas such condition may, however, exist.

The mechanical method above described is, of course, varied at some stations. If, at a station the pump is above ground, and has a fly wheel, the motor is not used but an iron frame or yoke substituted that carries on either side the chemical pumps and stirring device precisely as on the motor. This gives the same automatic principle of starting the treatment with the circulation of water from the pump, and in case of gas engine pumping it is preferable to the water motor.

The process described may be summarized as follows: The system is continuous insofar as injecting and mixing the raw water with the proper chemicals is concerned. Our standard apparatus will treat from 3,000 to 12,000 gallons per hour. Properly speaking, the process is not continuous as the capacity of the plant in softened water per 24 hours is dependent on the settling tankage required. If an increased amount of water is required at any point, one or more settling tanks are put up at comparatively small expense, or they may be removed and set up elsewhere.

This process we find preferable and less expensive than a continuous process, which is not well adapted to varying conditions unless such a plant is first installed large enough to suit future demands. The complete softening of hard water involves the time element, inasmuch as it is aimed to introduce *only* the required amount of chemicals to produce reaction, without excess. We find, for instance, that the greater portion of the reaction occurs in a few seconds, but it is not completed for a long time. If an excess is added the chemical reaction is completed in a short time. Exhibitions of the chemical effect of reagents on hard water are deceptive.

Each chemical house is provided with a small chemical outfit for testing the raw

and treated water as often as an assistant, in the field, can visit the plants to adjust the formula to the varying conditions.

Some ground water is quite variable. Surface water varies much in some localities, dependent on dry or wet season.

Once a month, samples are taken at random from service tanks and analyses made at the laboratory. These results are tabulated monthly in a chart. Incrustating matter is represented by a broad line to scale, and the graphic charts are issued in blue print form. Where treating plants are established, the amount of matter removed is blocked out in red from this broad line. Analyses of the water at a number of stations on the Pacific and Coast Divisions are given by the accompanying table.

At Saugus, San Joaquin Division, we have a Kennicott continuous machine with capacity of 4,500 gallons per hour. All other points have the Stillman patent apparatus just described.

## M. C. B. Reports.

SUBJECTS.

*For investigation by committee.*—1. The use of steel in passenger car construction.—An individual paper will be presented at the convention on this subject, but it is of sufficient importance to require further investigation by a committee.

2. Specifications and tests for bolsters, brake-beams, etc.—The Association has just installed at Purdue University, Lafayette, Ind., a drop-test machine for M. C. B. couplers. The machine is available for testing other parts of cars, and it is suggested that a committee be appointed to study the question of specifications and tests for bolsters, brake-beams and such other car details as require tests of that character to determine their strength and efficiency.

3. Grain doors.—The Central Traffic Association has suggested the adoption of a suitable grain door to meet the requirements of large-capacity cars. This subject should be investigated.

4. Flexible car trucks vs. rigid trucks.—To consider what flange wear of wheels, if any, is reduced over rigid trucks, and what difference, if any, exists as to absorption of power.

5. Recent designs of heavy trolley-car trucks.—To see if the prevailing combination of iron and wood trucks in passenger car service cannot be superseded by a lighter, stronger and cheaper all-steel truck.

6. Axles.—To investigate the practice of some roads of turning car axles so that there is a shoulder right behind the wheel hub, which hub is faced and wheels mounted to within $^{1}/_{16}$ in. of this shoulder, it being claimed derailment will not attend a loose wheel when this practice is followed.

The report is signed by J. T. Chamberlain, chairman; C. A. Schroyer, J. S. Lentz.

CAST-IRON WHEELS.

The designs of wheels are shown by complete drawings, Figs. 1, 2 and 3. Fig. 1 shows a 600-lb. wheel recommended for cars of 60,000 lbs. capacity. Fig. 2 shows a 650-lb. wheel recommended for cars of 80,000 lbs. capacity. Fig. 3 shows a 700-lb. wheel recommended for cars of 100,000 lbs. capacity. The minimum weights allowed in interchange should be 585, 635 and 685 lbs. for the three classes of wheels. The following specifications are submitted as part of the report:

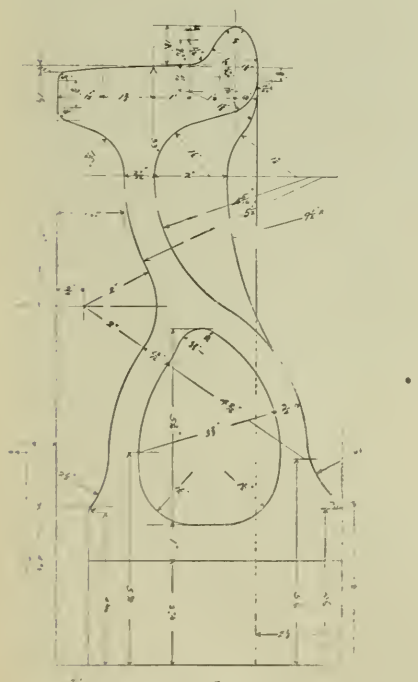


Fig. 1.—Cast Iron Wheel (600 lbs.).

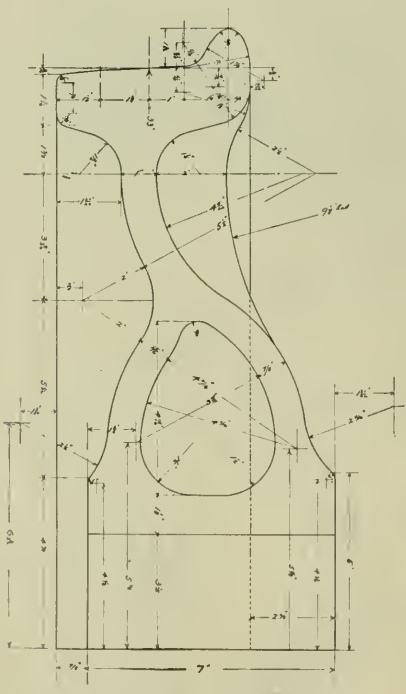


Fig. 2.—Cast Iron Wheel (650 lbs.).

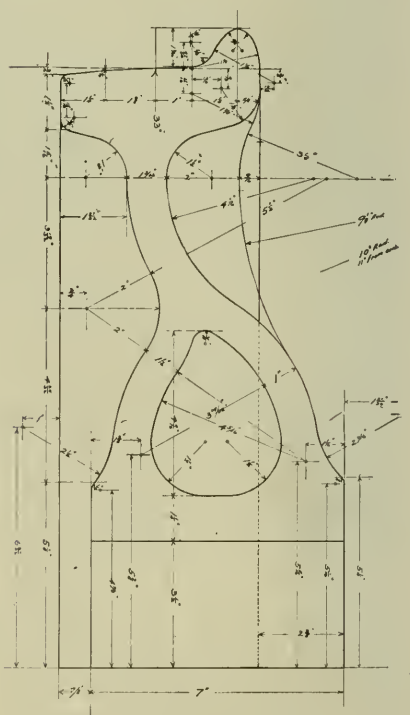


Fig. 3.—Cast Iron Wheel (700 lbs.).

*Specifications for 33-in. Cast-Iron Wheels Weighing 600, 650 and 700 lbs., for Cars of 60,000, 80,000 and 100,000 lbs. Capacity.*

1. Chills must have the same inside profile as shown by M. C. B. drawings of wheel tread. The inside diameter of chill must be the M. C. B. standard of 33½ in., measured at a point 2⅝ in. from outside of tread of wheel.

2. Wheels of the same normal diameter must not vary more than ¼ in. above or below the mean size measured on the circumference, and the same wheel must not vary more than $^{1}/_{16}$ in. in diameter. The body of the wheel must be smooth and free from slag, shrinkage or blowholes. The tread must be free from deep and irregular wrinkles, slag, chill cracks and sweat or beads in throat, and swollen rims.

3. The wheels must show clean gray iron in the plates, except at chaplets, where mottling to not more than ½ in. from same will be permitted. The depth of pure white iron must not exceed 1 in., nor be less than ½ in the middle of the tread, and shall not be less than ⅜ in. in the throat, for wheels weighing 600 lbs. It shall not exceed 1 in. in the middle of the tread, nor be less than $^{7}/_{16}$ in. in the throat for wheels weighing 650 lbs., and shall not exceed 1 in. in the tread, or be less than ½ in. in the throat for wheels weighing 700 lbs. The depth of white iron shall not vary more than ¼ in. around the tread on the rail line in the same wheel.

4. For each hundred wheels which pass inspection and are ready for shipment, two representative wheels shall be taken at random, one of which shall be subjected to the following tests:

The wheel shall be placed flange downward on an anvil block, weighing not less than 1,700 lbs., set on rubble masonry at least 2 ft. deep, and having three supports not more than 5 in. wide to rest upon. It shall be struck centrally on the hub by a weight of 200 lbs. For 600-lb. wheels 10 blows falling from a height of 9 ft. For 650-lb. wheels, 12 blows falling from a height of 10 ft., and for 700-lb. wheels, 12 blows falling from a height of 12 ft. Should the test wheel stand the given number of blows without breaking in two or more pieces, the inspector will then subject the other wheel to the following test:

The wheel must be laid flange down in the sand and a channel way 1½ in. wide and 4 in. deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of the channel way, and the clean flange must form as much

of the bottom as its width will cover. The channel way must then be filled to the top with molten cast iron, which must be hot enough, when poured, so that the ring which is formed when metal is cold shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through or into the tread, the one hundred wheels represented by the tests will be rejected.

5. In case of the drop tests, should the test wheel break in two or more pieces with less than the required number of blows, then the second wheel shall be taken from the same lot and similarly tested. If the second wheel stands the test it shall be optional with the inspector whether he shall test the third wheel or not; if he does not do so, or if he does, and the third wheel stands the test, the hundred wheels shall be accepted as filling the requirements of the drop test.

6. The lower face of the weight of 200 lbs. shall be 8 in. in diameter, and have a flat face.

7. Wheels shall not vary from the specified weight more than 2 per cent.

8. The thickness of the flange shall be regulated by the maximum and minimum flange thickness gages adopted by the M. C. B. Association.

9. All wheels must be numbered consecutively in accordance with instructions from the railroad company purchasing them, and shall have the number, the normal weight of the wheel, also the day, month and year when made plainly formed on the inside plate in casting, and no two wheels shall have the same number. All wheels shall also have the name of the maker and place of manufacture plainly formed on the outside plate in casting.

10. Individual wheels will not be accepted which

(1) Do not conform to standard design and measurements.
(2) Are under or over weight.
(3) Have physical defects described in Section 2.

Any lot of one hundred wheels submitted to test will not be accepted

(1) If wheels broken do not meet the prescribed drop test.
(2) If the wheel tested does not stand the thermal tests.
(3) If the conditions prescribed in Section 3 are not complied with.

11. All wheels must be taped with M. C. B. standard design of wheel circumference tape having numbers 1, 2, 3, 4, 5 stamped ½ in. apart, the figure three to represent the normal diameter, 103.67 in. circumference; the figure one, the smallest diameter, and the figure five, the largest diameter.

The report meets with the full approval of the Wheelmakers' Committee. It is signed by William Garstang, chairman; G. R. Henderson, E. D. Nelson, W. H. Lewis, Alex. Kearney and H. J. Small.

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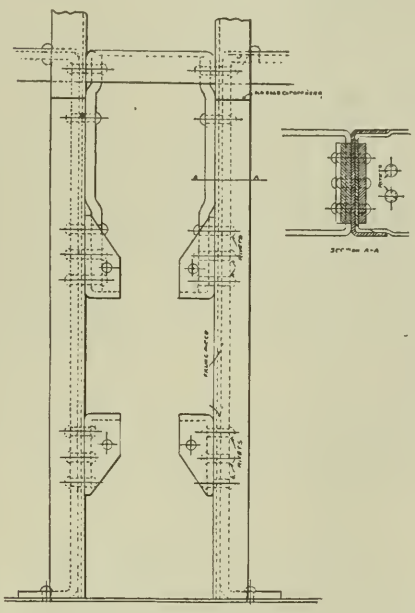
PRICES FOR REPAIRS TO STEEL CARS.

The cost or price of labor used for repairing steel cars should be based on a set price per rivet, including removing, fitting and replacing. Where the parts removed require straightening, this to be done and a separate price paid for the operation.

Basing the cost or price of repairs to steel cars on a fixed price per rivet is the only equitable basis that could be found. If it was attempted to pay for the work on a basis of per piece fitted and applied, every different design of steel cars and cars constructed with steel underframes would have to be taken into consideration, and each part or piece numbered or marked so that the proper price could be fixed for such operation.

The committee recommends that the following price govern the removal and replacing of rivets, such price to include removing, fitting and replacing damaged parts, less straightening or repairing: All rivets, 10 cents per rivet.

Where the parts or pieces removed from a damaged car require straightening or repairing, it is recommended that such straightening be charged for per pound. If this work would be charged for per piece, the different design and construction of steel cars would have to be taken into consideration. It is, therefore, recommended that the following price govern such work: Sixty cents per 100 lbs.



Repairs to Steel Cars.

Where cars are damaged to such extent that the parts damaged do not have to be removed for repairs, but straightened on car, also any parts that require straightening, repairing or renewing, not included on the rivet basis, it is recommended that the present M. C. B. price for labor, covering repairs to wooden cars, namely, 20 cents per hour, govern in all such work.

The painting of steel cars, after receiving repairs, should be governed by the present M. C. B. practice for painting of wooden cars.

The committee would recommend that the splicing of sills on steel cars and cars constructed with steel underframe be permissible, the splice, except as otherwise herein stated, to be located not less than 8 in. from either side of the body bolster and to be not less than 24 in. long, consisting of butt joints. The butt joints to be reinforced by plates on both sides, not less than same thickness of web plate, with the one on the inside of channel to include flangers also, while the outside plate should only cover the web. The rivets to be spaced as may be necessary to obtain efficiency at the point of splicing, but each splice to have not less than 18 rivets.

In cases where cars are damaged to such extent that the center sills have to be cut off less than 8 in. from bolster, in such case a plate, with an angle at each end not less than 6 in., is to be used between end sill and bolster and to be full width of channel and not less than ⅝ in. thick. This to be applied on the outside, between end sill and bolster, between web of channel or I beam, as the case may be, as shown on the drawing.

The committee recommends that where it is necessary to apply any new material to steel cars or cars constructed with steel underframe, that such material, where cars are constructed of structural steel shapes or material that can be purchased in the open market, be charged at market price. Where cars are constructed of pressed steel shapes or material that cannot be purchased in the open market, such material to be charged at manufacturer's price.

Where any material is applied to a steel car, the name of the part renewed and the dimensions of same must be shown on bill.

The committee recommends that scrap material removed from cars constructed of pressed or structural steel shapes be credited at ¾ cent per pound.

Where patching is done on steel cars, the committee would recommend that such patching be done in a mechanical manner. Where floor or interior patches are applied, the outside edges should be chamfered and patch riveted to place with thin flat head rivets.

The committee finds from the answers received that the oldest steel cars have been in service eight years, and as yet no steel cars have been put out of service due to deterioration from age. Nothing definite has been obtained on which to base a report as to the depreciated value of steel cars and cars constructed with steel underframes. The committees would recommend, however, that a depreciation of 4 per cent. upon the yearly depreciated value be used for the bodies of all steel cars and cars constructed with steel underframes, allowing the present 6 per cent. per annum upon the yearly depreciated value of trucks to remain as at present in the rules, but no depreciation should exceed 60 per cent.

In the present rules there is no special provision for the settlement of destroyed steel cars, which are of more expensive construction than the average wooden car of similar capacity, and the committee would recommend that a special committee be appointed to carefully consider the price for all steel cars of various classes, as well as cars constructed with steel underframes. In order to provide for an equitable way of settlement for the coming year, until the committee's report is received, it is recommended that all steel cars or steel underframe cars destroyed be treated on the same settlement arrangement as now in effect for "Special Constructed Cars," as covered by M. C. B. Rule No. 113 of the 1903 code.

The report is signed by T. H. Russum, Chairman; R. F. McKenna, I. N. Kalbaugh, G. N. Dow, E. B. Gilbert.

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COUPLING CHAINS.

There are two classes of coupling chains, permanently attached coupling or safety chains and loose chains, usually carried in the caboose for chaining up cars under special conditions.

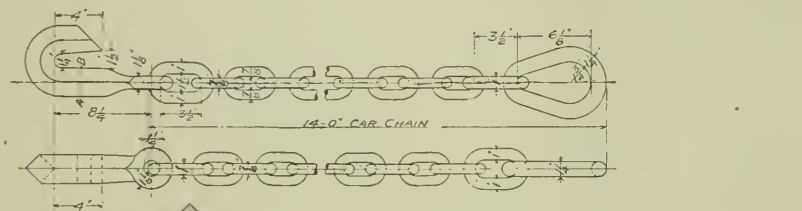
*Permanent Safety Chains.*—The majority of the railroads object to the use of any permanent safety chain, for the following reason:

To permit cars to pass freely around curves, there must be considerable slack in such chains when coupled, and the further away from the center of the car these chains have to be located, the greater the amount of slack necessary. When couplers give way, the jerking, due to the slack in these chains, breaks the hooks and links and cracks or pulls off the end sill.

It is not practicable to place these chains

nearer to the center of the car than the position shown on M. C. B. Sheet "A," on account of location of longitudinal sills and dead blocks, and on account of interference with air-brake angle cocks and hose. A permanent safety chain might be placed closer to the center, perhaps attached under the end sills to the longitudinal sills or draft sills and crossed under the coupler, in which case the chain could be hooked up fairly tight, but this would seriously interfere with the coupler and air-brake connections.

If the safety chain is used it should be attached to inside of the end sill by draft springs and followers so as to cushion the jerk, should the couplers part, and save the damage to the end sill. Another way would be to have the chains attached to the longitudinal sills and not secured in any way to the end sills, the purpose of this being to avoid injury to the end sills in case the safety chains are called into use. Of these suggestions, the latter is probably the preferable one.




Coupling Chains.

The number of cars equipped with safety chains is small, and these are mostly flat cars or drop-end gondolas, many of them steel cars of modern construction. Some roads have a limited number of refrigerator, stock, horse and special ventilated box cars equipped with safety chains for the purpose of running such cars in passenger trains, and have the safety chains coupled to the regular passenger car safety chains in such service.

The committee recommends that the M. C. B. Sheet "A," recommended practice for end-sill safety chains or coupling chains, should remain as shown, but that the nuts and washers shown on this drawing as securing the chain at the back of the end sill should be omitted from the drawing and notation placed thereon to the effect that such chains should be secured firmly to the longitudinal sills and located as nearly to the distance as shown on Sheet "A" as the location of the longitudinal sills will permit.

*Loose Chains.*—After tabulating the lengths, links, size of links, dimensions of hooks and other details of chains carried on wrecking cars or in cabooses on a number of roads, the committee prepared a drawing, showing two chains, one 14-ft. chain, with diamond hook, made of ⅞-in. link, common proof chain, which is of the dimensions most generally recommended for chaining cars together, either for double loads or in case of draw-heads being pulled out on the road; and one 18-ft. wrecking chain made of 1-in. standard short-link proof chain, with diamond hook, for general wrecking purposes, and which can also be used for chaining together large-capacity cars in special heavy train service where the 14-ft. chain of ⅞-in. links might not be considered heavy enough. A flat hook is also shown, which is probably cheaper to make and easier to handle than the diamond hook.

The committee recommends that the Association set a fair value on such chains according to the market price which might prevail from year to year, and when it is desired for such chains to continue over different roads with a double load they could be continued to destination and be billed by the initial road against the road at destination at the M. C. B. cost. In case the chains are returned, same cost figure could be used in counterbilling without reference to the identity of the individual chain, so long as the chains conform to the proposed recommended practice.

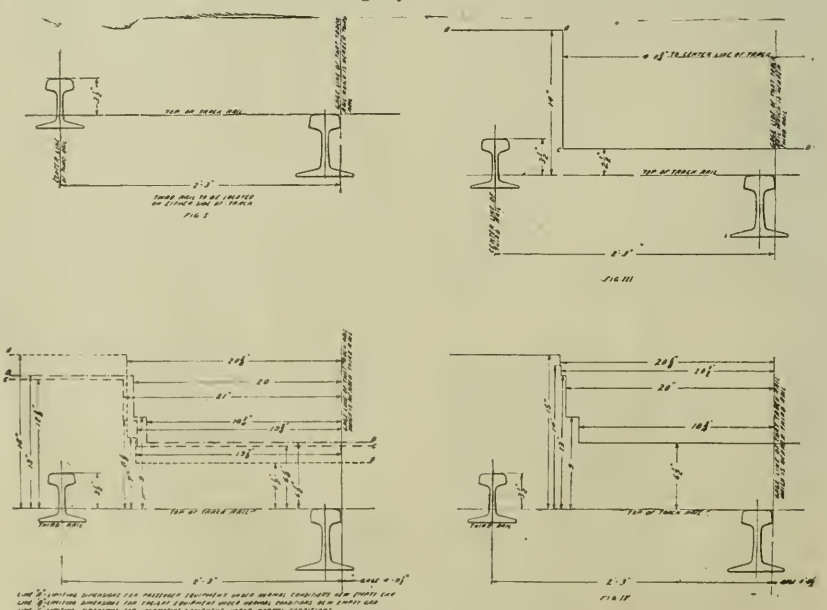
The report is signed by R. P. C. Sanderson, Chairman; R. L. Klein, R. B. Rasbridge, Jas. Macbeth.

### STANDARD LOCATION OF THIRD RAIL.

The representatives of various railroads about New York City, after much consideration of the subject, have fixed upon a location for third rail, which is very apt to be standard in the electrical construction on steam railroads about New York City, and this location is shown in Fig. 1. Some of the railroads which will be operated electrically have adopted a location for third rail slightly different from the location shown in Fig. 1, but the difference is so slight that the equipment which is constructed to take current from the third rail located as shown in Fig. 1 will operate satisfactorily over construction with the slight variation referred to. Fig. 1, then, can be considered as the most pronounced standard for location of third rail, and one which no doubt will be followed more or less closely by such roads as may take up electrical operation in the future.

The Pennsylvania Railroad and the Long Island Railroad have determined upon certain clearances which will be required for passenger car equipment, freight car equipment and locomotive equipment which will run over their electrical installation, and these clearances are indicated in Fig. 2. Only the clearances prescribed for passeuger car equipment and for freight car equipment need be considered, but clearance for locomotive equipment is also shown, in order that the same may be upon record. The New York Central & Hudson River has determined upon certain clearances which will be required for all classes of equipment, and these are shown in Fig. 3. The Pennsylvania, the Long Island and the New York Central installations are shown in Fig. 4, which is a composite clearance diagram.

The Master Car Builders' Association cannot adopt any of these clearance diagrams as standard as yet. The most that the labors of this committee could do is to place upon record the clearances of such third rail installations as have so far been determined upon. The report is signed by F. M. Whyte and A. S. Vogt.



Location of Third Rail.

### WHAT IS THE BEST PREVENTIVE OF RUST ON STEEL CARS?

The committee prepared and submitted to the members a circular embodying 14 questions. The answers to the various questions indicate a wide difference of opinion as to the best methods of overcoming this trouble, and also show a wide variation in the methods of removing rust and scale from steel cars, preparing the metal for painting, and the character and number of coats of paint applied.

In general, the methods pursued in the treatment of steel cars are as follows:

(a) Inside of car—wire brushes, scraping, sand blast and hammering, and in one case,

after cleaning, the car is blown off with compressed air.

(b) Outside and underneath—wire brushes, scraping and sand blast, and in one instance, gasolene paint burner and scraping.

(c) Character of paint used for first coat, varies from graphite paint, carbon paint, red lead and lampblack and oil, to the various patented paints now on the market. For the second or succeeding coats practically the same character of paint is used, with the exception of a few roads, which use their standard freight car color.

(d) The number of coats of paint applied varies from two to three.

(e) The time between paintings varies from eighteen months to three years. The majority of answers indicate, however, that there is no specified time for painting, it being done whenever the condition of the car requires. One road states that it has discontinued the painting of steel cars, while another road follows up its cars very closely, and whenever rust appears it is removed and the spot repainted.

The general opinion of the roads operating steel cars is that the greatest amount of corrosion is found at the seams and joints, slope sheets and hoppers. The sides also deteriorate very rapidly from abuse, such as loading of hot billets or hot cinders in the cars, and hammering the sides with mauls for the purpose of loosening load. The practice of allowing cars loaded with coal to stand on siding or in storage yard for an undue length of time is found to be detrimental to the cars, as the sulphur water from the coal destroys the sheets very rapidly.

The use of brush and air for applying paint is about equally divided among the different roads, some preferring the brush for the first coat and air for the succeeding coats, while one road uses air at the seams and a brush on flat surfaces.

In consideration of the limited experience in the use of steel cars, and in view of the lack of definite results from experiments which have been made or are being made, the knowledge of this subject is not complete enough to allow of positive recommendations being made as to the best methods of treating steel cars in order to prevent the formation of rust on same. The committee submits the following suggestions:

*For new cars—*

(a) The steel should be thoroughly cleaned of all rust and furnace scale before the car is assembled.

(b) All joints before assembling should be thoroughly coated with coal tar.

(c) After car is assembled, all grease should be thoroughly removed from the steel, and same given a good coat of carbon or graphite paint on the outside and underneath and the inside a heavy coat of crude petroleum, coal tar applied hot, or some similar substance.

(c) The outside to be given a second coat of graphite or carbon paint, as may be desired.

*For old cars—*

(a) All scale and rust should be removed wherever it appears on the car, by steel brushes or scrapers; and in the case of the inside of the car by any of the above methods or by the use of pneumatic hammers or mauls.

(b) After all scale and rust have been removed, the car should be thoroughly cleaned with steel scrapers or wire brushes, and blown out with air, in order to present a clean surface for the paint.

(c) The methods of painting recommended for new cars should be followed out in the case of old cars, after a clean surface is obtained.

As some of the most prolific causes of deterioration of steel cars are the loading them with hot billets, the use of mauls, bars, etc., on the outside to assist in the unloading of cars, and allowing cars loaded with soft coal to stand a long time with the load in them, it is recommended that steps be taken to do away with these practices as much as possible.

If the above recommendations are followed out, and if care is taken to repaint the outside of and underneath cars at least eighteen months or two years, coating the inside with crude petroleum or coal tar about once a year, excellent results will be obtained.

It is an open question as to whether the use of the sand blast is desirable for this class of work, on account of the hardships it imposes upon the men operating same, and also on account of the expense attached to its use, due to the very rapid deterioration of the hose and nozzles.

The report is signed by H. S. Hayward, chairman; J. S. Lentz, W. G. Gorrell, T. H. Russum, C. E. Fuller.

### OUTSIDE DIMENSIONS OF BOX CARS.

The committee was unable to determine what finished sizes of timber should be used in the body framing for box cars but submitted the style of side framing shown in Figs. 1 and 2 for 80,000 and 100,000 lbs. capacity cars, and the style of side framing shown in Fig. 3 for 60,000 lb. capacity cars. The style of end framing shown in Fig. 4 is preferable to other styles, and the committee recommends these styles of framing as indicated.

The committee is not yet in position to make any recommendation as to the sizes and disposition of iron rods.

A plank lining 1¾ in. thick on the inside of the ends of cars, extending from the floor to the under side of the end carline is recommended. It should be understood that this would necessitate lengthening the car 1¾ in., or thereabouts, if such plank lining were adopted, in order to maintain the inside dimensions, 36 ft. long, adopted by the American Railway Association.

The committee considered the location of the center of the body bolster and bolster post with reference to the face of the end sill, and a distance of 5 ft. 2 in. from the center of the bolster and bolster post to the face of the end sill is recommended. The center posts and corner posts of the ends of cars should be reinforced with angle plates and I-beams. The committee also recommends the use of two belt rails in the side and end framing of cars.

The recommendations of this committee made in 1902 are submitted to the convention for adoption as part of this report. They are as follows:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 in. wide and 8 ft. high, be submitted to letter ballot for adoption as standard.

2. For box cars on high trucks (four feet to top of floor):

| | Ft. | In. |
|---|---|---|
| Height, top of rail to upper edge of eaves. | 12 | 6¾ |
| Width at eaves, at above height, maximum | 9 | 7 |

be submitted to letter ballot for adoption as standard.

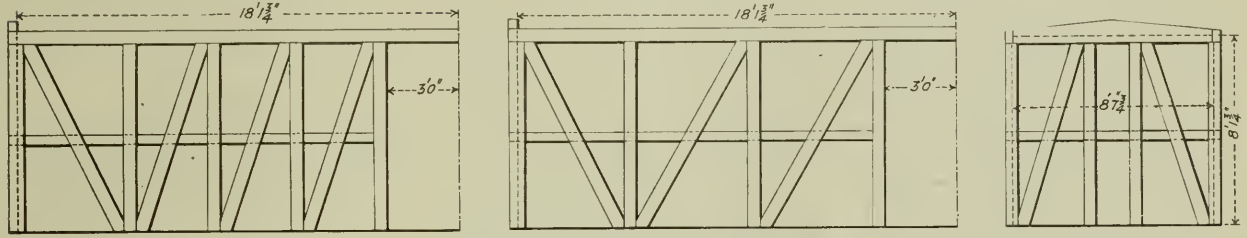
3. For box cars on low trucks (3 ft. 6 in.):

| | Ft. | In. |
|---|---|---|
| Height, top of rail to upper edge of eaves. | 12 | 0¾ |
| Width at eaves at above height, maximum | 9 | 7 |

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard 12 ft. 6¾ in. by 9 ft. 7 in." be stenciled in 3-in. letters on the end fascia boards on all cars built to these dimensions.

The report is signed by W. P. Appleyard, Chairman; C. A. Schroyer, Jos. Buker, A. S. Vogt, F. H. Clark, H. F. Ball, J. J. Hennessey.




Outside Dimensions of Box Cars.

### AIR-BRAKE HOSE SPECIFICATIONS.

Rule No. 69 of the Rules of Interchange requires that after July 1, 1904, all air-brake hose applied to foreign cars will be considered as wrong repairs unless they are made in accordance with the M. C. B. specifications and are so labeled. There is nothing in the M. C. B. Rules, however, which requires the owners of a car to apply M. C. B. standard specification hose to their own equipment, therefore, Rule No. 69 will not prevent a great deal of the trouble which is being experienced with burst hose of inferior quality. The committee has recommended to the Arbitration Committee that it be made compulsory on the part of a railroad to use M. C. B. standard specification hose on all equipment which is interchanged, after July 1, 1905.

In order that this rule may be made operative and the M. C. B. standard maintained, the committee recommends that arrangements be made with Purdue University to have M. C. B. specification hose tested there; hose to be removed from equipment as the committee may see fit, to be given the M. C. B. standard tests, after being in service from six months to one year. In this way the committee could obtain some valuable data on the life of air-brake hose from which to make up standard specifications in the future.

The original specifications for air-brake hose provided for a woven hose with seamless tubing.* The present specifications do not cover this feature. It is advisable to

allow this form of air-brake hose to be used if it will meet the tests.

A number of roads have kept service records to determine the life of hose made by the different manufacturers. Two of the most notable points brought out in these records are, the rapid taking off in the friction between the layers of duck after a comparatively short life, and damage at the nipple end of the hose, due to separating cars without uncoupling the hose by hand. Nearly all of the hose tested stand the bursting pressure satisfactorily after being in service for some length of time, showing that the present bursting test, calling for 500 lbs. pressure for 10 minutes is higher than necessary. This service record, to a large extent, should determine whether the present specifications are correct. The records show that it is not always the M. C. B. specification hose that gives the longest life. At least 80 per cent. of air-brake hose fail on account of unfair usage, for which the manufacturer is not responsible. The committee has recommended a specification which should give as long life as the present M. C. B. standard. It can be made for at least 7 cents per foot less than the present M. C. B. standard, and the saving to the railroads should be very large.

The life of an air-brake hose is governed largely by the treatment it receives in service. The most destructive practice is pulling cars apart without uncoupling hose by hand, for which the responsibility in some cases lies with the Motive Power Department and in other cases with the Transportation Department. If the hose in large terminal yards were cut by the inspectors, this damage would be largely decreased. If the responsibility is divided between the yard men and inspectors, there is no way of stopping the abuse on account of the responsibility being divided. The committee recommends that the responsibility for parting air-brake hose by hand be placed entirely on the Motive Power Department in terminal yards, and that united action be taken by all railroads to put a stop to the present abuse.

The improper location of train pipe and angle cock is fully as bad as pulling the cars apart without uncoupling hose by hand. The standard 22 in. hose is of sufficient length if the angle cock and train pipe are located as per M. C. B. recommended practice. If, however, the train pipe is located over 13 in. away from center line of car and the angle cock is vertical, the distance is greatly increased, and when the slack is taken out of the couplers the hose is ruptured. This is a condition which should receive immediate attention.

On account of excessive damage to hose at the nipple end, the committee has increased the inside diameter ⅛ in. This will not increase the cost of manufacture above hose manufactured with enlarged ends, and will give a little larger diameter at the nipple end where it is greatly needed.

Particular attention is called to the damage done to the inner tube by improper mounting of hose. Air machines for mounting hose, if not properly made, do great damage to the inner tube. It is also very important that the hose be so applied to cars that the heads will register properly when they are coupled. If it is necessary to twist them in order to couple, the danger from burst hose is greatly increased on account of the liability of hose bursting when the slack is taken up on the train.

Specifications and test for air-brake hose are herewith modified as follows:

(1.) All air-brake hose must be soft and pliable and not less than two ply nor more than four ply. They must be made of rubber and cotton fabric, each of the best of its kind made for the purpose; no rubber substitutes or short-fiber cotton to be used.

(2.) The tube must be hand-made, composed of three calendars of rubber. It must be free from holes and imperfections, and in joining, must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting the tube. The tube must be of such composition and so cured as to successfully meet the requirements of the stretching test given below. The tube to be not less than $^{3}/_{32}$ in. thick at any point.

(3.) The canvas or woven fabric used as wrapping for the hose to be made of long-fiber cotton, loosely woven, and to be from 38 to 40 in. wide, and to weigh not less than 20 and 22 ounces per yard, respectively. The wrapping must be frictioned on both sides, and must have, in addition, a distinct coating or layer of gum between each ply of wrapping. The canvas wrapping must be applied on the bias. Woven or braided covering should be so loose in texture that the rubber on either side will be firmly united.

(4.) The cover must be of the same quality of gum as the tube, and must not be less than $^{1}/_{16}$ in. thick.

(5.) Hose is to be furnished in 22-in. lengths. Variations exceeding ¼ in. in length will not be permitted. Rubber caps not less than $^{1}/_{16}$ in. nor more than ⅛ in. must be vulcanized on each end.

The inside diameter must not be less than 1⅜ in. nor more than $1^{7}/_{16}$ in., nor must the outside diameter exceed 2 in. Hose must be smooth and regular in size throughout its entire length, except at a point 2½ in. from either end where the inside calendar of rubber may be increased $^{1}/_{16}$ in. for a distance of ¼ in. toward either end and then tapering to the regular diameter.

(7.) Each length of hose must have vulcanized to it a badge of white or red rubber as shown. On the top of the badge the name of the purchaser; on the bottom the maker's name; on the left-hand end the month and the year of manufacture, and on the right-hand end the serial number and the letters "M. C. B. Sta." The letters and figures must be clear and distinct, not less than $^{3}/_{16}$ in. in height, and stand in relief not less than $^{1}/_{32}$ in. so that they can be removed by cutting without endangering the cover. Each lot of 200 or less must bear the manufacturer's serial number, commencing at one (1) on the first of the year and continuing consecutively until the end of the year.

For each lot of 200, one extra hose must be furnished free of cost.

(8.) Test hose will be subject to the following tests:

*Bursting Test.*—The hose selected for test will have a section 5 in. long cut from one end and the remaining 17 in. will then be subjected to a hydraulic pressure of 100 lbs. per sq. in., under which pressure it must not expand more than ¼ in. nor develop any small leaks or defects. The section will then be subjected to a hydraulic pressure of 400 lbs. per sq. in. for ten minutes, without bursting.

*Friction Test.*—A section 1 in. long will be taken from the 5 in. piece previously cut off, and the quality of the friction determined by suspending a 20-lb. weight to the separated end, the force being applied radially, and the time of unwinding must not exceed 8 in. in ten minutes.

*Stretching Test.*—Another section 1 in. long will be cut from the balance of the 5 in. piece, and the rubber tube or lining will be separated from the ply and cut at the lap. Marks 2 in. apart will be placed on this section, and then the section will be quickly stretched until the marks are 8 in. apart and immediately released. The section will then be remarked as at first and stretched to 8 in. and will remain so stretched 10 minutes. It will then be released, and 10 minutes later the distance between the marks last applied will be measured. In no case must the test piece break or show a permanent elongation of more than ¼ in. between the marks last applied. Small strips taken from the cover or friction will be subjected to the same tests.

(9.) If the test hose fails to meet the required tests, the lot from which it was taken may be rejected without further examination, and returned to the manufacturer, who shall pay the freight charges in both directions. If the test hose is satisfactory, the entire lot will be examined, and those complying with the specifications will be accepted.

The report is signed by LeGrand Parish, Chairman; T. S. Lloyd, J. Milliken, F. H. Scheffer, H. Swoyer.

### DRAFT GEAR.

The committee is still unable to make definite recommendations or to design a standard draft gear. The recommended practice as shown on M. C. B. Plate B for attachment of automatic couplers to cars, should be withdrawn as not being of sufficient capacity for modern cars. Something should be done

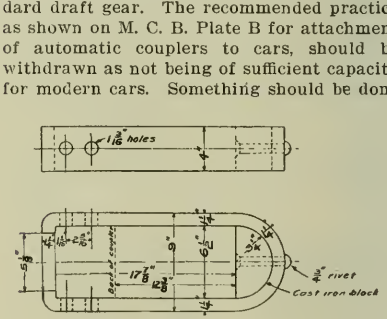



Fig. 1.

to restrain the rapid increase in the number of designs, which vary but slightly in detail. If limiting dimensions could be adopted within which the designers might work, the benefits derived would be considerable. The majority of cars recently built use either friction, tandem or twin spring devices.

*Spacing for Center Sills.*—The committee recommends that the spacing between cen-

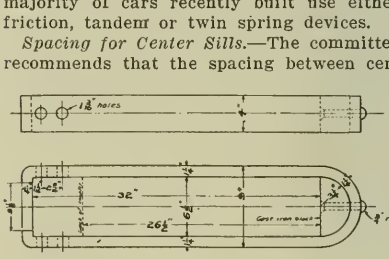



Fig. 2.

ter sills should be 10 in. for cars with wooden sills, and 12⅞ in. for cars with metal sills.

*Distance from Horn of Coupler to Face of Buffer Beam.*—The committee recommends the distance from horn of coupler to face of buffer beam to be: 1¾ in. for twin spring; 1¾ in. for tandem spring; 2¾ in. for friction type.

*Distance Between Stops.*—The committee

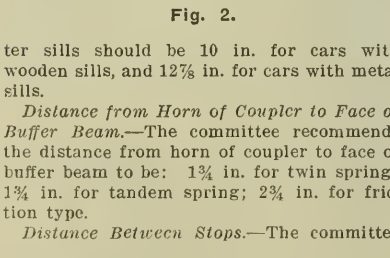



Fig. 3.

recommends that the distance between the front and back stops should be: 12⅜ in. for twin spring; 26½ in. for tandem spring; 24⅝ in. for friction type.

*Followers.*—The committee recommends that followers 1⅝ in. thick be used with the tandem spring, and 2¼ in. thick be used with the twin spring and friction type.

*Yoke.*—The committee recommends the design of yoke as shown in Fig. 1 for twin spring, Fig. 2 for tandem spring, and Fig. 3 for friction type.

The committee calls attention to the necessity of using on all wooden construction some form of check plate, in which the front and back stops are united in one piece, this plate to be L or T shape, so that bolts may pass vertically through the center and draft sills, as well as horizontally through the center or draft sills. Many cars are still being built or perpetuated in which short timbers are being used, secured to the car by a few bolts only. Where the draft timber does not go through the body bolster, heavy rods should be used, with front ends secured to draft gear, passing through body bolster and the tie timber to which they are secured. Anchor blocks should also be used between the sills and the draft timbers, and filling blocks should be used back of the body bolsters to give continuous resistance to draft timbers. The committee recommends that "continuous draft rigging" be abandoned as speedily as possible.

The report is signed by E. D. Bronner, Chairman; T. A. Lawes, Le Grand Parish.

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STAKE POCKETS.

While a majority of the roads are not in favor of the tapering wedge in back of pockets, the committee thinks it is due to a misunderstanding of the results that can be obtained, due to not having had any experience with this form of construction.

The committee recommends the wedge in back of pocket next to sill as shown in Fig. 1 for the following reasons:

It adds additional strength to the pocket and the rest of the pocket can be made much lighter. It is necessary to taper pocket only in one place, viz.: at the back, which is the wedge. This makes it necessary to dress the stake tapering only on the outside on account of the pocket being straight on the remaining three sides. When fitted to a car equipped with this design of pocket, and the car is empty, stakes 6 ft. high will be 6 in. closer at top than at bottom, before car is loaded, or before stakes have been wired or cleated. This shows that stakes fitted to a tapering back, stake pocket would have to move out 3 in. at top before stakes will be straight, which would be ample to take up slack due to loose "U" bolts or side sills or careless wiring or cleating. A car with stakes fitted to stake pockets without wedge in back would be straight before car is loaded or stakes wired or cleated, and stakes would necessarily spread when loaded. Practical experience shows that loads have to be adjusted very much less with the design of stake pocket with wedge in back. If, for any reason, it would be advisable to have stakes stand straight at the start, all that need be done is to reverse stakes. Stakes can be fitted much better against metal than wood. The wedge also prevents damage to sills of wooden cars.

Only one objection could be raised against the use of the wedge in back of pocket. The stake would not have as long a leverage with this form of pocket, from the fact that the stake projecting through the pocket would not come in contact with the sill of car, which would have a tendency to throw more strain on the top U-bolt. It is the experience of many roads that stakes are seldom so neatly fitted that the stakes will come in contact with the sill of the car at the bottom so as to get the advantage of this leverage. In designing the pockets shown in Figs. 1 and 2, the wedge at the bottom has been dropped as low as practical to meet this objection. This one objection is more than offset by the many points in favor of construction of stake pockets with tapering-wedge pocket.

A majority of the roads favor stake pocket being held by rivets on steel cars, but the committee strongly recommends the use of U-bolts, even with steel construction, for the following reasons:

It makes a stronger design to have stake pockets on steel construction held by U-bolts. If desired, in construction or repairs, U-bolts can be riveted on the inside. Where

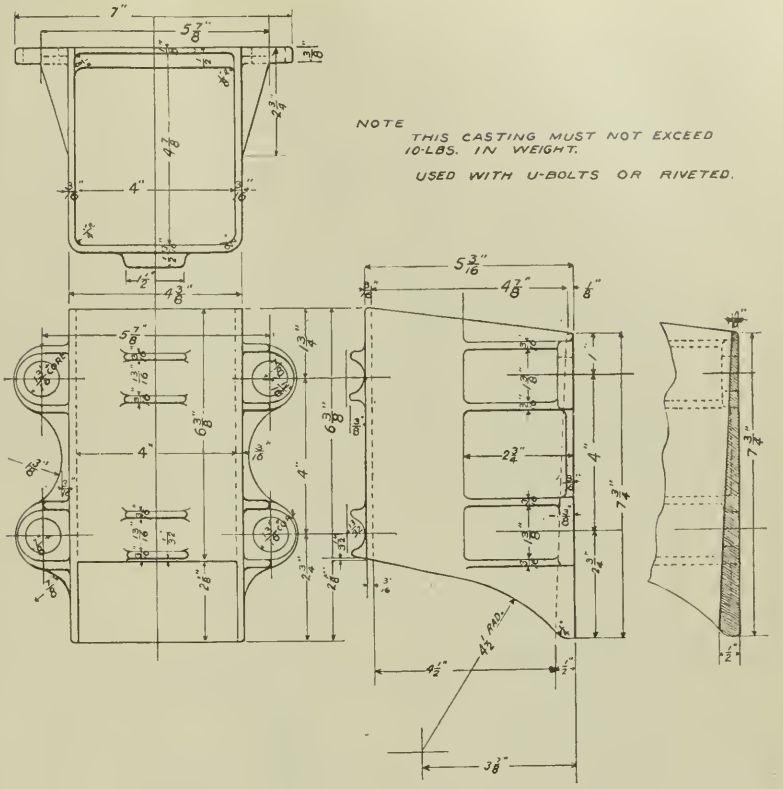


Fig. 2—Stake Pockets.

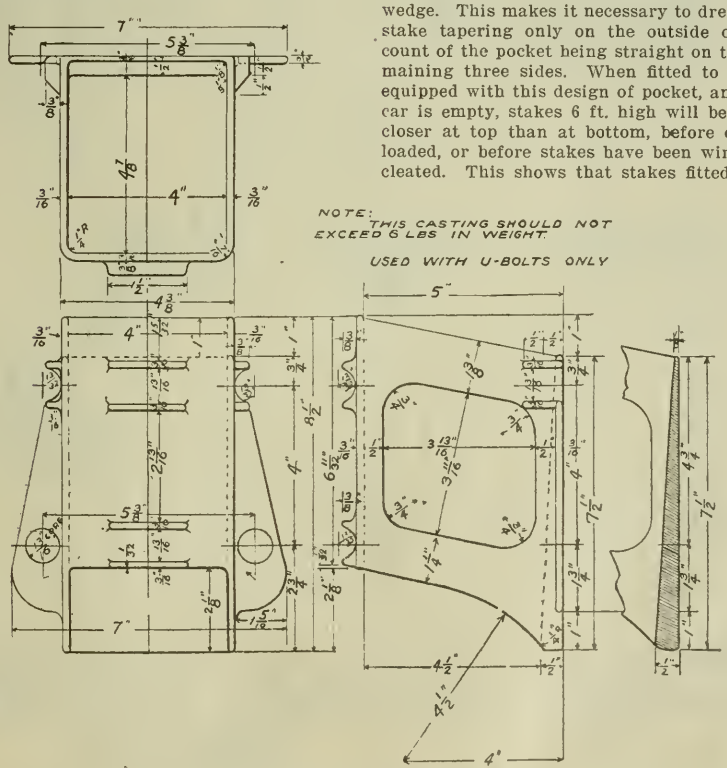


Fig. 1—Stake Pockets.

pockets are riveted, all the strain is thrown on flange of pocket and it would require a pocket of much stronger design. If stake pockets are held by rivets, it will require two different standards of stake pockets, as spacing for U-bolts will have to be different in order to give room for rivets to be driven or for the heads of the rivets.

In order to get the matter before the Association in proper shape, the committee has designed a stake pocket for steel cars to be held on by rivets, shown in Fig. 2. This will not interchange with pocket shown in Fig. 1.

A number of roads apply stake pockets to side sill of cars, and temporary stake pockets or strap to side of the car. This is good practice, and this class of cars should be equipped in that manner.

The committee would, however, recommend that the temporary stake pocket or strap be 4¼ by 5¼ in. inside dimensions, so as to receive standard stakes; and that dimensions for this temporary stake pocket or strap be not less than ½ by 2½ in.; held by bolts or rivets.

The conclusions and recommendations of the committee summarized are:

First.—That a standard stake pocket be adopted.

Second.—That inside dimensions of same be 4 in. wide, 5 in. deep.

Third.—That a tapering wedge be used, as shown in Figs. 1 and 2.

Fourth.—That the method of securing stake pockets to both wooden and steel construction be by U-bolts, held by nuts or riveted.

Fifth.—That malleable iron be used as standard construction.

Sixth.—On a 40-ft. car that *not less* than 10 pockets be applied, in the following manner. Measuring from center of car, pockets to be applied equal distances from each side of center.

On a 35-ft. car, *not less* than nine pockets to be applied; first pocket in center of car and balance of pockets spaced equal distances apart.

On 32-ft. cars, *not less* than eight pockets; measuring from center of car, pockets to be spaced equal distances from center of car.

If any roads desire that pockets be placed closer at ends of car and wider apart at center, this can be done.

The report is signed by J. S. Chambers, Chairman; W. E. Fowler, J. E. Keegan, R. P. C. Sanderson, M. Dunn.

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### STEEL IN PASSENGER CAR CONSTRUCTION.*

A study of the comparative efficiency of wood and steel for a structure like a 70-ft. passenger car may be made by reference to the diagrams, Figs. 1 and 2, showing the usual construction in wood, and a proposed section for a steel passenger car frame. It is often claimed that for equal weight wood is as strong as iron or steel, and for ordinary rectangular beams this may be true, but it is not correct when steel is disposed in the shape of a deep plate girder with a thin web and heavy flanges. In this way a large moment of inertia and a high moment of resistance is obtained per unit of weight, which cannot be secured in wood, as there is not room enough in the space available in car construction for the volume of wood required. To illustrate this we may take the section of the side of a wooden car below window sills as equivalent to a solid beam 4 in. thick by 28 in. deep, and the weight of Norway pine as 40 lbs. per cu. ft. The weight of steel being 480 lbs. per cu. ft., the ratio of weight of pine to steel is 1 to 12. The ultimate strength of pine may be taken as 4,000 lbs. per sq. in., and of low carbon steel 50,000 lbs., the ratio being about the same. The strength of the sections will be proportional to their moments of resistance. Now—

$M = fs.$

$f$ = safe unit load = 1,200 lbs. for Norway pine.

$S$ = section modulus.

$$S = \frac{bh^2}{6} = \frac{4 \times 28^2}{6} = 523, \text{ for wood beam.}$$

$M = 1{,}200 \times 523 = 627{,}600$ in. lbs.

For the steel section (Fig. 3) taking 16,000 lbs. per sq. in. as outside fiber stress in tension at lower flange and 10,000 lbs. unit stress in upper flange, the moment of resistance is found as follows:

(For calculation of moment of inertia of the steel girder see appendix.)

Section modulus top flange $S_c = 162.$

" " bottom flange $S_t = 170.$

$\therefore M_c = 162 \times 10{,}000 = 1{,}620{,}000$ in. lbs. and $M_t = 170 \times 16{,}000 = 2{,}720{,}000$ in. lbs.

The top flange being the weaker, its value of $M$ will govern and

$$\frac{1{,}620{,}000}{627{,}600} = 2.58$$

Fig. 3.

This particular steel girder is about 2.6 times as strong as the assumed wooden one. The wood section 1 ft. long weighs 31 lbs., and the steel section 52 lbs. The comparative strength for equal weight is therefore 1 to 1.55 in favor of steel.

Mr. George I. King, General Manager and Vice-President of the Middletown Car Works,

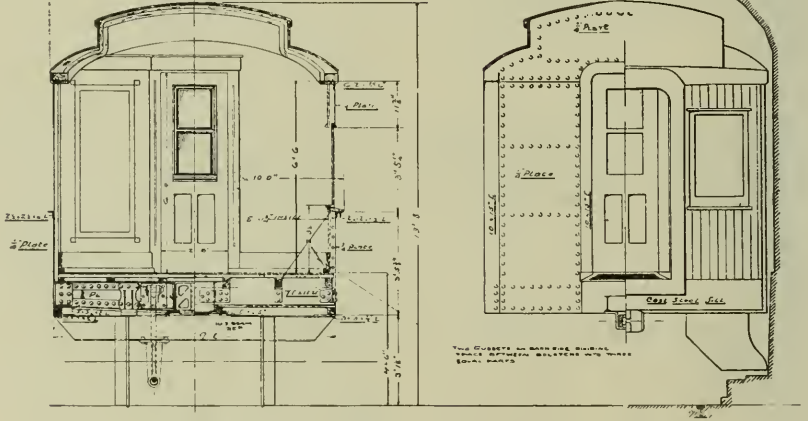


Fig. 4a—Steel Underframe Passenger Car.

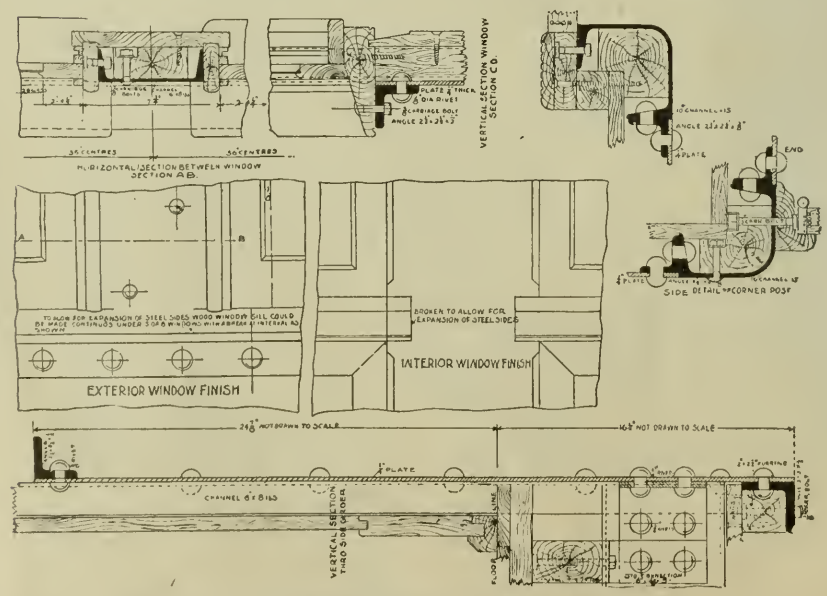
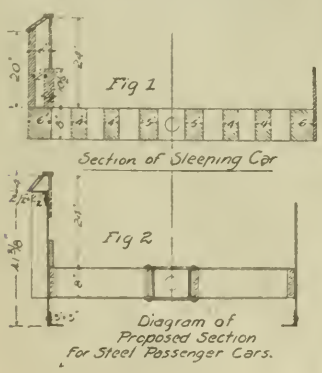



Fig. 5—Plate Girder, Side Sill and Channel Iron Posts.

*Extracts from an individual paper by William Forsyth, read at the Master Car Builders' Association Convention, Saratoga, June 23, 1904.



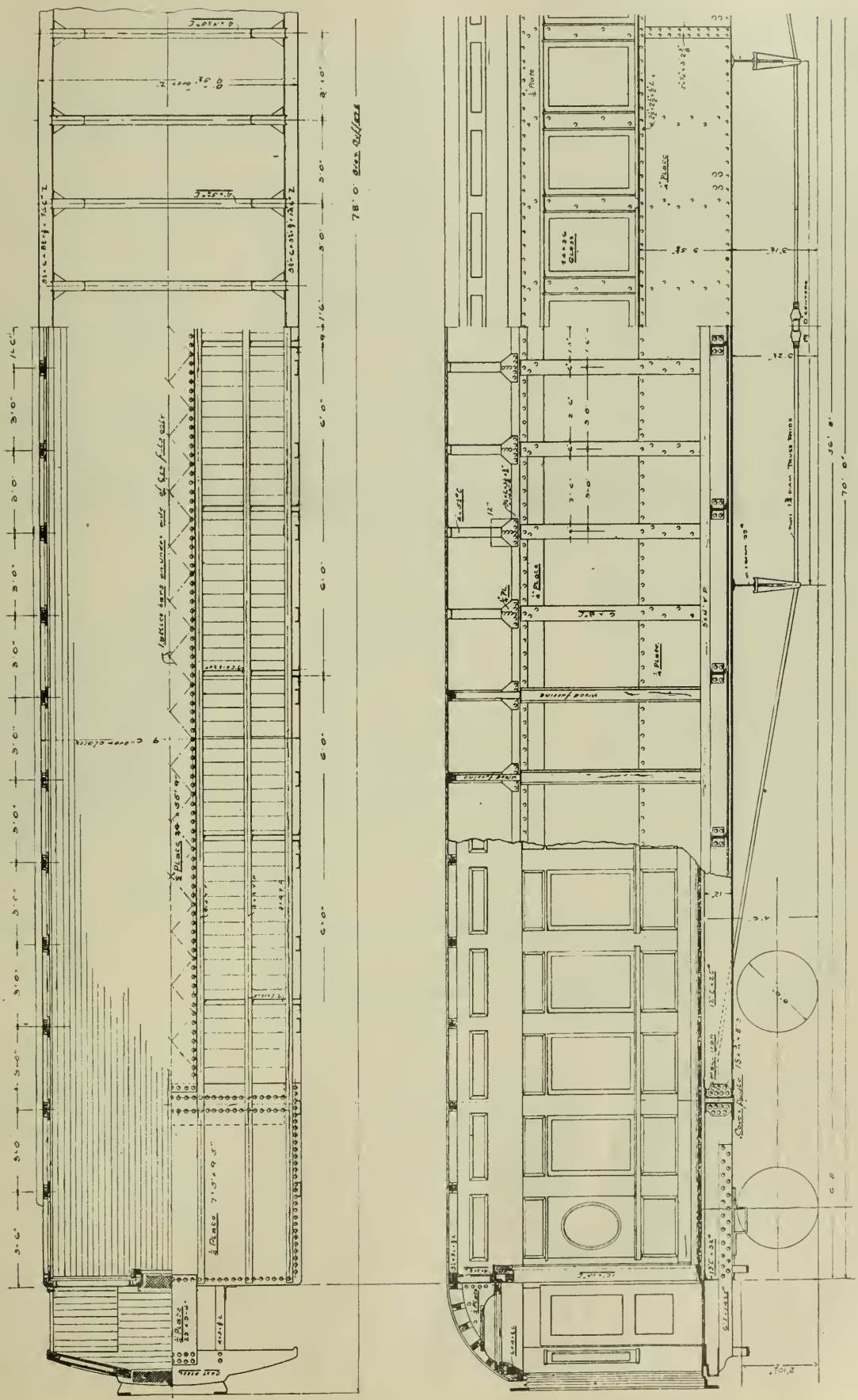


Fig. 4—Passenger Car With Steel Underframe.

Middletown, Pa., has designed a steel passenger car shown in general plan in Fig. 4 and 4a and details in Figs. 5, 6, 7, and 8. The side of the car below the windows is formed of a deep steel girder made of ¼-in. plate, 41⅜ in. deep with 2½ x 2½ x ½-in. angles at the top and 3 x 3 in. x ½-in. at the bottom. The center sills are made of 12-in. channels, 25 lbs. per ft., with lattice bracing and flange plates 6 in. x 1 in. on the bottom and ½-in. and a stiff side plate connecting them at the top, the whole construction being tightly bound together. It is probable that the first cost and the weight of a car of this design will be somewhat greater than the regular wooden coach, but from the experience gained in building such cars it is believed that with a steel car of somewhat similar construction, having the advantage of pressed steel forms wherever possible, and calculations relating to the strength and stiffness of this steel coach frame are given in the appendix.

Steel underframes for sleeping and dining cars, 65½ ft. long, have been built in England by the London & North Western Railway for the fast trains on the east coast route between London and Edinburgh. In these cars the center sills are of 9¼ by ⅜-in. channels, and the side sills 10 by ⅝-in.

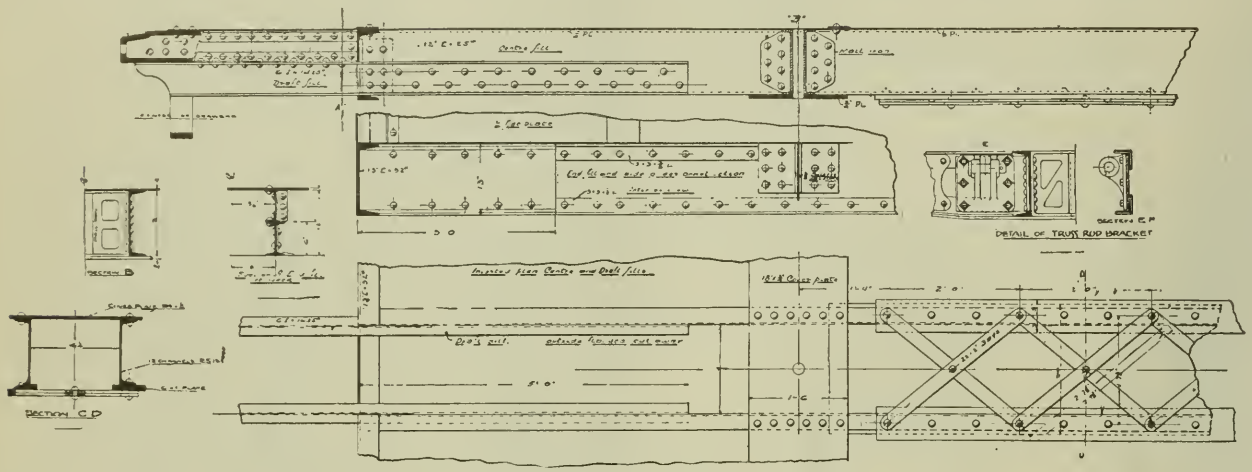



Fig. 6—Center Sills and Draft Timbers.

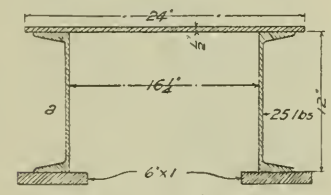



Fig. 9—Section a.

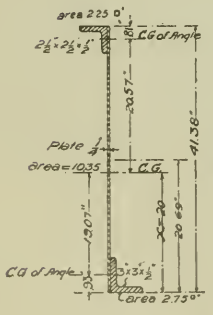



Fig. 12.

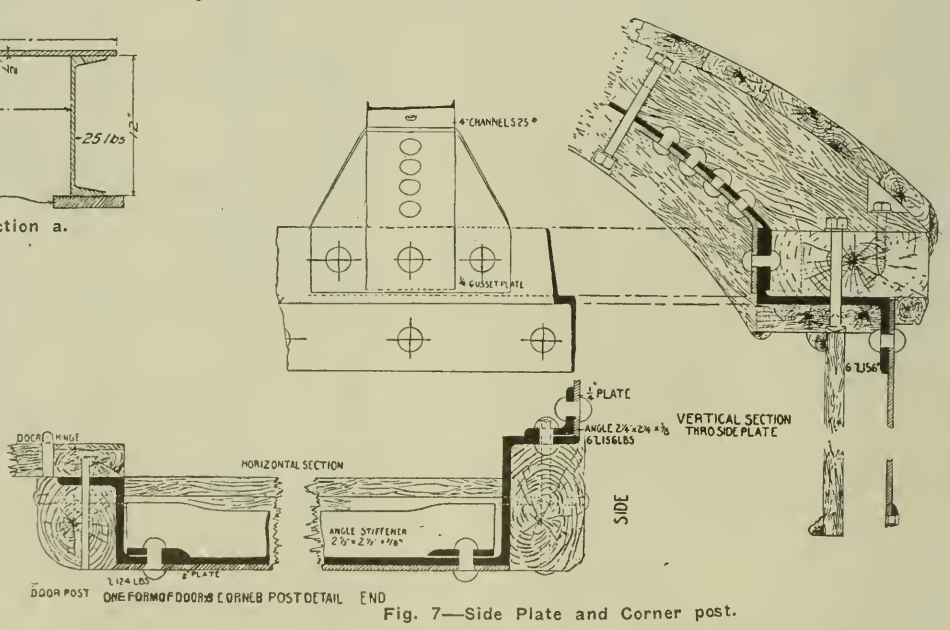



Fig. 7—Side Plate and Corner post.

plates 24 in. wide on top. The posts between the windows are made of 6-in. channels which extend from floor to roof. The longitudinal plates are 6-in. Z bars 15.6 lbs. per ft., and steel carlines connect these for the upper deck. The whole outside and ends of the car, except the windows and doors, are made of ¼ in. steel plates with rivet heads plainly showing. The center sills and side sills are connected by 7-in. channels 12¼ lbs. per ft., and the body bolsters are quite similar to those used in steel freight car construction. The end corner posts and the end door posts are formed of 10-in. channels, 15 lbs. per ft., bent to a quarter circle. Some of these features, in connection with the Z-bar plates and the end posts, have been patented by Mr. King. The whole side of the car is a compound steel girder made up of the deep plate girder below the windows, with numerous posts riveted to it, such improvements as are always developed in actual construction, a cheaper and lighter car can be built by the use of steel which will be stronger in resisting the force of collision and practically fireproof. The steel passenger car will thus be developed by experience in construction, by a display of ingenuity in designing efficient details, and the adaptation of fireproof materials to a simpler inside finish.

All the large timbers are removed and the floor can be made entirely fireproof. The quantity of wood in the car body is very much reduced and the small sections could easily be made fireproof. It is desirable to have wood or an equivalent non-conductor on the inside of a steel car of this or almost any other construction, not only for inside finish but as a non-conductor in order to make the interior comfortable in hot or cold weather and to prevent noise. The calculations relating to the strength and stiffness of this steel coach frame are given in the appendix.

The majority of the large cars for long distance electric lines are now built with steel underframes. The new cars for the Rapid Transit Company of New York are built almost entirely of steel. These cars are 51 ft. 2 in. over platform sills, and they are 8 ft. 7 in. wide over sheathing. The cars have a capacity for 54 passengers. The channels. There are four truss rods, the outside one being 1½ in. in diameter, and the center ones are 1¼ in. in diameter. They are braced diagonally and the drawbars are continuous. In order to prevent noise and to make the car less rigid, the sills are covered with a thin strip of pine and on this a continuous line of rubber is laid, and the car body is bolted to the sills. The car body weighs 58,000 lbs., two trucks 32,000 lbs., total 90,000 lbs. A model of this car is now on exhibition at the St. Louis Exposition.

Illinois Central has designed and built at its own shops quite a number of large steel suburban cars, having 100 seats. These cars are 64 ft. long over end sills and 10 ft. 4 in. wide. The underframe consists of four 9-in., 21-lb. steel I-beams, spaced nearly equal distances apart. The end sills are 9-in., 25-lb. steel channels, set with the backs to the square ends of the longitudinal sills and riveted to them by double angle plates reinforced by plate gussets. A steel floor ¼ in. thick is riveted to the sills, forming a continuous metal surface, extending the whole width and length of the car, thus insuring perfect rigidity of the underframe and completely protecting the car from fire underneath. The side posts are made of 3-in., 4-lb. steel channels, and the side plate is 4½ x ½-in. iron. The car body weighs 61,400 lbs., trucks 23,200 lbs., total 84,600 lbs. These steel cars have been in service more than a year, and one of them is on exhibition at the St. Louis Fair.

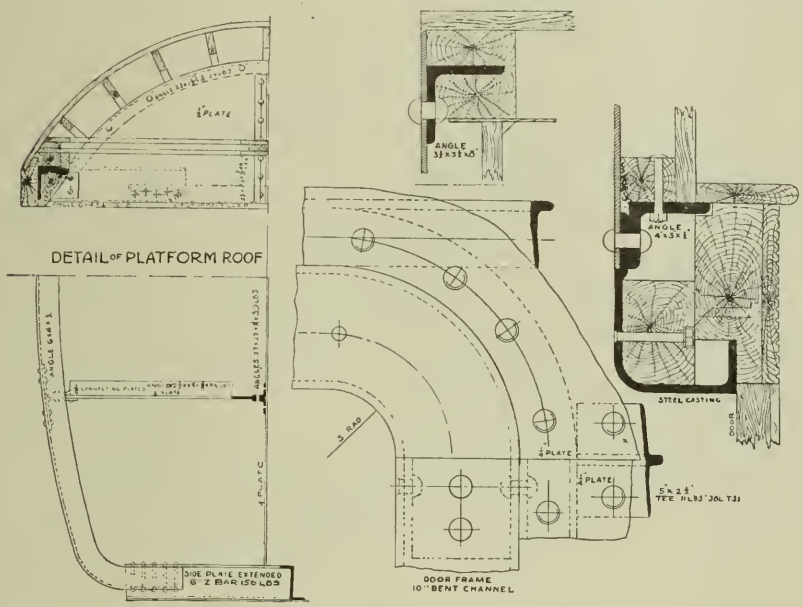



Fig. 8—Platform Roof and Door Post.

Many car builders prefer to think that wood construction is good enough for passenger cars, but the use of steel for this purpose is gradually growing, and the conditions of our passenger service seem to indicate that before long it will be forced upon us. When the Interborough Company, of New York City, decided to use steel cars they found it impossible to interest any of the large car builders of this country, and the sample car was designed and built by the Pennsylvania Railroad as an accommodation. Even after the car was built many were skeptical as to its success in service, but the tests of the car have been so satisfactory that the Interborough Company has given the order for the construction of 200 steel passenger cars, and this is really the beginning of this industry in the United States. The Pressed Steel Car Company has been for some time working on plans for steel passenger cars, and this is really the make contracts for the steel frames of such equipment.

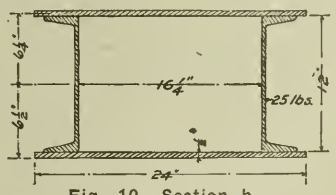



Fig. 10—Section b.

The subject is of sufficient importance to demand further treatment, and should be included in the list of subjects for committee investigation for the coming year.

*Appendix.*—The maximum load of passengers which a coach is required to support does not exceed four or five tons, which is so small as compared with the dead weight of the construction that it might be neglected altogether in figuring the members of the frame. There is a very considerable difference in this respect between a passenger car and a freight car in that in the latter designs the structure must carry a weight several times that of the car, with the result that something like an approximation can be made as to the sections needed to support this weight, making such a liberal allowance for shocks and vibrations as the result of experience and some experimental work may make desirable. On the other hand, to assume anything like a normal vertical load in designing a passenger car might result in sections that would be insignificant, and to assume a load of, say, 25 tons to be evenly distributed would necessitate more material than normal operating conditions should warrant. The ability of the steel frame to support its vertical load would equally apply as to its strength to resist buffing shocks. Unfortunately, with such a complex frame as shown in our proposed plan, it is practically impossible to say what path the maximum stresses would traverse from end to end of the car, or what these stresses would amount to. We have therefore assumed certain sections as desirable, have to a great extent ignored their *ultimate strength* and have based final judgment as to their fitness, upon the matter of deflection, which in a long span becomes a serious matter.

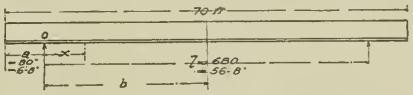



Fig. 11.

The following calculations, based on the sections as shown in the plan, have been made by Mr. King to show the safe load the steel frame would carry, and he has derived a formula which is used to determine the deflection of the side and center girders under the safe loads as obtained by these calculations. These figures are given to illustrate a method of arriving at necessary sections in steel car construction where the spans and loading are different from those used for freight cars. They are not intended as an exact and complete solution of the problems connected with the design for a 70-ft. steel coach, but are sufficient to show the necessity of using truss rods for such long spans if excessive weight is to be avoided.

Center sills as shown on drawing, section a, is very similar to section b.

Either section would give practically the same result as to stiffness and strength, and since it simplifies the calculation to ignore the slight eccentricity as to center of gravity in (a), we shall base our figures on (b).

I of one channel = 144.

I of whole section = 2 (144) + 2 (12) 39.

I = 288 + 936 = 1,224.

$$\frac{I}{v} = S = \frac{1,224}{6.5} = 188.$$

Now $M = fS$.

Assume $f$ = 10,000 lbs. per sq. in. for compression side, which should allow ample margin for draft and shocks, since center sills, unlike top flange of side girder, are well supported sidewise (and vertically to some extent) by crossbearers and floor with deafening.

M = 10,000 (188) = 1,880,000 in. lbs. = safe moment at center.

Since $\frac{I}{y}$ for both tension and compression are the same (the neutral axes being at the center of the section) the above moment will cause an outside fiber stress of 10,000 lbs. per sq. in. at the center of car in both tension and compression flanges.

However, before determining from the above moment the safe load with these stresses, let us figure the deflection under a load of 180 lbs. per ft. or a total load of 12,600 lbs. for the center girder.

To derive deflection formula, beam thus:

Make origin at O.

Formula for M at any point x between supports $= \frac{P}{2}(xl - x^2 - a^2)$

Slope $i = \frac{1}{EI}\int M dx$

Deflection $v = \int i dx$.

(a) $i = \frac{P}{2EI}\int (xl dx - x^2 dx - a^2 dx)$.

$= \frac{P}{2EI}\left(\frac{x^2 l}{2} - \frac{x^3}{3} - a^2 x\right) + C$

Now $i$ = O when $x = \frac{l}{2}$

Therefore, $C = -\frac{P}{2EI}\left(\frac{l^3}{8} - \frac{l^3}{24} - \frac{a^2 l}{2}\right)$

Substituting this value below, we have

(b) $v = \int i dx$.

$= \frac{P}{2EI}\int \left(\frac{x^2 l}{2} - \frac{x^3}{3} - a^2 x - \frac{l^3}{8} + \frac{l^3}{24} + \frac{a^2 l}{2}\right) dx$.

$= \frac{P}{2EI}\left(\frac{x^3 l}{6} - \frac{x^4}{12} - \frac{a^2 x^2}{2} - \frac{l^3 x}{8} + \frac{l^3 x}{24} +\right.$

$\frac{a^2lx}{2} + C_1\Big)$

Now v = O when $x = o$ ∴ $C_1 = O$.

but v is *max.* where $\frac{l}{2} = x$.

$$\therefore v = \frac{P}{2EI}\left(\frac{l^3}{48} - \frac{l^3}{192} - \frac{a^2l^2}{8} - \frac{l^3}{24} - \frac{a^2l^2}{4}\right)$$

$$= \frac{P}{2EI}\left[\frac{a^2l^2}{8} - \frac{5l^3}{192}\right]$$

Therefore, $v = \frac{Pl^2}{384EI}\left(24a^2 - 5l^2\right)$ = deflection at center.

Using this to determine deflection of center sills we have by substitution:

P = 15 lbs. per in., or 180 lbs. per ft.

$$V = \frac{15 \times 680 \times 680}{384 \times 30{,}000{,}000 \times 1224}\left(24\left[6{,}400\right] - 5\left[680\right]^2\right)$$

= 1.06 in. deflection, say 1 in. approximately.

This deflection would not be very apparent in a length of almost 57 ft., nevertheless it is objectionable from some points of view, and it is therefore desirable to use truss rods in order to reduce deflection of center sills.

(e) Side girders.

To find the center of gravity of whole section.

$x\,(2.25 + 10.35 + 2.75) = 2.75\ (.93) + 10.35\ (20.69) + 2.25\ (40.57)$ $15.35x = 2.56 + 214.14 + 91.28 = 307.98$.

$x = 20$ in.

(f) To find moment of inertia of whole section about its center gravity.

Moment plate about *its* C. G. $= \frac{1}{12}\,bl^3$ ∴ $I_c = \frac{1}{12} \times \frac{1}{4} \times 41.38^3 = 1478$ = moment of plate.

$I_c$ Top angle ($2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{2}$) = 1.23.

$I_c$ Bottom angle (3 x 3 x $\frac{1}{2}$) = 2.22.

Final $I_o = 1478 + 1.2 + 2.2 + (10.35 \times .48) + (2.25 \times 20.57^2) + 2.75 \times 19.07^2$

= 1481 + 5 + 951 + 1000 = 3437.

$$S_t = \frac{3437}{20} = 172 \text{ tension flange.}$$

$$S_c = \frac{3437}{21.38} = 160 \text{ compression flange.}$$

Now M = *f s.*

= 16,000 (172) tension side.

= 2,752,000 in. lbs. = 229,333 ft. lbs.

= 10,000 (160) compression side.

= 1,600,000 in. lbs. = 133,323 ft. lbs.

The top or compression flange is evidently the weaker and will have to govern; 10,000 lbs. fiber stress for compression in a flange 70 ft. long is entirely too high *except* that the stiffening effect of the through window posts would seem to make it safe.

(h) To determine P the safe load per lineal foot for tension of side girder, see sketch Fig. 11.

$$P = \frac{2M}{b^2 - a^2} \text{ from } M = \frac{P}{2}\,(b^2 - a^2).$$

Where M is moment at center, $b$ is ½ distance center to center of trucks and $a$ is body overhang.

$$P = \frac{2M}{b^2 - a^2} = \frac{2(229333)}{758} = 605 \text{ lbs. per ft.}$$

70 × 605 = 42,350 lbs. per girder = 84,700 lbs. per car (safe load), carried by two side girders with maximum fiber stress in tension of 16,000 lbs. per sq. in.

To determine P for compression in side girder.

$$P = \frac{2(133{,}333)}{758} = 352 \text{ lbs. per ft.}$$

Safe load = 352 (70) = 24,640 lbs., say 25,000 lbs. each, carried by two side girders with maximum fiber stress 10,000 lbs. per sq. in. in compression.

= 50,000 lbs. per car.

Since the compression flange of side girders is considerably stiffened by through window posts, it is safe to assume total load on side girders as 60,000 lbs. per car. Adding to this 12,600 lbs. supported by center sills, makes a total of 72,600, or say 75,000 lbs. that the car frame will safely carry. Possibly 5,000 lbs. of the total weight of the body will be concentrated at or near each transom (including weight of body bolsters, center plates, side bearings and other fixtures), and moreover, while the whole load has been assumed to be uniformly distributed, as a matter of fact, the portions overhanging each truck will weigh more per lineal foot than the central parts, thus reducing still further the positive bending moment at the center, and increasing the capacity at this point.

It is true our calculations take no account of pulling or buffing forces, but since our fiber stresses are one-half or less the elastic limit of medium steel, and for the reason that all such forces are distributed over the whole frame by means of the large floor plate extending from each transom to its nearest end sill, the structure would seem to be amply strong.

While the center sills could be made much stiffer by using additional top and bottom cover plates instead of lattice bars, the proportion of the total load borne by them is probably near their capacity as above determined, because practically the whole side and roof framing is supported by the side girders. Moreover, lattice bars have the advantage of making all connections on sides of 12-in. channels easily accessible from below, which would not be the case were a bottom cover used in addition to the top plate.

Deflection of side frame.

(a) Load per lineal inch = $\frac{30{,}000}{840}$ = 36 lbs. per in.

(b) I = 3437.

$$\therefore v = \frac{2.5}{2.8}(1.06)$$

= .9 in.

It should be remembered that the main side girder *below* the windows is securely tied to the lesser girder *above* the windows, and that both must deflect together and to the same extent. This upper girder will strengthen very considerably the lower girder.

However, since each side girder and the center sills deflect approximately 1 in. under the above loads (which represent little more than the dead weight of body), it is recommended that at least two truss rods be used to give the frame a slight upward camber.

## REVISION OF STANDARDS AND RECOMMENDED PRACTICE.

The committee on revision of standards and recommended practice considered 27 changes in the existing code and submitted in its report recommendations as to the action which should be taken by the association. The report is signed by W. P. Appleyard, Chairman; T. W. Demarest and T. S. Lloyd.

## REVISION OF AIR-BRAKE AND SIGNAL INSTRUCTIONS.

The joint committee of the Master Car Builders' Association and the American Railway Master Mechanics' Association appointed to revise the existing code of air-brake and signal instructions, presented a report in the form of a new set of rules covering modern air-brake and signal equipment. The report is signed by William McIntosh, A. J. Cota, A. W. Gibbs and W. S. Morris for the Master Car Builders' Association, and by A. J. Cota, representing the Master Mechanics' Association.

### TESTS OF M. C. B. COUPLERS.

The committee obtained two couplers with the new contour lines adopted as standard Jan. 1, 1904, and had them applied to cars for a service test. The trial included the two couplers with new contour lines coupled passing around curves, and coupling and uncoupling on tangent and on curve; a similar trial was made with a coupler having the new contour lines coupled to one with the old contour; and still another trial under like conditions, using a badly worn coupler with the old contour lines and one with the new contour. In all instances the action of the couplers with the new contour proved satisfactory and no trouble was experienced on curves.

These same couplers, after being removed from the cars, were given a test to determine the maximum amount of angling between the center lines of the couplers, which clearly demonstrated that the new contour lines afforded a slightly increased amount of angling. From the experiments that have been made with the new couplers, the committee is satisfied that no difficulty will be experienced with the new contour lines adopted last year to take effect Jan. 1, 1904. As the designs of these gages are giving satisfactory service and have developed no defects, the only change the committee recommends is to give the gages the contour adopted Jan. 1, 1904, and to have the year "1904" cast in raised figures on the frame. These changes are shown herewith.

Upon examination of a large number of couplers and after carrying out a series of experiments with worn couplers, it was found that the controlling feature that allows the couplers to part is the distance from the point of the knuckle to the guard arm. The points of greatest wear are the inside face of the knuckle, the lock and the knuckle pin, enlargement of the knuckle-pin hole, the distortion of the guard arm and the opening of the knuckle. All these features affect the distance between the point of the knuckle and the guard arm, and it is this distance, as has been said before, that allows uncoupling. The wear on the outside face of knuckle and coupler body opposite the pivot pin is another point to be considered, but as this is very slight, and as the wear of the other parts takes place so much more rapidly, it can for interchange purposes be neglected.

The knuckle failures at the link pin hole and slot are due to the old design and have been overcome by the adoption of the solid knuckle, and although the wear on the inner face of the knuckle affects, to a certain degree, the breakage of the slotted knuckles at these points, it has been found from an examination of a number of broken knuckles that a large percentage of these have less wear than a great many knuckles remaining in service; furthermore, this distance from the inner face of the knuckle to the head does not gage the wear alone, but includes the distortion of the knuckle. This gaging distance can be omitted and a gage embracing the distance allowable from the point of the knuckle to the guard arm will cover all the points necessary for condemning couplers. For safety the distance from the knuckle point to the guard arm should not exceed 5⅛ in., which is practically what the present M. C. B. worn limit coupler gage allows at this point, and which would apply to couplers with new and old contour lines.

By making certain changes in the present standard wheel defect gage, so as to include

the dimension of 5⅛ in., a satisfactory worn limit coupler gage can be combined with the wheel defect gage. The present M. C. B. wheel defect gage is too wide to be used as a coupler gage. Reducing its width necessitates the relocation of the gaging points and distances for wheel defects. The gage should be narrower and the edges should be rounded off at both ends.

*Drop Test Machine.*—The M. C. B. drop-test machine, with the modifications described in the report for 1903, for Purdue University, has been completed and stands on its foundation at Lafayette, Ind., ready for operation. The committee has given it a trial test and found that the machine is entirely satisfactory and especially so as regards the single coupler jerk test. A number of knuckles were tested and the fractures showed a great variation of material, some having fine grain steel as though the knuckle had been well annealed, while others showed a large crystalline structure as if the knuckle had not been annealed. One make of knuckle appeared to be made of malleable iron, malleableized to a depth of $^1/_{16}$ in.; another style showed very poor design, it having the tail cored out until the walls were about ½ in. thick, and in one of the latter the core had floated, leaving the wall but ⅛ in. thick on one side and ⅝ in. thick on the other.

The knuckles were considered as having failed if a crack 1 in. long developed or a crack opened more than $^1/_{16}$ in., or if some portion was broken. The very wide difference in the knuckles tested shows conclusively that specifications for the separate knuckle test should be instituted at the earliest possible date, and with this end in view the committee recommended specifications.

The report is signed by R. N. Durborow, Chairman; Jos. Buker, W. S. Morris, W. P. Appleyard, F. H. Stark.

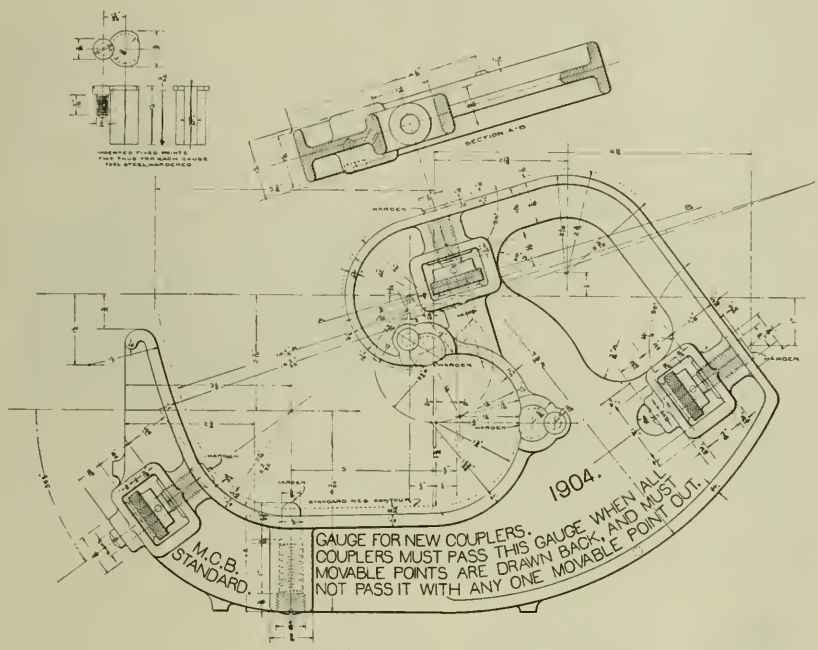

1904.
M.C.B. STANDARD.
GAUGE FOR NEW COUPLERS. WHEN ALL COUPLERS MUST PASS THIS GAUGE, AND MUST MOVABLE POINTS ARE DRAWN BACK, AND MUST NOT PASS IT WITH ANY ONE MOVABLE POINT OUT.

Fig. 1—Gauge for New Couplers.

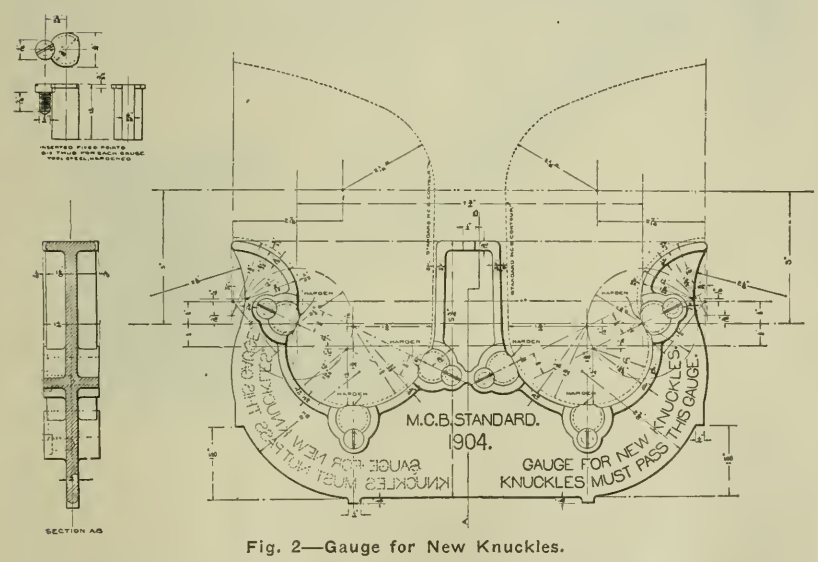



Fig. 2—Gauge for New Knuckles.

The French railroads in 1902 used 6,050,000 tons of coal, at an average cost of $3.74 per ton. More than two-fifths of this coal was imported, and this cost on the average $4.05 per ton.

## Exhibits at the Saratoga Conventions.

The exhibits at Saratoga this year are quite as elaborate and equal in number to the exhibits of previous years. The following is a partial list of exhibits in place up to Tuesday night. The remainder placed during the week will be printed in another list next week:

Acme Railway Supply Co., Chicago.—Samples of Acme vestibule diaphragms.

The Adams & Westlake Co., Chicago.—Large, handsome pavilion in cream and gold surmounted by gilded dome studded with 2,000 2-in. glass bull's-eyes and 30 8-in. glass bull's-eyes; the whole lighted by 118 acetyline gas lamps supplied from five Adlake generators. Within the pavilion were the various kinds of car fixtures and chandeliers for acetylene lighting, and two Adlake generators for exhibition purposes.

American Steam Gauge & Valve Mfg. Co., Jamaica Plain, Boston, Mass.—Locomotive steam gages, locomotive pop safety valves (muffled and open), American-Thompson improved steam engine indicator, recording gages, chime whistles, test pumps and locomotive water gages.

American Brake-Shoe & Foundry Co., New York City.—Samples of the different types and styles of brake-shoes made by this company.

Anti-Friction Bearing Co., Pittsburg, Pa.—Samples of Hartman ball-bearing center plates and side bearings.

William C. Baker, New York.—Single coil fireproof heater showing two distinct circuits with steam on one coil; Mighty Midget, perfected double coil, riveted "fireproof" double coil heaters and exhibit of extra heavy fittings, combination cocks, draw-off cocks and safety vents.

Bettendorf Axle Co., Davenport, Iowa.—Exhibits of 30-ton and 40-ton Bettendorf cast-steel freight truck, passenger truck side frame, 30-ton and 40-ton body and truck bolsters, brake-beams and section of steel underframe for freight cars.

S. F. Bowser & Co., Ft. Wayne, Ind.—Exhibit of Bowser three-measure, self-measuring oil tanks and pumps; shop and gasoline tanks.

Chas. Bridgeford, Rochester, N. Y.—Heavy double axle lathe.

Buckeye Steel Castings Co., Columbus, Ohio.—Sample "Major" coupler, mounted to show operation, and also steel castings of all descriptions.

Buffalo Brake Beam Company, Buffalo, N. Y.—The Buffalo brake-beam.

Buffalo Forge Co., Buffalo, N. Y.—A Buffalo electric driven down draft forge.

The Carborundum Co., Niagara Falls, N. Y.—Cases containing carborundum products, carborundum wheels, stones and carborundum fire sand for lining brass furnaces.

The Celluloid Co., New York City.—Samples of "Texoderm" for upholstering and car curtains.

L. C. Chase & Co. (Sanford Mills), Boston, Mass.—A full line of samples of Mohair plush for upholstering car seats, also "Chase Leather" (an imitation leather) for upholstering and car curtains.

Chicago Car Heating Co., Chicago.—Vapor car heating apparatus under steam, which is described elsewhere in this issue.

Chicago Electric Hose Co., Wilmington, Del.—Samples of rubber hose for water, pneumatic, air-brake, signal and steam lines, made under a new process.

Chicago Pneumatic Tool Co., Chicago, Ill.—Sample line of Boyer pneumatic hammers. Boyer and "Little Giant" piston air drills, yoke riveter, pneumatic painting machine, stay bolt cutter, rock drills, stone dressing machines, sand sifter, grinders, air compressors, hoists, Welles gas system forges and furnaces.

Cleveland Car Specialty Co., Cleveland, Ohio.—Exhibit of pressed steel carlines.

Commercial Acetylene Co., New York.—Exhibit of acetylene gas lighting fixtures and apparatus for the storage system under high pressure. The chandeliers in the main parlor of the Grand Union will be lighted for the convention week by acetylene gas supplied from one large holder. A new application for acetylene gas is shown in connection with a two-blade, gas signal installation of the Hall Signal Co. The semaphore lamps will be lighted by ⅛ cubic feet burners supplied from an acetylene gas storage tank.

Consolidated Car Heating Co., Albany, N. Y.—Full line of car heating apparatus, including Sewall and Consolidated couplers, steam traps, steam drums and valves.

Crosby Steam Gage & Valve Mfg. Co., Boston, Mass.—Recording gages, steam and hydraulic gages, safety valves, locomotive chime whistles, globe, angle and gate valves,

muffled pop safety valves, indicators and other steam specialties.

Paul Dickinson, Chicago, Ill.—Sample of the "Dickinson Giant" cast-iron smoke-jack for roundhouses, and a model of the Dickinson movable smoke-jack.

Duner Co., Chicago, Ill.—Water closets for railroad cars.

The O. M. Edwards Co., Syracuse, N. Y.—Models of window fixtures and models of automatic extension platform trap doors.

The Fabrikoid Co., Newburg, N. Y.—Samples of "Fabrikoid" leather for upholstering and curtains.

Fairbanks, Morse & Co., Chicago, Ill.—A 6 h. p. gas engine direct connected to a dynamo furnishing power for an electric power pump; a number of duplex steam pumps, gasoline air compressor, Barrett jacks, hydraulic jacks, rail bender and samples of tinware, oil cans, etc.

Farlow Draft Gear Co., Baltimore, Md.—Samples of the Farlow draft gear.

Federal Mfg. Co., Elyria, Ohio.—Working models of Keeler curtain fixtures.

Forsyth Bros. Co., Chicago.—Samples of the Chaffee draw-bar centering device, Yerk sliding yoke, Stucki "Radial" draw-bar controlling device. "Safety" deck sash ratchet.

Franklin Manufacturing Co., Franklin, Pa.—Magnesia boiler lagging, asbestos goods of all kinds, including asbestos dust guards, journal box packing.

Franklin Railway Supply Co., Franklin, Pa.—Sheedy cylinder circulator, McLaughlin lock nuts, McLaughlin metal flexible conduit, Worthington coupler, Elvin driving box lubricator, Player brake-shoe.

The General Pneumatic Tool Co., Montour Falls, N. Y.—Exhibit of pneumatic and electric hoists.

The Gold Car Heating & Lighting Co., New York City.—A complete car heating apparatus on the Gold system in operation.

The Gould Coupler Co., Depew, N. Y.—Roller side bearings, steel platform and vestibule, spring buffers, journal boxes, tender and freight couplers, self-contained friction draft gear for freight and passenger cars.

The Hale & Kilburn Co., Philadelphia, Pa.—Exhibit of car seats.

H. G. Hammett, Troy, N. Y.—Richardson and Allen-Richardson balanced slide valves, oil cups, "Sansom" bell ringer, link grinders and Trojan metallic packing, triple valve bushing roller.

Hancock Inspirator Co., New York City.—Inspirators, injectors, strainers, boiler washers, special steam valves and double checks with stop valves for locomotive use.

Handy Car Equipment Co., Chicago.—Full-size locomotive pilot equipped with the Handy horizontally-swinging pilot coupler. Samples of the Snow wrecking frogs.

Heywood Brothers & Wakefield Co., Wakefield, Mass.—Car seats and parlor car chairs.

Holland Co., Chicago, Ill.—Dake compressed air and steam engines and motors for operating locomotive turntables, fans, blowers, hoists, portable machines, etc.; Martin flexible joints for steam, air, oil and other liquids, especially adapted for connection between locomotive and tender: Dake pneumatic hoist, Scott rail anchor, Holland fuel oil regulating valve and oil conduit for connection between engine and tender.

Homestead Valve Mfg. Co., Pittsburg, Pa.—A large gilt model of the Homestead locomotive blow-off valve; also samples.

Hunt-Spiller Manufacturing Corporation, Boston, Mass.—Samples of Hunt-Spiller "gun-iron," especially suited for locomotive castings.

Ingersoll-Sergeant Drill Co., New York.—Class H. C. air compressor, Haeseler "Axial valve" pneumatic chipping and riveting hammers, pneumatic drilling machines, quick-acting hose coupling, Ware adjustable vise, MacDonald riveting forge, Pedrick & Ayer pneumatic hoist, riveter and punches, Foley pneumatic anvil and "Antipeel" hose.

The H. W. Johns-Manville Co., New York City.—Samples of asbestos and magnesia products; also roofing and building materials, steam packings, Vulcabeston, molded mica, fireproof cements, boiler and pipe coverings, etc.

John Lucas & Co., Philadelphia, Pa.—Samples of prepared paints.

McConway & Torley Co., Pittsburg, Pa.—Exhibit of Kelso couplers and the Pitt coupler, the latest product of this company, which combines a lock-set, a lock to the lock and an automatic knuckle opening feature; also, the Buhoup 3-stem coupler equipment for freight cars.

McCord & Co., Chicago, Ill.—Outside dust guard, McCord journal box, Climax and National journal boxes, "Center Bearing" journal box lid, McCord spring dampener, McKim gaskets, McCanna force feed lubricator, McCord draft gear.

Manning, Maxwell & Moore, New York City.—Appliances made by Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hancock Inspirator Co., and Metropolitan Injector Co.

The Mason Regulator Co., Boston, Mass.—Steam specialties.

Merritt & Co., Philadelphia.—Combination sheet steel ventilated, dustproof and expanded metal lockers.

Metropolitan Injector Co., New York City.—Injectors, ejectors, water heaters and hose strainers.

Michigan Lubricator Co., Detroit, Mich.—A new triple sight-feed lubricator with automatic safety device to prevent injury from blowing out of glasses; also a new glass may be put in and filled with water without closing throttle or interfering with any of the other feeds; new bull's-eye triple feed lubricator.

The Midland Supply Co., Chicago.—Samples of the Perry roller side-bearing.

National Car Coupler Co., Chicago, Ill.—Models of National steel platforms and buffers, freight and passenger couplers, National centering yoke, Hinson draft gear and friction buffers, Hinson emergency knuckle.

The National Lock Washer Co., Newark, N. J.—Full-size models of curtain fixtures, sash locks and sash balances and lock washers.

National Malleable Castings Co., Cleveland, Ohio.—Tower and Climax couplers in malleable iron and steel, engine and tender couplers and pocket castings.

A. O. Norton, Boston, Mass.—Ball-bearing lifting jacks, journal, bridge and track jacks.

Norton Grinding Co., Worcester, Mass.—Exhibiting a locomotive crank pin and piston rod, ground on the Norton plain grinder.

Philips, Justice & Co., Philadelphia.—Exhibit of the "Reliance" jacks.

Spencer Otis Co., Chicago, Ill.—Republic friction draft gear.

Pantasote Co., New York City.—Model of section of a passenger car showing seats and curtains of "Pantasote" leather.

Pittsburg Spring & Steel Co., Pittsburg, Pa.—Samples of elliptic and spiral car and locomotive springs.

Rand Drill Co., New York City.—Full line of Imperial pneumatic tools; also Rockwell portable oil rivet forge, duplex steam, compound air, type 10 air compressor, compound type 10 compressor driven with Morse chain driven by a Westinghouse 50 h. p. motor, and fitted with the Cutler-Hammer starter and passenger equipment; springs, coil and elliptical, type 11 compressor and a belt driven type 11 compressor.

Robins Conveying Belt Co., New York City.—Model of the Robins belt conveyor for handling all kinds of material and fitted with Richardson automatic scales.

Safety Car Heating & Lighting Co.—Booth showing various designs of overhead and bracket Pintsch gas lights. This exhibit occupied a prominent place in the corridor of the Grand Union Hotel.

Simplex Railway Appliance Co., Chicago.—Samples of "Simplex" 100,000, 80,000 and 60,000-lbs. capacity body and truck bolsters and "Simplex" I-beam tender truck bolster; also "Simplex" brake-beams for all service, and "Susemihl" roller side-bearings for freight and passenger equipment; springs coil and elliptical for all classes of equipment.

Louis A. Shepard, New York.—Cast-steel bolsters and brake-shoes. Representing Benj. Athar & Co. and South Baltimore Steel Car and Foundry Co.

Sherwin-Williams Co., Cleveland, Ohio.—Samples of railroad paints and varnishes.

Standard Car Truck Co., Chicago, Ill.—Models of trucks fitted with Barber roller bearings for lateral motion.

Standard Coupler Co., New York City.—Standard steel platform, Sessions-Standard friction draft gear and Standard couplers.

Storrs Mica Co., Owego, N. Y.—Mica headlight chimneys and lantern globes.

The T. H. Symington Co., Baltimore, Md.—Samples of the Symington patent journal boxes and dust-guards; also a full-size working model driven by a G. E. motor showing the comparative action of the waste and oil in the Symington and standard M. C. B. journal boxes.

U. S. Metal & Mfg. Co., New York City.—Combination steel draft gear and underframe, U. S. steel truck, Johnson hopper door, Camel adjustable journal bearing, Dunham hopper door, Columbia lock nut, Perfect pressed steel car replacer, Cliff and Guibert safety automatic hose reels, malleable iron brake jaw.

Walworth Mfg. Co., Boston, Mass.—Locomotive injectors, wrenches, pipe cutters, steam whistles, stocks and dies, pipe vises, taps and cutters and Smith's track ratchet.

West Disinfectant Co., New York City.—Samples of chloro-naptholeum, Taussig automatic and Protectus disinfectors, improved W. D. C. bug exterminator, especially adapted for railroad coaches and dining cars.

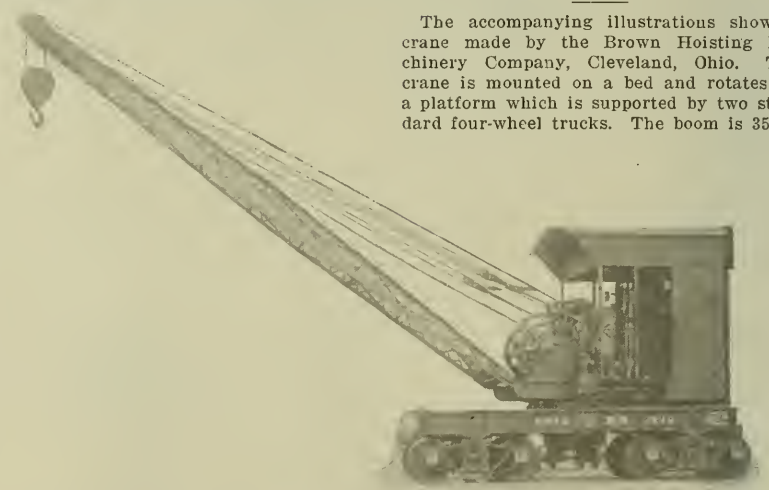
Western Tube Co., Kewanee, Ill.—Samples of "Kewanee" brass and iron ball-joint unions from ½ in. to 3 in.

The Westinghouse Air Brake Co., Pittsburg, Pa.—The American Brake Co., St. Louis, Mo.; Westinghouse Automatic Air and Steam Coupler Co., St. Louis, Mo.; Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Two quarter-size four-wheel car models fitted with Westinghouse air-brake: Westinghouse friction draft gear, Westinghouse automatic air and steam coupler, American automatic slack adjuster, Westinghouse high speed reducing valve, Westinghouse track shoe brake, etc.

Yale & Towne Mfg. Co., New York City.—Exhibit of Triplex hoists and Blount door checks.

## A Self-Propelled Yard Crane.

The accompanying illustrations show a crane made by the Brown Hoisting Machinery Company, Cleveland, Ohio. The crane is mounted on a bed and rotates on a platform which is supported by two standard four-wheel trucks. The boom is 35 ft



Self-Propelled Crane Built by the Brown Hoisting Machinery Company.

long and has a capacity for lifting from 20,000 lbs. at an 8 ft. radius to 5,800 lbs. at a 35 ft. radius. The crane will swing these loads through a full circle without being clamped to the tracks. A full load can be hoisted at 42½ ft. p. m., and the truck travel of the crane at full load is about 500 ft. p. m. The crane is equipped with a pair of vertical 9 in. x 7 in. cylinders, coupled at right angles. The boiler is the vertical tubular type 54 in. in diameter, 8 ft. 3½ in. high and has 98 tubes each 2½ in. in diameter. The drums are driven directly from the main engine shaft by a train of cast steel gearing. Both drums can be turned either independently or at the same time. One drum operates the closing rope of the bucket and the other drum operates

the bucket holding rope. The Grafton patent rotating gear is used for swinging the boom. This consists of a steel pinion, controlled by friction clutches meshing into a slip-ring of large diameter, whereby rotation in either direction may be accomplished without reversing the engines. This slip-ring is made of rolled steel, and has teeth cut in its periphery. The ring rests loosely on a bearing on the upper surface of the truck. The upper surface of the slip-ring, which is bev-

Coaling Locomotive With Crane.

eled, forms the path or bearing for the conical rollers carrying the superstructure. There are six of these rollers—four in front to take the thrust of the boom, and two in the rear. The slip-ring is free to move in either direction, when the rotating-clutch is thrown into gear, but is retarded in this motion by the frictional resistance between the ring and its seat, due to the weight of the crane superstructure and load resting upon it. The action of the slip-ring is therefore that of a safety when rotating the crane under light or heavy loads, and the resistance of the ring to rotation is directly proportional to the load hanging on the crane.

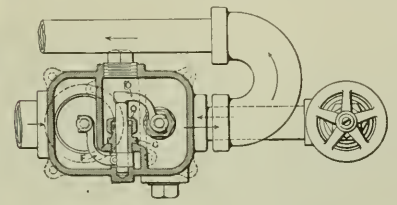
The traveling mechanism is taken by a clutch operating through bevel-gears and driving a vertical shaft in the center of the crane, which passes downward through a hollow-steel center-pin, which unites the upper and lower base of the crane and forms the axis of rotation. The lower end of this vertical shaft has a bevel-pinion gearing into a bevel-wheel mounted on a horizontal longitudinal shaft running between two truck-axles, one on each truck. Each end of this shaft has a bevel-pinion meshing into bevel wheels on the respective truck-axles. The bevel-wheels on both axles are split, and are easily detached. The horizontal shaft is coupled by means of steel universal couplings to allow the crane to travel around curves when operated under its own power.

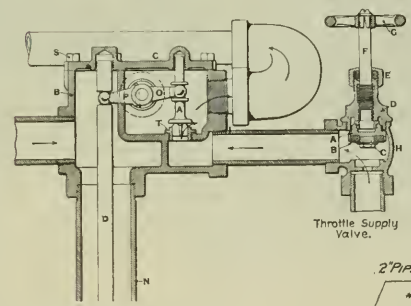
The bevel wheels on the truck axles are arranged with a clutch so that they can easily be thrown out of gear. The boom is raised and lowered by means of a train of gears which are in control of the operator through a positive clutch. The radius can be varied from 12 ft. to 35 ft. The space required for rear overhang of crane is 9 ft. 8½ in. The crane is equipped with a Brown patent two rope grab bucket of 54 cu. ft. capacity. This bucket is of special design, particularly adapted for coaling locomotives directly from cars. The pitch of the blades is such that in closing they do not dig into the pile of coal but scrape the pile off level. This permits getting all of the coal out of the car. The bucket has separate ropes for opening and closing the blades. The crane is supplied with hand brakes, a water tank with a capacity of 200 gal., and space for 600 lbs. of coal. The extreme height of the crane from top of rail to top of smoke stack is 18 ft., the extreme width 8 ft. 6 in., and the length of truck over all is 22 ft. The height of the crane can be reduced to 16 ft. by lowering the stack, which is hinged. The weight of crane is approximately 95,000 lbs.

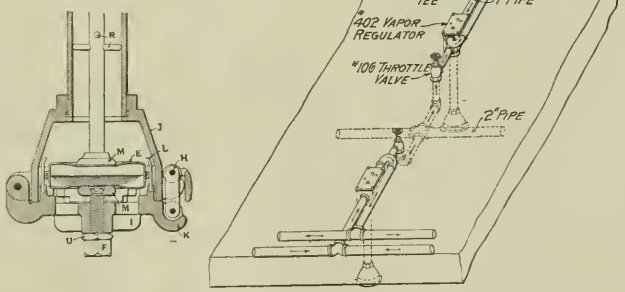
One of these cranes is used at the Cleveland shops of the Erie Railroad. The average amount of coal handled by it in a day of 12 hours is 168 tons, and the average number of trips made per hour is 52. The average cost per ton is $2^1/_7$ cents, as against 12.1 cents per ton compared with methods previously employed. The best record made with the crane was the handling of 180 tons of coal in a day of 12 hours.

## Vapor System of Car Heating.

A new system of car heating involving principles radically different from any now used is shown in the accompanying engravings. The scheme in general provides for the circulation in the radiating pipes of each car in the train of steam or vapor at 212 deg., to give a uniform temperature throughout the train regardless of variations in the train-pipe pressure. The apparatus contains no novel mechanical features, only slight changes from details already in general use being required. The well-known expansion trap mechanism is employed, with an admission valve substituted for a discharge valve. The conditions existing at the outlet chamber containing the diaphragm are unchanged, but an important difference is that this expansive diaphragm is used to open and close automatically a valve in the branch pipe supplying steam to the radiating pipes inside the cars, instead of a trap valve. The passage for the discharge of condensation is left open to the atmosphere.






Vapor System of Car Heating—Chicago Car Heating Co.

When the steam entering from the train pipe has circulated through the radiating pipes and finally reaches the outlet, it expands the diaphragm, which shuts off the supply. It then instantly contracts enough to allow just sufficient steam to enter the radiating pipes to make up for what is being condensed. This condition continues as long as steam is on the apparatus. Therefore, the temperature of the outlet of the apparatus, containing the diaphragm, is maintained at about 200 deg., and consequently all the pipes between the outlet and the inlet are maintained at a temperature varying from 200 deg. at the outlet to about 212 deg. at the inlet. As the radiating pipes are open to the atmosphere, their temperature cannot exceed 212 deg. at the hottest point.

The details of operation are as follows: Leaving the train pipe at the strainer cross, the steam passes through the throttle supply valve and the automatically-operated regulating valve, A, in the intake chamber of the vapor regulator. Until the steam reaches the valve A it is, of course, at train-pipe pressure. From the vapor regulator it passes through the usual feed pipe into the radiating pipes inside of the car, and circulating through them, finally reaches the outflow chamber of the vapor regulator, passes down the tube N and around the expansive diaphragm to the atmosphere.

The vapor regulator is divided by a partition into two parts—an intake and an outflow chamber, so that steam entering the device at valve A has to pass entirely through the radiating pipes before it reaches the outlet and comes in contact with the expansive diaphragm. Motion from the diaphragm at the outlet, to the automatic valve A at the inlet, is transmitted through the dividing partition by means of the lever, O, passing through the stuffing box, Q. The difference in pressure on the two sides of this stuffing box is inappreciable and as the motion of the axis of the operating lever is almost nothing, the stuffing box is a feature which needs no attention after the device is in service. The maximum movement of the valve A is ¼ in. The weight of the rod D will keep the valve open when the diaphragm is cold. The strainer cross on the train pipe prevents dirt, scale, pieces of rubber hose, etc., from passing out of the train pipe into the automatic regulator valve, A, and interfering with its proper working. The throttle supply valve is designed to permit steam to be forced back to the rear of train rapidly.

From results thus far obtained with this system, the apparatus has proved to be entirely automatic and quite simple. There being no pressure on the radiating pipes, the possibility of burst pipes is avoided. The radiating pipes being open freely to the atmosphere require no steam-traps or drip-valves. Also, there are only two valves to operate.

This system is the invention of Mr. Egbert H. Gold, President of the Chicago Car Heating Company, Chicago. It has been under test continuously during the past winter, and the company states that these tests have substantiated all of its claims.

## Steel Car Design.

II.

BY A. STUCKI.

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*Truck Bolsters.*—In designing the sections for truck bolsters, maximum moments only should be considered. Between the center of the bolster to the point R (Fig. 4), the

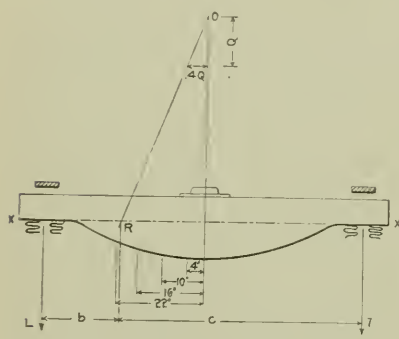



Fig. 4.

maximum moments can be obtained by assuming a horizontal force of such magnitude that it brings the intersection of the resultant of the horizontal and vertical forces, with the line x-x, into the vertical plane for which the section moment is to be found. The point R corresponds with a horizontal force of .4 Q, which is the greatest horizontal force which need be considered.

Example: To obtain the moment of an 80,000-lb. truck bolster at a point 10 in. from the center with the bolster springs spaced 76 in. apart. The vertical force is $Q^1$, which is half the load, half the weight of the car body and the weight of the truck bolster. For an 80,000-lb. car this is 56,500 lbs. Consider this force as applied 10 in. to the left of the center. Then, taking moments about the right-hand spring, the load on the left-hand spring will be

$$\frac{56{,}500\left(\frac{76}{2}+10\right)}{76} = 35{,}684 \text{ lbs.}$$

The section moment, 10 in. to the left of the center, will be 35,684 × (38—10) = 999,152 in. lbs.

The moments for a number of sections are tabulated below for the three standard capacity cars:

| | 60,000 lb. cars In. lbs. | 80,000 lb. cars In. lbs. | 100,000 lb. cars in. lbs. |
|---|---|---|---|
| In the center | 825,000 | 1,073,500 | 1,328,200 |
| 4 in. from center | 815,600 | 1,062,000 | 1,314,000 |
| 10 in. from center | 766,300 | 999,200 | 1,238,000 |
| 16 in. from center | 674,800 | 883,200 | 1,099,000 |
| 22 in. from center | 541,000 | 713,700 | 894,500 |

Since the center plate distributes the load uniformly for some distance on each side of the center, the moment at that point can be disregarded and the moment at a point 4 in. to one side of the center can be taken as a maximum. The bolster can, therefore, be made straight for 8 in.

In determining the section modulus at the center, the center pin hole in the cover plates of built-up bolsters is compensated for by the center plate, provided enough rivets are used in the center plate. The holes for machine-driven rivets in built-up bolsters need not be deducted from the effective cross-sectional area for compression in calculating the section modulus.

The moments in the bolster between the point R and the end of the bolster are more easily obtained than those between R and the center. The maximum load on the springs remains the same in all cases and corresponds to the values of L used in designing the arch-bars. The moments are directly proportional to the distance of the section for which the moment is to be found, from the center of the spring.

Example: The moment for a 100,000-lb. truck bolster, 9 in. from the center of the spring is L × 9, or 45,700 × 9 = 411,300 in. lbs.

The sections between the point R and the side bearings have smaller moments than those obtained as above. In reality, the product of the pressure between body and truck side-bearings multiplied by the distance from the center of these bearings to the section under consideration, should be deducted from the moment obtained by the other method. Ordinarily, this can be neglected and the bolster designed as above.

The fiber stress in a truck bolster should be kept low to provide for the shocks and vibrations to which this part of the car is subjected. For open hearth steel with carbon from 0.15 to 0.20 per cent., 12,500 lbs. per sq. in. is a fair figure.

Truck bolsters should be made stiff and strong, horizontally as well as vertically. The forces in a horizontal direction are closely proportional to the weights (not capacities) of the trucks. In order that the additional fiber stresses, due to end shocks, do not exceed the liberal allowance made in choosing a low fiber stress as given above, the section modulus in a horizontal direction should be made not less than 50 per cent. of that in a vertical direction. In a box girder construction, the horizontal strength is usually so manifest that a special analysis in this direction is unnecessary.

The tables give the moments of inertia and moments of resistance for the different sections commonly used in truck bolster construction. They will be found useful in preliminary work.

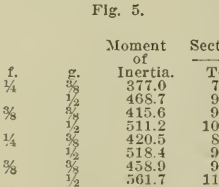



Fig. 5.

| H. | f. | g. | Moment of Inertia. | Section Modulus. Top. | Bottom. |
|---|---|---|---|---|---|
| 11½ | ¼ | ⅝ | 377.0 | 77.3 | 56.9 |
| | | ½ | 468.7 | 90.0 | 74.4 |
| | ⅜ | ⅝ | 415.6 | 93.4 | 58.9 |
| | | ½ | 511.2 | 105.7 | 76.5 |
| 12 | ¼ | ⅝ | 420.5 | 82.2 | 61.0 |
| | | ½ | 518.4 | 95.4 | 78.9 |
| | ⅜ | ⅝ | 458.9 | 98.4 | 62.5 |
| | | ½ | 561.7 | 111.3 | 80.7 |
| 12½ | ¼ | ⅝ | 462.5 | 86.6 | 64.5 |
| | | ½ | 570.5 | 100.7 | 83.4 |
| | ⅜ | ⅝ | 504.8 | 103.6 | 66.1 |
| | | ½ | 618.2 | 117.3 | 85.5 |
| 13 | ¼ | ⅝ | 506.9 | 91.0 | 68.2 |
| | | ½ | 625.8 | 106.1 | 88.1 |
| | ⅜ | ⅝ | 553.3 | 108.9 | 69.8 |
| | | ½ | 678.0 | 123.2 | 90.4 |
| 13½ | ¼ | ⅝ | 553.7 | 95.8 | 71.7 |
| | | ½ | 684.1 | 111.4 | 92.9 |
| | ⅜ | ⅝ | 604.5 | 114.2 | 73.6 |
| | | ½ | 741.2 | 129.3 | 95.3 |
| 14 | ¼ | ⅝ | 602.9 | 100.5 | 75.3 |
| | | ½ | 745.7 | 116.9 | 97.8 |
| | ⅜ | ⅝ | 658.3 | 119.7 | 77.4 |
| | | ½ | 807.7 | 135.5 | 100.4 |

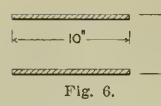



Fig. 6.

Section Modulus.

| H. | t=5/16. | t=⅜. | t=7/16. | t=½. |
|---|---|---|---|---|
| 5 | 13.75 | 16.08 | 18.27 | 20.33 |
| 5¼ | 14.53 | 17.01 | 19.35 | 21.56 |
| 5½ | 15.30 | 17.97 | 20.45 | 22.81 |
| 5¾ | 16.09 | 18.87 | 21.50 | 24.06 |
| 6 | 16.86 | 19.80 | 22.61 | 25.28 |
| 6¼ | 17.63 | 20.72 | 23.68 | 26.50 |
| 6½ | 18.41 | 21.67 | 24.77 | 27.74 |
| 6¾ | 19.19 | 22.59 | 25.85 | 28.99 |
| 7 | 19.98 | 23.55 | 26.95 | 30.24 |
| 7¼ | 20.76 | 25.05 | 28.05 | 31.50 |
| 7½ | 21.53 | 25.42 | 29.13 | 32.73 |
| 7¾ | 22.32 | 26.34 | 30.22 | 33.98 |
| 8 | 23.12 | 27.27 | 31.31 | 35.21 |
| 8¼ | 23.88 | 28.20 | 32.40 | 36.44 |
| 8½ | 24.65 | 29.20 | 33.49 | 37.69 |
| 8¾ | 25.41 | 30.16 | 34.58 | 38.94 |
| 9 | 26.22 | 31.02 | 35.67 | 40.19 |
| 9½ | 27.77 | 32.90 | 37.00 | 42.68 |
| 10 | 29.33 | 34.77 | 40.20 | 45.17 |
| 10½ | 30.89 | 36.63 | 42.11 | 47.65 |
| 11 | 32.45 | 38.48 | 44.39 | 50.15 |
| 11½ | 34.03 | 40.43 | 46.59 | 52.65 |
| 12 | 35.56 | 42.25 | 48.76 | 55.44 |
| 12½ | 37.12 | 44.11 | 50.92 | 57.60 |
| 13 | 38.72 | 46.00 | 53.14 | 60.13 |
| 13½ | 40.19 | 47.81 | 55.28 | 62.59 |
| 14 | 41.80 | 49.76 | 57.50 | 65.12 |

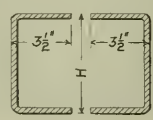



Fig. 7.

Section Modulus.

| H. | t=5/16. | t=⅜. | t=7/16. | t=½. |
|---|---|---|---|---|
| 5 | 11.37 | 13.17 | 14.84 | 16.37 |
| 5¼ | 12.15 | 14.08 | 15.88 | 17.54 |
| 5½ | 12.91 | 15.00 | 16.94 | 18.74 |
| 5¾ | 13.71 | 15.93 | 18.00 | 19.94 |
| 6 | 14.50 | 16.88 | 19.10 | 21.16 |
| 6¼ | 15.31 | 17.84 | 20.21 | 22.42 |
| 6½ | 16.15 | 18.82 | 21.34 | 23.69 |
| 6¾ | 16.99 | 19.83 | 22.44 | 24.99 |
| 7 | 17.83 | 20.09 | 23.67 | 26.31 |
| 7¼ | 18.71 | 21.86 | 24.85 | 27.66 |
| 7½ | 19.58 | 22.91 | 26.04 | 29.00 |
| 7¾ | 20.04 | 23.96 | 27.27 | 30.39 |
| 8 | 21.39 | 25.04 | 28.52 | 32.00 |
| 8½ | 23.85 | 27.25 | 31.06 | 34.67 |
| 9 | 25.15 | 29.50 | 33.67 | 37.61 |
| 9½ | 27.11 | 31.82 | 36.33 | 40.63 |
| 10 | 29.12 | 34.22 | 39.10 | 43.77 |
| 10½ | 31.18 | 36.67 | 41.92 | 46.97 |
| 11 | 33.27 | 39.20 | 44.83 | 50.71 |
| 11½ | 35.58 | 41.77 | 47.81 | 53.62 |
| 12 | 37.45 | 44.40 | 50.86 | 57.08 |
| 12½ | 39.49 | 47.16 | 53.99 | 60.63 |
| 13 | 41.96 | 49.86 | 57.19 | 64.24 |
| 13½ | 44.57 | 52.69 | 60.45 | 67.94 |
| 14 | 47.06 | 55.57 | 63.80 | 71.74 |

*Short Truck Bolster.*—In some designs of trucks the springs are not placed under the arch-bars, but are located about 27 in. from the center of the truck. In this case the bolster is much shorter and need not be made so strong. The method of analysis is precisely the same as before and need not be gone over again. The maximum load $L_1$ is, in this case, 39,100 lbs. for 60,000-lb. cars, 50,200 lbs. for 80,000-lb. cars, and 61,300 lbs. for 100,000-lb. cars. The maximum moment on these bolsters at a point 4 in. to one side

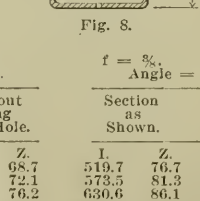



Fig. 8.

| | f = 5/16. g = ⅜. Angle = 3x3x5/16. Section as Shown. | | Without King Pin. Hole. | | f = 5/16. g = 7/16. Angle = 3x3x5/16. Section as Shown. | | Without King Pin. Hole. | | f = ⅜. g = ½. Angle = 3x3x⅜. Section as Shown. | | Without King Pin. Hole. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. |
| 11½ | 445.3 | 64.8 | 460.9 | 65.5 | 449.7 | 67.5 | 468.9 | 68.7 | 519.7 | 76.7 | 539.4 | 77.6 |
| 12 | 490.8 | 68.6 | 507.5 | 69.4 | 492.2 | 70.9 | 511.8 | 72.1 | 573.5 | 81.3 | 595.3 | 82.3 |
| 12½ | 537.8 | 72.4 | 555.9 | 73.1 | 542.4 | 75.2 | 562.6 | 76.2 | 630.6 | 86.1 | 654.3 | 87.2 |
| 13 | 587.7 | 76.3 | 607.4 | 77.0 | 594.2 | 79.4 | 616.1 | 80.5 | 690.9 | 90.8 | 716.6 | 92.0 |
| 13½ | 641.3 | 80.3 | 661.0 | 81.0 | 649.0 | 83.8 | 672.7 | 85.0 | 754.8 | 95.9 | 782.8 | 97.2 |
| 14 | 694.6 | 84.1 | 717.8 | 85.0 | 706.7 | 88.9 | 732.4 | 90.1 | 821.0 | 100.7 | 851.1 | 102.2 |
| 14½ | 751.5 | 88.0 | 780.7 | 89.4 | 767.2 | 93.0 | 794.8 | 94.3 | 891.7 | 105.9 | 924.3 | 107.4 |
| 15 | 813.2 | 92.3 | 846.0 | 94.4 | 833.0 | 97.4 | 862.7 | 98.8 | 966.2 | 111.2 | 1000.2 | 112.7 |

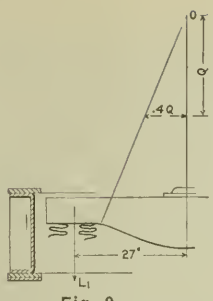


Fig. 9.

of the center is 581,000 in. lbs. for 60,000-lb. cars, 746,000 in. lbs. for 80,000-lb. cars, and 911,000 in. lbs. for 100,000-lb. cars.

*(To be continued.)*

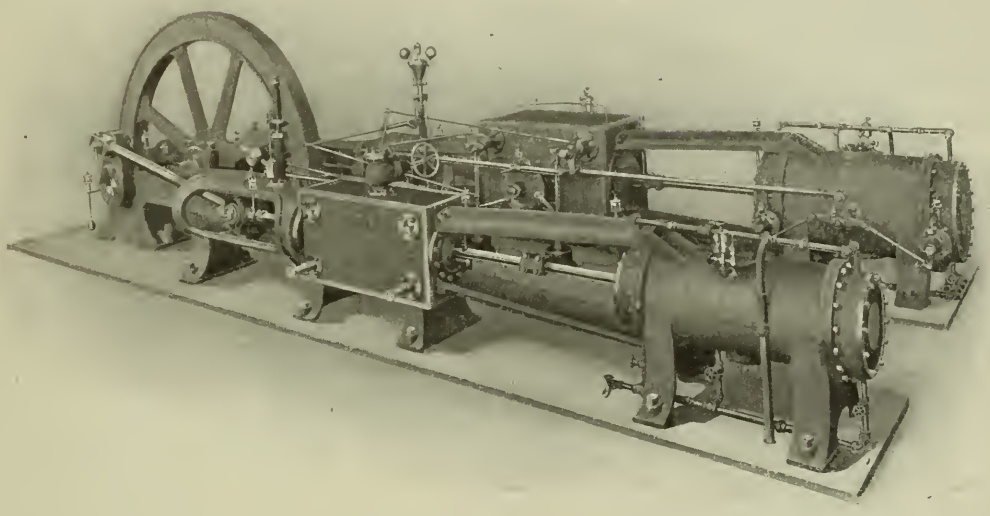
## Sullivan Air Compressors for Railroads.

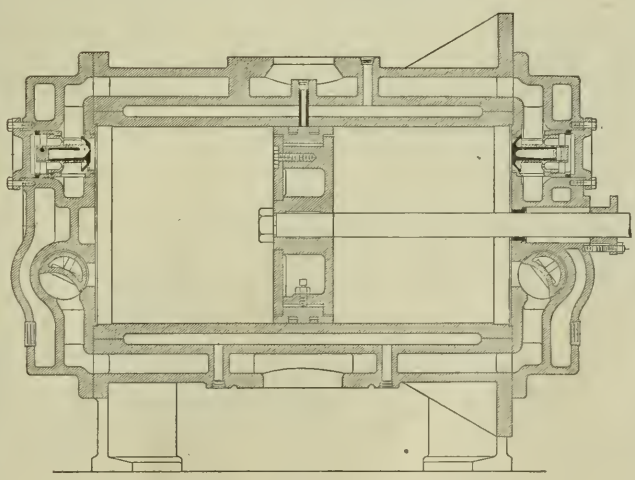
Careful design and construction and high economy of operation are claimed for the compressor shown in the engraving, which is the Sullivan cross-compound two-stage type. The cylinders are made of semi-steel. The studs and cap screws on the cylinder heads, valve gear, etc., are steel, and the nuts are steel, case hardened. A steam-jacketed receiver and reheater is placed between the high and low-pressure cylinders, as at low speeds condensation would be great without these accessories. The bonnets and the steam and exhaust valve levers are semi-steel. All rods in connection with the valve motion and dash-pots are made of machinery steel, turned and polished. The rods have phosphor-bronze key heads at both ends which are adjustable for wear by means of wedge blocks and set bolts. The dash-pots are semi-steel, ground with emery to an air-tight fit, so that no packing is used. The valves for the steam cylinders are semi-steel attached to the T-shaped heads of the valve stems so as to follow up wear automatically. The ends of the steam and exhaust valves toward the back of the cylinders are provided with eye-bolt holes, so that the valves may be removed through the back bonnets with eye-bolts provided for that purpose, without disturbing the valve setting. The valve stems are forged steel.

The steam governor is provided with an oil cushion cylinder and an automatic device, which stops the compressor in case the governor belt breaks. The automatic air governor operates in connection with the steam governor and automatically controls the speed of the engine. The engine frames are the girder type. The construction of the air cylinders is shown in the accompanying engraving. The cylinder casting and liner are separate, the liner being made of semi-steel. These loose liners are pressed into the bored-out cylinders with hydraulic pressure after the ends of the liners are turned to fit the cylinder bore. The end of the cylinder flanges and liners are then faced off to the same length. The loose liner is claimed to be preferable to the one-piece construction, as all shrinkage strains are avoided, and in case of injury to the liner a new one may easily be put in. Each air cylinder and head is water jacketed over its entire surface.

The pistons are semi-steel with adjustable bull rings so that the piston rods may be adjusted to line central with the engine cylinders and guide. The piston rods are hammered open-hearth steel. The intercooler between the two air cylinders is placed below the floor line. The air from the intake cylinder enters at the top of the intercooler and leaves it at the bottom, allowing accumulated moisture to be drawn off by a drain cock. The air cylinder heads are semi-steel, and water-jacketed, and contain the valve seats for the intake and discharge valves. The intake valves on both cylinders are rotary, or Corliss, type, mechanically operated by means of independent eccentrics on the engine shaft. The air outlet valves on both cylinders are the poppet type, cushioned to work without noise. The valve and valve seat, which are made of phosphor-bronze, are inside of a removable cage, and held in place by a hand hold plate. When this hand hole plate is removed, the valve cage containing the valve and seat may be removed with the hands. The pressure of the plate forms a tight joint between the cylinder head and the valve cage. Thus, when the valve seat becomes worn or leaky, it may be removed, together with the valve and cage, without disturbing the cylinder head, and a spare valve and case inserted. The worn valve seat may then be ground and fitted.

These compressors are built by the Sullivan Machinery Company, Chicago. This company also builds several classes of a straight-line type, including belt-driven designs, which are also suitable for railroad shops.


The Sullivan Air Compressor.


Air Cylinder—Sullivan Air Compressor.

## Local Freight Agents' Association.

The seventeenth annual meeting of the American Association of Local Freight Agents' Associations met in Peoria, Ill., June 14th; President C. H. Newton in the chair. The delegates and their families were welcomed by Mayor Woodruff. Congressman Joseph V. Graff delivered an address on "Railroads and Our Country's Development," and Editor Baldwin, of the Peoria *Evening Star*, on "Who Pays the Freight?"

Most favorable reports were received concerning the condition of the association. During the year the following associations have been received into the Inter-American Association: St. Paul, 13 members; Pekin, 7 members; Erie, 6; Seattle, 9, and Dallas, 5. The following associations were dropped for lack of interest and non-payment of a small per capita tax: Lima, Canton-Massillon (one) and Waverly, leaving a membership of 72 local associations with an individual membership of 765. The treasurer has $1,300 on hand and owes nothing. A change was made in the constitution so that the American Association will henceforth recognize in its sessions only those actually in

charge of freight stations or piers, who shall be listed as active members. Car service managers, inspection bureau and commercial or soliciting agents, will have no voice.

The following topics were discussed by the convention, each being proposed by members from the city named: *St. Louis*—"Why Should Loaded Cars be Rejected by Connections on Account of Bad Order, Shifted Load or Over-load?" The proposer argued that the expense of transfer was the same whether performed by one line or another and that fewer cars would be transferred if the expense were borne by the receiving line; and the apparent injustice would equalize itself. The association, however, decided by a close vote that such cars should not be rejected but be received and transferred by the receiving line, and the expense paid by the delivering line.

*Cleveland*—"What is the Best Method of Conveying to Switching Crews Instructions for Switching Cars at Large Terminals?" The practice at many large centers was brought out and each was given as the best that that association had been able to devise. To discover a "best" that might be suited to different conditions, the subject was turned over to the incoming Conference Committee for a recommendation.

*Peoria*—"Best Seal." A collection of seals in use was exhibited. There was considerable discussion, but no unanimity of opinion, and this subject also was given the Conference Committee for a recommendation.

*Louisville*—"Uniform Blank for Recording Passing Inter-line Way Bills at Terminals." It was unanimously voted that this would be a good idea and the secretary was instructed to take up with the Accounting Officers' Association and ask it to provide a form.

*Des Moines* desires "an improvement in billing, that all information, including marks on packages be shown on bills of lading, full name of shipper, point of origin, rates, divisions in full; that the freight bill at destination have exactly the same information shown on B. L." The proposition was agreed to but the subject was referred to committee.

*Chicago*—"Classification on dry goods, boots and shoes, hats and caps, underwear, gents' furnishing goods, clothing, millinery and liquor in cases when packed in second-hand, or re-coopered cases should be given a lower class when corded and sealed." A former attempt failed to get a ruling that boots and shoes be corded and sealed; but all agreed that from their experience such an inducement would save the transportation companies in claims more than enough to justify the loss in revenue from the slight reduction in rate. The committee will make an effort to bring about the necessary change in classifications.

*Pittsburg* proposed a sliding scale car service (demurrage) charge, increasing with the number of days' detention. This proposition developed a two hours' discussion of the car service rules of different sections. Varying conditions prevent uniformity in application of rules, but it appeared that the greatest hindrance to good results was the interference by traffic or other officials through a lack of confidence in competitors. Where a better confidence has been established the rules are more effective and are satisfactory to both consignees and railroads. The association voted that the established uniform rate of one dollar a day is preferable to the proposed sliding rate, except that vegetables and fruits might be made exceptions where conditions require a more prompt movement.

*Lincoln*—On the recommendation of Lincoln the association voted that L. C. L. shipments should be weighed when conditions will permit; also that when possible freight should be received, weighed, checked and loaded at one handling.

*Wheeling*—"Does the training which a local freight agent receives in the faithful performance of his duties qualify him for a promotion in any other, and in what departments?" The association agreed that if the individual possessed executive or other proper qualifications, his training as an agent especially fitted him for promotion in the transportation, traffic or accounting departments.

It was recommended to the Master Car Builders in the Western, Southern, Official and Canadian Classification districts that in future doors of box cars, 36 ft. long or longer, be made 6 ft. in width.

*Detroit* recommended that to secure the return of chains to point of origin they be regularly billed, showing as freight the value of chain; on the return this sum could be entered as charges. This was adopted as the sense of the association.

*Savannah* presented an able paper, affirming the perfectly successful use of the manibill, but in view of its discontinuance by the Baltimore & Ohio, for causes given by some of the agents of that road, the association voted that it was without sufficient information to either approve or condemn it. Many expressed a firm belief in its ultimate success, if adopted with the full purpose to use it and adopt it entire; modifying the accounting methods to suit its use.

The election of officers resulted as follows: C. H. Newton (Wabash), Toledo, President; G. W. Dennison (Penna.), Toledo, Secretary; J. H. Dunlevy (P. R. R., 23d St.), Pittsburg, Treasurer.

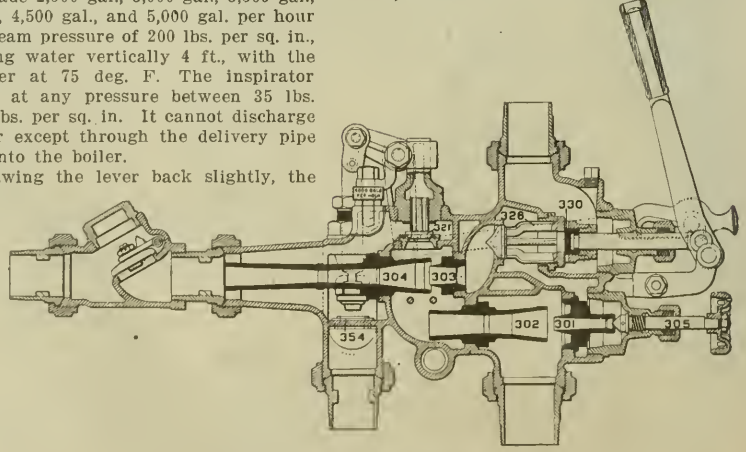
All these were re-elections. Mr. M. A. Wheeler (L. E. & W.), Peoria, was elected Vice-President, and Minneapolis was chosen as the place for the next meeting, June 13, 1905.

This convention was of much interest throughout, 40 associations being represented by 140 delegates. An inspection of terminals by special train, trolley rides and visits to public institutions, provided entertainment for the members and their wives. At the close, the Chicago, Peoria & St. Louis tendered a special train to St. Louis to those returning by way of that city, and nearly all availed themselves of it to attend the World's Fair.

## The Hancock Inspirator.

The Hancock locomotive lifting inspirator type "E" is shown in the accompanying illustration. By changing the nozzles and tubes only, the capacity of the inspirator can be made 2,500 gal., 3,000 gal., 3,500 gal., 4,000 gal., 4,500 gal., and 5,000 gal. per hour with a steam pressure of 200 lbs. per sq. in., and lifting water vertically 4 ft., with the feed water at 75 deg. F. The inspirator will feed at any pressure between 35 lbs. and 350 lbs. per sq. in. It cannot discharge the water except through the delivery pipe leading into the boiler.

By drawing the lever back slightly, the lifter steam valve (330), is drawn from its seat, allowing steam to flow through the lifter steam nozzle (301), and through the lifter tube (302), thus lifting the intermediate overflow valve (321). The steam then passes through the opening in the final overflow valve seat (354), and the overflow pipe to the atmosphere, thus lifting the water. As soon as the water is lifted, it fills the body or shell of the inspirator. The lever is then drawn back, opening the forcer steam valve (326), allowing the steam to flow through the forcer steam nozzle (303), where it is condensed by the water in the forcer combining tube (304), driving the water in this tube with sufficient force to close the auxiliary overflow valve (321), and to overcome the boiler pressure. The lifting apparatus constantly forces the water to the forcing apparatus, and when the lever is fully drawn out, the final overflow valve (326), closes on the seat (354), and diverts the water from the overflow into the boiler. The capacity is regulated by the regulating valve (305), which increases or decreases the amount of steam going to the lifting apparatus. The stems are made of Tobin bronze, and all the nozzles, tubes, valves and valve seats are of a composition which does not contain any zinc. The inspirator is made by the Hancock Inspirator Company, New York.




The Hancock (Type E) Inspirator.

## Stay-Bolt Iron*

The high pressure and large boilers now used have increased the breakages of stay-bolts, and have given rise to many devices for overcoming the difficulty. The two principal difficulties are: (1) Leakage, (2) Breakage. Breakages are caused by the vibration due to unequal expansion of the inside and outside sheets. The object of flexible stay-bolts is to provide for the vibration. Such stay-bolts have not proved altogether satisfactory for the reason that with incrusting waters the ball joint becomes filled with scale and becomes rigid. They are also expensive to apply and to maintain, and usually give more trouble from leakage than the ordinary stay-bolt because the thread in the fire-box side is apt to be stripped in driving, inasmuch as there is less support for holding on, and also because of the tendency to drive them when in service without taking off the caps so as to enable the workman to hold on to the bolt.

Designers have been trying to reduce failures by increasing the length of the bolts and by decreasing their diameter. There

*Abstract of a paper by H. V. Wille, read at the Atlantic City meeting of the American Society for Testing Materials.

are several reasons why a ⅞-in. bolt should last longer than the 1-in. bolt, notwithstanding the fact that it has a smaller area. Stay-bolts are not loaded to a definite fiber stress (in which case the bolt of larger diameter would be the more serviceable), but they are deflected through a given angle, and the amount to which they are deflected cannot be altered by any increase in strength or in diameter. Inasmuch as the angle through which the axis of the bolt is bent is independent of the diameter of the bolt, the outer fiber of the smaller bolts and a crack will thus start sooner in the 1-in. bolt than in the ⅞-in. bolt. The time between the starting of the crack and the breakage of the bolt will be greater for bolts of large diameter than for bolts of small diameter. However, the bolt which remains in service the shortest time after a crack is started is the more desirable bolt, for after it is cracked, the sooner it is removed the better.

A cable composed of a large number of strands will bend and twist many times without breaking, although the tensile strength is very much less than the strength of a solid bar of the same diameter. The nearer we approach to this condition in boiler design the less trouble we will have. Boilers have been built with bolts of ¾-in. diameter, but the bolts were spaced more closely than is usually the practice.

Small bolts also have an advantage in heading, for the hard hammering necessary to head a bolt of large diameter or of hard iron is liable to strip the thread of the bolt. Bolts of small diameter will not require heavy hammering and will therefore probably give less trouble from leakage than bolts of large diameter. Furthermore, the head of the bolt of small diameter would not be heated to as high a temperature as the bolt of large diameter, because it is more readily cooled by the water, and hence it would not expand as much. When the metal in the bolt expands it enlarges the hole in the sheet and puts a permanent set in the sheet and thus causes leakage. Another advantage in the use of bolts of small diameter is that they can be replaced many times without greatly increasing the diameter. The life of the fire-box would thus be increased. The future will probably see the more general use of ¾-in. bolts with closer spacing. The present practice of using a ⅞-in. bolt is a compromise between the most advanced and most conservative practice. An analysis of the stress in stay-bolts shows that the extent to which the bolt is strained increases in direct proportion to the diameter and decreases as the square of the distance between the sheets. Assuming as a basis a stay-bolt 1 in. in diameter and deflected .03 in. and a distance between sheets of 6 in., we find that the bolt has a fiber stress of 35,000 lbs. per sq. in. If the diameter is reduced to ¾ in. the stay-bolt is strained to but 26,250 lbs. By decreasing the distance between the sheets to 5 in. the bolts are strained to 50,400 lbs. for the 1-in. bolt, and 37,700 lbs. for the ¾-in. bolt. These results show very clearly the cause of stay-bolt breakage and what should be done in order to reduce the trouble to a minimum, namely make the water space as wide as possible, and use a small bolt with a closer space if necessary.

A few railroads have recently specified very high tensile strength for stay-bolt iron. The question arises, is the tensile test a proper one upon which to rate stay-bolt iron? If a member is subjected to a direct tensional strain or a definite load a high tensile strength or elastic limit is desirable because it gives a high factor of safety. If, however, a member is subjected to a definite deflection then the stiffer the iron, the greater the load necessary to produce this deflection. In other words, a bolt of high tensile strength is subjected to a higher fiber stress than a soft bolt of low tensile strength. It is for this reason that steel gives excellent results in axles, etc., which are loaded to a definite fiber stress, but it will not answer for stay-bolts which are bent through a given angle. The manner in which the iron is piled and rolled plays a far more important part in the life of the bolt than the tensile strength, and after many experiments, those who have given the subject thought have decided upon a fagotted bar-piled iron. The central core is composed of a number of bars, approaching in appearance a bundle of wires. This core is enclosed by an outside sheath of metal with circular fibers. This insures a good thread and prevents the bolt being strained in a direction at right angles to the fibers. A soft ductile iron piled in this way undoubtedly gives better results than a hard iron of high tensile strength piled in the usual slab form. Stay-bolt iron made in this manner may be strained by bending in a direction at right angles to the fibers, and it would then have a very low life.

This subject has been thoroughly demonstrated by making vibratory tests of various makes of stay-bolt iron, and the results obtained in the vibratory machine have been confirmed by practice. The writer's attention has recently been directed to a marked difference in the life of stay-bolts on two groups of engines of precisely the same design and in operation on the same division. Upon investigation it was found that a very high-priced special brand of high tensile strength stay-bolt iron was used in the engines which gave trouble, while a good grade of well piled soft and ductile iron was used in the engines which were giving good service. The requirements specified by a number of roads in this country, follow:

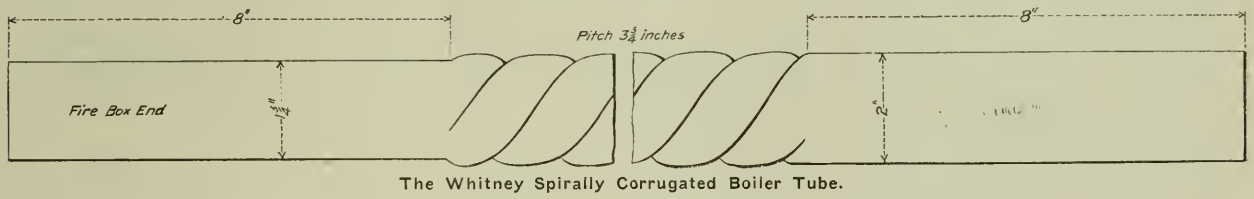
| Road. | Tensile strength. | Elongation, per cent. |
|---|---|---|
| Atchison, Topeka & S. Fe.. | 48,000 | 28 in 8 in. |
| Baltimore & Ohio..... | 48,000 | 25 in 8 in. |
| Chesapeake & Ohio..... | 48,000 | 25 in 2 in. |
| Burlington & Missouri River | 48,000 | 30 in 2 in. |
| Chicago, Burlington & Q... | 49,000 | 28 in 8 in. |
| Lehigh Valley ..... | 50,000 | 30 in 4 in. |
| Missouri Pacific ..... | 47,000 | 26 in 8 in. |
| Mexican Central ..... | 48,000 | 25 in 8 in. |
| New York Central..... | 48,000 | 28 in 8 in. |
| Norfolk & Western..... | 48,000 | 25 in 8 in. |
| Pennsylvania ..... | 48,000 | 25 in 8 in. |
| Philadelphia & Reading.... | 46,000 | 45 in 2 in. |
| Seaboard Air Line..... | 48,000 | 25 in 8 in. |
| Southern ..... | 52,000 | 28 in 8 in. |
| Harriman associated lines.. | 52,000 | 28 in 8 in. |

It is almost universal practice to specify 48,000 lbs. tensile strength, it being generally realized that an iron is thus secured which is strong, which will take a good head without hammering enough to strip the thread, and which will withstand the alternate bending.

A stay-bolt should be tested in a manner similar to which it is strained in service. Some years ago this matter was thoroughly agitated, and a large number of experiments were made with make shift apparatus. The results varied widely largely because of the different methods of holding the bolt, and because the bolts were vibrated in one plane. Very good results would be obtained if the bolt was vibrated in a plane parallel to the direction of piling, while very poor results would follow if it were vibrated at right angles thereto. A machine has been designed to record the number of vibrations of a given amplitude which a test-bar will withstand. It is especially adapted to the requirements of stay-bolt testing, and will hold stay-bolts from 3 in. to 8 in. long. The upper end is held rigidly while the lower end is given a circular vibratory motion, which can be adjusted from zero to a circle of ⅜-in. in diameter.

## New Boiler Tube.

The accompanying illustration shows the Whitney corrugated boiler tube. The makers of this tube claim greater heating surface and a longer life than that of the ordinary straight tube; also freedom from live sparks and leaky ends. The hot gases are retained longer with this tube than with the straight tube on account of the rotating motion induced by the spiral form of the tube. The tube is naturally elastic, due to its spiral form, which relieves the strain on the flue sheets and prevents leakage at the flue ends. Tests made show that it will stretch ⅜ of an inch in 16 ft. before the elastic limit is exceeded. The fire-box end of the tube is drawn out for a distance of 8 in., and is made one to 1½ gages heavier than the body of the tube. This prolongs the life of the tube, inasmuch as the fire-box end of a tube is subjected to much severe service. The fire-box end of the tube is smaller in diameter than the other end. This increases the circulation around the fire-box flue sheet. These tubes have been tried for five years on a number of roads and they have given satisfaction. They are made by the New Jersey Tube Company, Newark, N. J.




The Whitney Spirally Corrugated Boiler Tube.

## Ideal Car Service (Demurrage) Report.*

Notwithstanding the fifteen years' experience, there is still a great deal of diversity in the office methods and accounting of the Car Service Associations. In no respect is this greater, perhaps, than in the form of agents' daily car reports. Some require cars to be reported upon arrival and repeated, as each subsequent movement occurs, until the car is released. Others require cars to be reported upon arrival and not again until released. Still others (and the great majority) do not have any report made of the car until it is released, when the whole record is shown. Some managers have a report of all cars on hand once a week, some a report of all cars when they have been on hand six days, and others (the great majority) get no report, as stated before, until cars are released.

The thing most needed is an agent's daily car report, to include all cars on hand each

*Paper read before the National Association of Car Service Managers at Niagara Falls, June 16, by A. L. Gardner, of Baltimore.

day, and show the location of cars at the time the report is made; whether or not placed for unloading, and whether the delay is on the part of the railroad or consignee, and how much belongs to each. It is generally conceded that such a report is highly desirable; but it has not been adopted because of the objection raised by agents to the amount of labor involved in its preparation under the present system of entering all arrivals in the car service record book in date order. This objection can be overcome by abandoning the car service record book, and using as a substitute one carbon copy of the previous days' report, as described further on.

It should be remembered that upon arrival each car is entered in the book on the date it reaches destination. Then when the car reaches delivery track the original entry in the record book must be located, and the date and hour of placing the car entered in the proper column; and again when the car is released must this original entry in the book be found and date and hour of unloading entered. A third search in the book and entry in the "Ordered" column must be made for all cars that are held on arrival awaiting disposition of shipper or consignee. To prepare his daily report the agent must take the entries of cars released during the preceding 24 hours from the record book, turning the pages from entry of the oldest car released, until he has gone through the book to the latest arrivals, which involves the expenditure of more time in locating in the book the cars to be reported than in the actual making of the report.

In starting the new system the agent should make a complete inventory of all cars on hand at 6 p. m. on a given date. These cars should be entered on the daily report form in order of arrival, and complete data should be shown for every car in each column of the report, if released at that time; or, if not yet released, but in position for unloading, the entry will stop at "Placed" column; and if not yet placed, the entry will so state and in proper column will be shown "why not placed." This report should be made in duplicate, with indelible pencil, with the aid of carbon paper (two or more carbon copies may be made at the same writing, to be used as suggested below).

The carbon or duplicate copy of the preceding day's report becomes the basis for report of the next day. All changes of position of cars not yet unloaded, and the time of release of any that have been unloaded, should be noted on this carbon copy (instead of making entries in the book, as at present); thus when these changes have been noted, all that is necessary is to copy the amended form on a fresh sheet, and, after all entries have been taken from the old sheet, to enter the current day's arrivals, omitting, of course, all cars reported as released the preceding day.

The advantages of this system are:

First—The agent may have for his own information a complete inventory of all cars on hand, revised every 24 hours, and this without any cost in labor. Some stations may have such an inventory now, but if so, the labor of preparing it is in addition to that of making the car service reports. Were such an inventory made daily for the agent, he would have before him a record of each and every car on hand every day, and steps could be taken to hurry the placing or unloading by calling attention of yardmaster to cars not placed; of Superintendent or Freight Claim Agent to cars on hand unclaimed or refused, and by duplicate notices (or telephone) to consignee of cars which in the judgment of the agent were being unduly delayed.

Second—That a second carbon copy may be made, without any cost in labor, and sent each day to the Division Superintendent for his information. From this copy he may know what cars are at each station on his division and whether in position and under charge for detention or not. Such a report would be a valuable addition to the information already received by Superintendents and would enable them to reduce the delay to cars on their division, particularly delay in placing for delivery.

Third—Such a method of reporting cars would assist inspectors in checking stations. Instead of comparing their list of cars noted on tracks they would refer to carbon copy of preceding day's business (amended as above), which is in more compact form. To illustrate: At one of our largest stations it takes the inspector two days to make a round of all the delivery tracks and sidings, list the cars he sees and note the condition of contents. To check this list against the agent's record book consumes three additional days, and then the inspector does not know that cars have been reported as entered in book. To determine this it is necessary to check the list in the Manager's office against the agent's reports. If the system advocated were adopted, but one checking would be necessary, and this could all be done by the inspector in about one-sixth of the time required by the present method.

Fourth—The Manager may receive each day a complete statement, for each station, of all cars on hand; and for those not yet released this report will show who they are for, whether placed on public or private track and if not in position for unloading whether the delay is on the part of the railroad or consignee. The desirability of having this information each day is obvious. In fact, it may be said that without such a statement, the manager is not in position to know that the rules are properly enforced by all interests alike.

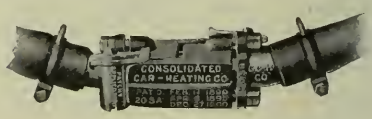
Fifth—It is believed that the system proposed could be operated without any additional labor or expense in the agent's office, and that the work necessary to transfer cars on hand to the new sheets each day, is more than offset by the time consumed in finding cars in the record book for final entries and transfer to report. Instead of having cars on hand scattered over 50 or 100 pages of a record book, they would be confined to from 6 to 10 sheets even at the largest stations; and at most stations to a single sheet.

A prominent transportation official recently said that, "Now, more than formerly, officials in charge of operation are keeping in close touch with cars and car movements, as their handling is the most important factor in transportation." This doubtless has reference more particularly to the movement and handling of cars in transit, but I have yet to hear of any detailed system of locating and checking delay to cars standing under load at stations and terminals. The Car Service Association is usually only furnished with sufficient force to partially check the more important stations, and the Manager can (and doubtless most managers do) report a considerable number of the more aggravated cases of delay and inattention to the proper officer of the road interested; whereas, by the system herein proposed the Superintendent is furnished a report of every car under load at each station day after day, *while the delay is occurring*, and when the trouble can be noted and corrected. It has been truly said that "no system, however perfect, will run itself, and that the ablest and most trustworthy employee will perform letter service if his work is carefully and regularly checked."

The latest word from high official quarters seems to be to the effect that the Car Service Associations should not be satisfied with getting cars released within the free time, but that their aim should be to secure their release as much inside of the limit as possible. Of course, no one should be satisfied with anything short of the very best, but it should not be overlooked in this connection that consignees have been releasing their cars with an average of about one day and a quarter, and we hardly think this record can be much improved under present conditions, although, with increased terminal facilities and careful supervision of the details of operation, there is no doubt that the detention to cars, both by railroad and consignee, can be still further reduced.

## The Sewall Automatic Lock Coupling.

The accompanying cut shows a pair of 1½ in. steam couplings of the Sewall type, with automatic locks, made by the Consolidated Car Heating Co., Albany, N. Y. These couplings are interchangeable with the smaller sizes, but where intended to couple with 1⅛




Sewall Automatic Lock Coupling.

in. couplings, gaskets are used having a somewhat reduced opening. The automatic lock prevents uncoupling or leakage of steam due to the rigidity of 1⅝ in. hose. These results are also obtained when but one of the couplers is fitted with the locking device. The locks do not interfere with the automatic uncoupling, in the event of the train parting. This device is also made in the form of a clamp lock which can be applied to old couplings.

## Railroad Telegraph Superintendents.

The 23d annual convention of the Association of Railway Telegraph Superintendents met at Indianapolis, June 15, President Charles S. Rhoads (C. C. C. & St. L.) in the chair. Mr. Rhoads delivered a brief address congratulating the Association on the fact that it was more prosperous than ever before. Hon. J. W. Holzman, mayor of Indianapolis, welcomed the delegates to the city, and Mr. Charles Selden, superintendent of telegraph of the Baltimore & Ohio, responded. After the transaction of some routine business 12 new members were elected; also 3 associate members and 4 honorary.

At the afternoon session there was a paper on the "Telephone in Railway Service," by A. G. Francis, of Chicago, railroad agent of the Chicago Telephone Company. Among other subjects, Mr. Francis discussed the equipment of railroad signal towers. The discussion on the paper was participated in by almost every member present. It was shown that trains are moved successfully on telephonic train orders on many railroads, and up to the present time there is no record of an accident traceable to the use of the telephones. The subject of the paper was referred to a committee with instructions to bring it before the American Railway Association, looking to action permitting the movement of trains on telephonic orders. The committee appointed for this purpose consists of Messrs. Charles Selden, Baltimore; E. P. Griffith, New York, and J. H. Jacoby, South Bethlehem, Pa.

The next paper was by F. G. Sherman, of the Central of New Jersey, on "The Economic Use of the Commercial Telegraph by Holders of Telegraph Franks Issued on Account of a Railroad Contract." This paper

also was discussed at great length, and many abuses of the articles of contract were told of.

At the evening session the members listened to a paper by J. B. Taltavall, on "The Telegraph Operator in the Railroad Service," which was given in the *Railroad Gazette* last week. The discussion that followed showed that the working of the telegraph could be improved without increasing expense, and many superintendents of telegraph told how their respective roads had improved the worth of the individual operator.

Mr. William Kline, of Toledo, O. (L. S. & M. S.), explained a local telephone system operated by nine railroads in Toledo to facilitate the exchange of business between the different companies. He said that since its establishment the movement of traffic had been greatly expedited. Mr. Griffith (Erie), chairman of the Committee on Composite Circuits, read a report on the subject which named the railroads in the United States at present using composite circuits, and also the results attained in each case. The discussion was taken up by Messrs. Jacoby (L. V.), Rhoads (C. C. C. & St. L.), Selden (B. & O.), Van Etten (C. & E. I.), Millington (Michigan Central), Hope (Chicago, St. P., M. & O.), Weidman (Pere Marquette), Ryder (C. B. & Q.), Parsons (I. C.) and others. This discussion was kept up till 10:30 p. m.

On the second day Mr. M. J. O'Leary, of New York, secretary of the Telegraphers' Mutual Benefit Association, was given an opportunity to explain the good work accomplished by that organization in the interests of the telegraph profession. Many of those present were members, and assurances of hearty cooperation were given.

Papers were read on the "Typewriter in the Telegraph Service," by L. S. Wells (Long Island), and on "Recent Improvements in Wireless Telegraphy," by William Maver, Jr. Mr. Rhoads, chairman of the Committee on Cipher Code, reported that the American Railway Association had ordered printed an elaborate cipher code that could be utilized in the transaction of business by all departments of railroad service.

Chattanooga, Tenn., was selected as the place of meeting next year, the date being fixed for May 17. H. C. Hope (C., St. P., M. & O.), St. Paul, Minn., was elected president, and E. E. Torrey (Mobile & Ohio), vice-president; and P. W. Drew (Wisconsin Central), Milwaukee, Wis., was re-elected secretary-treasurer.

The entertainments provided for the members included trolley rides around the city, an excursion on the Belt Line railroad dinner at the Columbia Club, and a trip to St. Louis, over the "Big Four."

EXHIBITS.

J. H. Bunnell Company, New York.—A full line of telegraph apparatus, including the Leech combination resonator and stand, the Ghegan automatic repeater, a new type of star zinc and hanger and a new straight-line tapping clamp.

C. P. Chenault, of Frankfort, Ky.—Sound magnifier for relays, the invention of Mat Hacker, of Irvine Ky.

An Adams-Randall composite circuit set was shown in full operation; the object of this device is to increase the initial energy of telephone currents to suit conditions.

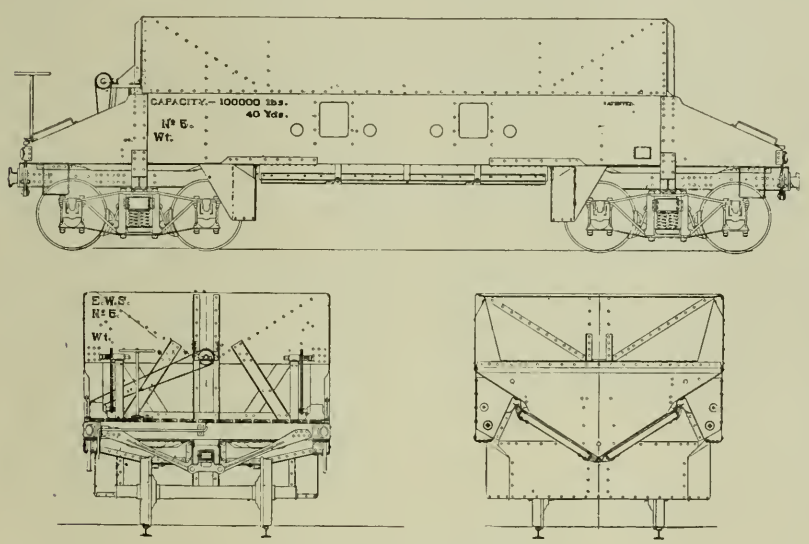
C. K. Jones, Quincy, Ill.—Automatic telegraph circuit protector and signaling machine. This apparatus was described in the *Railroad Gazette* of July 3, 1903, p. 499, and Mar. 4, 1904, p. 158.

Safety Insulated Wire and Cable Company, New York.—Insulated wire.

G. M. Dodge, Valparaiso, Ind.—Automatic telegraph sender, a device which transmits Morse characters for learners.

## The Summers Gravity Dump Car.

The illustrations herewith show a gravity dump car invented by Mr. E. W. Summers, Pittsburg, Pa. The design is not a convertible car, but the load can be dumped either between the rails or on both sides of the track. The operator discharges the load and closes the door from the operating platform at the end of the car without stopping the train. The doors do not extend beyond the clearance limits, and all material is discharged clear of the track. The floor of the car from truck to truck is formed by a single pair of doors, which form a V-shaped bottom. These doors are hinged on both edges so that they serve as a floor in the car and as a chute bottom for conveying the load in either direction. Any material that can be handled with a steam shovel will pass through the door openings at either side of car or in the center, the large openings permitting a quick discharge of the load. The doors are controlled and lowered by means of worm gearing, which enables the operator to distribute ballasting material in the quantity desired, the doors standing in any intermediate position between closed and full open. The sides of the car are deep and a large top flange area is provided to take care of the compression due to a vertical load. The lower part of the sides is heavy box section and the cross beams are deep. Each door is supported on four ⅝ in. coil chains. The chains and shafting are protected from the lading by the double web floor-beams, the doors only being exposed. The car has a capacity of 100,000 lbs. and a cubic capacity of 40 sq. yds. A number of these cars are being built by the Pressed Steel Car Company.




The Summers Gravity Dump Car.

## Demurrage Managers' Convention.

The sixteenth annual meeting of the National Association of Car Service Managers was held at Niagara Falls, June 16 and 17, the president, J. C. Loomis, of Louisville, Ky., in the chair. There was a large attendance, representing nearly all of the 40 Car Service Associations of the country. After roll call, the meeting was addressed by Mr. C. Peter Clark, Vice-President and General Manager of the Buffalo & Susquehanna, and a member of the Car Service Committee of the American Railway Association. Mr. Clark spoke on car service matters in general, and referred particularly to the difficulties encountered in distinguishing between a railroad proper and an industrial railroad.

The President's address contained some recommendations relative to uniform reports and statements to auditors, and after discussion it was resolved that a standing committee be appointed to consider the whole subject of office methods and accounting, and report at the next meeting. The committee on demurrage clause in bills of lading reported progress. No definite communication has been received from the Car Service Committee of the American Railway Association, to which this matter was referred.

The committee on uniform rules reported a set of Car Service Rules, which could be recommended as rules for universal adoption by Car Service Associations wherever the local conditions were such that they could be applied, and these rules as reported by the committee were adopted by the Association. The motion to refer this set of rules to the American Railway Association was defeated, it being the sense of the majority of the members present that owing to legislation in various states, and the promulgation of car service rules by railroad commissions, it would be impracticable at this time to recommend a uniform set of rules that could be adopted or carried out in all sections.

The much mooted error rule (each railroad company shall pay car service accruing by reason of its errors) was withdrawn by the committee, but it was subjected to considerable discussion; and a resolution was passed to appoint a committee of three to refer this question to the Car Service Committee of the American Railway Association. This committee consists of W. M. Prall, J. C. Haskell and A. G. Thomason.

A paper was read by Mr. W. M. Prall, Commissioner of the Pittsburg Car Service Association, entitled "Per-diem: as applied by Car Service Associations in their Industrial Rule." The discussion elicited by this paper was to the effect that in the minds of the members, car service and per diem are essentially different in principle, and intended to serve different purposes, and should be kept separate in their application; and it was Resolved, That the tendency which has become manifest in some quarters to substitute per-diem for car service is fraught with danger to the integrity of car service rules, and should be resisted with all our power whenever and wherever it occurs.

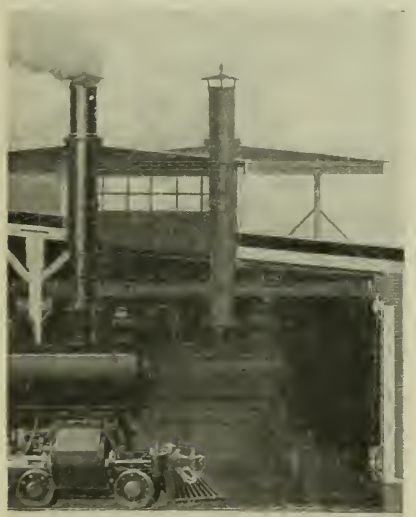
Mr. Gardner, of Baltimore, read a paper entitled "An Ideal Car Service Report," which will be found in another column. There was no discussion of this paper, the

members desiring to see it in print, and to give it careful study and consideration at home before expressing an opinion upon it.

Ashley J. Elliott, Manager of the Illinois & Iowa Car Service Association, Peoria, Ill., was elected President for the ensuing year, and Charles B. Peck, Manager of the Texas Car Service Association, Vice-President. A. G. Thomason, Scranton Pa., was re-elected Secretary and Treasurer. Washington, D. C., was selected as the place for the next annual meeting, which is to be held some time between May 3 and 15, 1905.

### Improvements in Roundhouse Design.

Roundhouse design, although considerably advanced in recent years, is still lacking in a number of respects, one of which is a satisfactory solution of the smoke-jack problem. The old fixed jack, requiring the locomotive to be set exactly on a particular spot to bring its stack directly under the center of the jack, was improved by schemes permitting more flexibility, such as swinging jacks, elongated hoods, etc. The accompanying engraving shows a more flexible arrangement than any heretofore devised. It consists essentially of a monitor having the section of roof over the pit lengthened and made movable. This section contains the jack, which may therefore have a range of movement parallel to the engine pit of almost any desired amount, but which in practice is made from 4 ft. to 12 ft. The movable section has secured to its under side two inverted T rails, weighing, ordinarily, 30 lbs. to the yard, which run on four sheaves in the top of the monitor frame. Movement may be accomplished either by means of a lever extending downward to within reach of the floor, or by chains passing over pulleys to a drum on the side of the wall. This arrangement not only avoids the need of "spotting" the locomotive under the jack, either when first entering the house or when wanting to get up steam, but also permits movement back and forth as may be required in connection with repairs made on the locomotive while hot.



Movable Roundhouse Monitor.

The illustration also shows a traveling crane. While the need and desirability of cranes in roundhouses has come to be thoroughly appreciated, their use has generally been regarded as impractical because of conflict with the smoke-jacks. This design ingeniously overcomes the difficulty by providing a multi-telescoping jack, operated by chains from a graduated drum affixed to the wall of the house. To prevent damage to the jacks through carelessness or accident, an interlocking device is provided which prevents the crane from moving up to a jack that is down, or the jack from being lowered if the crane is in the way.

The movable jacks may be applied to any roundhouse having a monitor, or on the roof of which a monitor or supporting framework for the movable roof can be built. The adoption of the traveling crane is, of course, dependent on the roof construction of the roundhouse. The scheme was devised and the appliances made by Paul Dickinson, Chicago.

### Lecture on Train Order Forms.*

The theory upon which the Standard Code rules is based is that the same order which takes away precedence from a superior train, also, and at the same time, confers right upon inferior trains.

Orders not in proper form or so worded that they are ambiguous, or which admit of different interpretations, must not be accepted, unless with the understanding that they are to be treated only as holding orders until proper orders are issued in their stead.

The word "meet" has but one simple meaning. Trains ordered to meet must go to the place of meeting, but not beyond, and must without fail wait at such place for the trains which they are instructed to meet, even though it be at the end of single track and the entrance to double track.

Trains must be positively identified; and each engineman, fireman, conductor and brakeman should assist in the identification of their train by giving its number to trains interested. The despatcher must, when necessary, add engine numbers; this is a good means of identification, unless there are duplicate numbers. Extras identify themselves when their engines can be seen. It must not be assumed that because there is a train on a siding, the engine of which is displaying a certain kind of signals, it is the train that is to be met or waited for; the true fact must be known. If in doubt about an approaching train, stop it.

Identification must sometimes be established by circumstantial evidence. If a regular train were waiting only for No. 1 and a passenger train looking like it passes on its time, displaying markers, and without green signals on the front of the engine, it may be concluded to be No. 1. If it were a passenger extra, white signals would be displayed on the front of the engine and, ordinarily, a meeting point would have been fixed with such extra, or it would have to stop to ascertain what regular train it was meeting.

To run freight trains as sections of first-class trains, especially as the first section, is confusing, and should not be done when possible to avoid it; or, if done, trains interested should be advised, or at least those likely to mistake the freight thus running as a first-class train, for some second-class train which they hold orders to meet, or to which they may be superior. Ordinarily, a train register is depended upon to indicate whether trains which are superior by right or class have arrived. When a train is made inferior to helpers, work-trains, water-trains, etc., which make several trips during a day, care should be exercised to know that such trains of superior right are met on the trip on which the order directs them to be met. Train-registering tickets (Form 56, Appendix) may in such cases be used to advantage, stating that the extra has arrived on the trip as indicated in a certain numbered order; and they are also useful when trains turn back from points where there are no train registers.

The rules do not require that the direction of extra trains be stated, except when necessary; but very little is gained by omitting the information at any time, and it would be better to habitually indicate the direction in which they are moving whenever they are mentioned.

Briefly stated, the seven governing principles relating to the movement of trains under train orders are:

First.—Meet does not mean anything but *meet*, even at the end of double track. A train is not met until the markers arrive, and until met, the waiting train may pass the meeting point only after receiving notice of the annulment of such opposing train; or after such train becomes 12 hours late; or after the order to meet is annulled; or after a new time-table takes effect while waiting, showing that there is no such opposing train; or after an order is received against such train, in which the words, "instead of" appear, thus superseding the "meeting" order.

Second.—Regular trains must be positively identified by their numbers, except as previously explained; and extra trains by their engine numbers.

Third.—Orders are in effect until fulfilled, superseded or annulled. One order does not supersede another unless the words "instead of" be added. When an order has been superseded it must not again be used. A part of an order may be either superseded or annulled, or one order may sometimes qualify another. Operators must never place on file an order addressed to a train.

Fourth.—Extra trains lose right when the last-named station mentioned in their "running orders" is reached, and they must pull into the siding at such station. Regular trains, and their sections, receiving train orders to run only to an intermediate station, lose their precedence upon their arrival at such station, and they must there pull into the siding. Every order held by such extra or regular trains becomes void upon their arrival at the last-named station to which they are directed to run, and must not again be used. Orders held by work-extras become void when the working order expires. Orders are fulfilled when trains running under them arrive at the district terminal. Helpers lose all their authority to run when they detach themselves from the train they are helping, unless they hold separate orders; and all orders held by them, while running as a part of the train which they are helping, become void when they separate from the train.

Fifth.—Time-orders make trains inferior only within the time-limits named, and the same orders confer right upon other trains to which such orders are addressed, while within such time-limits, but not beyond.

Sixth.—Trains may be created at initial stations by a clearance-card or by train orders addressed to them, but at other stations they can only be created by train-order and not by a message or a clearance-card. When a schedule is given a train, by clearance-card or otherwise, it retains its schedule between the points designated, or, in the absence of designation as to limits, to the end of its run on the district, unless such schedule is taken away from it by train order.

Seventh.—Orders not in proper form and which are not clear, if accepted, must be understood to have no further effect than as holding orders, in accordance with Rule 106, in such cases.

*From a forthcoming book on Rights of Trains on Single Track, by H. W. Forman, to be published by the *Railroad Gazette*.

RAILROAD GAZETTE

## THE MANHATTAN BRIDGE.

Elsewhere in this issue is shown a collection of drawings to illustrate the principal engineering and architectural features of the new Manhattan bridge which is to span the East river, connecting New York and Brooklyn a short distance above the old Brooklyn bridge and considerably below the Williamsburgh bridge. Without consideration, for the moment, of its engineering features, the noteworthy thing about the Manhattan bridge is the very praiseworthy effort which has been to make of this great piece of engineering work an imposing monument. In the great cities of Europe it is almost taken as a matter of course that beauty and utility must exist together in municipal works, but here in America, perhaps to a greater degree in New York than in certain other parts of the country, we have always been overtaken by our necessities. We have met the demands of the crowding population with great promptness and we have solved many new problems as fast as they have arisen, but we have been so engaged in thus considering the fundamental requirements of the growth in population that we have perhaps not always stopped to consider that our great municipal works must nevertheless stand as monuments, either of beauty or of ugliness, for generations. The use of steel, particularly of steel piers, in great bridges, tends to violate the architectural principle that for beauty's sake there should be seemingly ample support for whatever is supported. The strength of steel is so great in proportion to its section area that the eye gets a sense of inadequacy in viewing a massive roadway supported by slender towers and threadlike cables. A glance at the Manhattan bridge drawings will show how the architects, Messrs. Carrere & Hastings, have considered this and placed corbels in those places where the eye naturally seeks to find some buttress or reinforcement of the slender supports. By the pains taken in this and in other matters to treat the bridge as a monument instead of merely a traffic necessity, it loses no beauty as an engineering work, but gains the grace and dignity which befit the municipal engineering works of the greatest American city.

## RESPONSIBILITY FOR GRADE CROSSING ACCIDENTS.

It is perhaps unduly severe to say that Governor Odell, of the State of New York, is guilty of murder in any degree in the killing of Frank B. Read at Van Cortlandt Park on June 12; yet this and other frequent grade-crossing accidents were caused quite directly by him. So high-placed an officer should be presumed to have full knowledge of the fatal results of preventing the elimination of points where highways cross railroad tracks at grade. The records of years of killing and maiming at these points, increasing with increases of speed and density of traffic, were available to him, and during the years of his unfeeling opposition to this simple measure for saving life they have often been collected and presented to him in forms understandable by a most primitive mind. Nevertheless, he continues to veto the moderate appropriations needed for the fulfilment of a most beneficent law. And he kills people.

The Governor's point of view in the matter, if he has any, seems to be that grade-crossing removal is the sole concern of the railroad, and that State funds are needed for other purposes, such as escorting personally conducted parties to St. Louis. But the matter is fully covered by law, which takes into consideration the fact that many existing grade crossings date back through a long period of years to the time when the establishment of communication was the immediate necessity and the great congestion of population about large cities had scarcely begun. From the early desires of the commonwealth for means of transit and the absence of laws to the contrary, it is fair to say that the State of New York in early times assumed the responsibility for grade crossings, and it is obviously fair to suppose that some share at least of this responsibility still remains. Under the present laws if a new railroad crosses an existing highway, the expense of avoiding a grade crossing must be borne entirely by the railroad, and if a new highway is built crossing an existing railroad the expense is rightfully shared alike by the municipality which demands the highway and the railroad which by its location obstructs it. But where there are existing crossings—and they are shockingly numerous in the highly populated State of New York—half the expense of removal is to be borne by the railroad and the balance is divided equally between the municipality and the State. The cost to the railroad of grade-crossing removal, therefore, is twice as great as the cost to the State; yet, at the present time, the railroads in New York are most anxious to prosecute this work with zeal, and are provokingly delayed by the action of the State's chief officer, and by him alone.

The present grade-crossing law went into effect in 1897, prior to which the only crossings eliminated were those changed voluntarily by the railroad companies, or through mutual arrangements with the towns and municipalities. The law now provides for an annual appropriation by the Legislature out of any moneys not otherwise appropriated of $100,000, to pay the State's share of the expense of removing existing highway crossings from grade. That is to say, $400,000 a year is all that may be spent for this purpose, after the State's contribution has been swelled by the share borne by the railroads and the municipalities, respectively; but, if less than this is spent during any year, the balance, instead of going to the credit of the account, becomes part of the appropriation for the ensuing year, and does not increase it. Last year the Legislature appropriated sums for prosecuting the elimination of grade crossings generally throughout the State, and for two or three particular localities. The Governor vetoed all of these sums with the sole exception of $75,000 toward the total estimated cost of the State's appropriation of $275,000 for Schenectady.

This year the State Legislature appropriated the following sums:

(1) For general grade-crossing work still unexpended on sums appropriated two years ago, which, under the law, has to be re-appropriated, $74,893.

It is to be very much regretted that the Governor vetoed this appropriation, so that work which was started two years ago in good faith on sums then appropriated, has either to be discontinued or taken care of from the sum mentioned below in paragraph 3.

(2) For general grade-crossing work, not to be expended until next year and several years thereafter, so as to enable the Board of Railroad Commissioners to consider plans and approve them with the knowledge that money was available with which to do the work, $200,000.

This amount was vetoed by the Governor, so that the Railroad Commissioners are unable to consider and approve plans for which they have not the money in sight.

(3) For general grade-crossing work throughout the State, $150,000.

Out of this sum must come the $74,893 that remains unspent from the appropriation of two years ago, since the re-appropriation was vetoed by the Governor; and it must also provide for the further sum of about $25,000 for the expenditure of which the Railroad Commissioners are committed by previous action; so that there now remains available not over about $50,000 to be applied on work to be approved by the Railroad Commissioners, and this work may be still further decreased by cost in excess of estimates.

In other words, the great State of New York, with its 8,000 miles of railroad and 8,600 grade crossings, has less than $50,000 with which to continue the work of eliminating these crossings, to compare with the half million dollars appropriated annually by the State of Massachusetts for the same purpose. For the past two years the three parties in interest—the railroad company, the municipality, and the State, through its Legislature—have been willing and anxious to spend the money required to carry out grade-crossing elimination; yet, the will of these parties in interest is thwarted by the action of one man, who, for his own reasons, continues systematically to veto appropriations.

## BRITISH PRECAUTIONS AGAINST SUBWAY DISASTERS.

The circular of the British Board of Trade which is printed in another column embodies the recommendations which have been made from time to time by Mr. George Westinghouse as to precautions necessary for the safe operation of electric trains. The attitude of Mr. Westinghouse on this question has always been broad and far-sighted, and on several occasions he has taken pains to point out, freely and candidly, the danger places in electric traction, particularly as applied to elevated or subway lines, where the egress of passengers in case of accident is necessarily restricted. The danger due to the third rail has not been directly mentioned in the Board of Trade regulations, but the precautions demanded in the construction of the cars, roadbed, stations, etc., if conscientiously carried out, will reduce the third rail dangers to a minimum.

The Board of Trade takes a decided stand

on the use of multiple unit control in section 9 of its report, which says: "No main electric cable to be carried through the train, and motors to be placed on the front and rear carriages only. No motor to be situated in the middle of the train." The current required by a train of several cars is sufficient, if short circuited, to melt a good-size section of iron or steel and set fire to the woodwork about the car, roadbed or stations. As is well known, in the multiple unit system, each car takes up only enough power for its own operation, thus eliminating the use of a main electric cable passing beneath the entire train. The regulation prohibiting motor cars in the middle of the train will make necessary some changes in the make-up of trains on several of the London underground roads. The Great Northern & City line now runs seven-car trains consisting of three motor cars and four trailers. Each motor car has 250 horse-power in motors, so that if seven-car trains are still run, the use of but two motor cars, one at the head and one at the rear of the train, will cut down the power available for acceleration by 33⅓ per cent. High acceleration is one of the important features of electric traction, and where stops are frequent the average speed of a trip is dependent on the acceleration obtained on leaving stations. Of course, an underground road's acceleration is not so important as on surface or elevated roads, because the number of stops is not so large. The Central London Underground Railway runs six-car trains, including a motor car at each end of the train, but this arrangement of cars was made necessary because the tunnel is not high enough for cars having motors beneath the floor. The motor cars used are of special construction, the floor being raised over the trucks which carry the motors. In case of fire the use of a motor car at each end of a train is, of course, an element of safety, as the burning motor car can be quickly uncoupled from the train, but with the precautions taken to make the cars incombustible it is quite possible that this provision is unnecessary.

The full statement of precautionary rules and measures for the New York subway has not yet been made public, but, leaving out of the discussion the arrangement of motor cars, it may be said that the New York requirements will be in every respect equal, if not superior, to those laid down by the British Board of Trade. For example, all the lighting in the New York subway is to be done by circuits independent of the power circuit, while the British requirements provide only that "not less than 25 per cent. of the lights" be supplied from independent sources. Our signal system is the best that human skill can provide, and the steel cars, designed to supersede the experimental cars now in use on the elevated, are as nearly incombustible as possible.

## Railroads of the United Kingdom in 1903.

The preliminary summary for the year 1903, in comparison with the two previous years, gives the total length of line open for traffic at 22,380 miles, as against 22,152 miles in 1902 and 22,078 miles in 1901. Of the present mileage, 9,905 miles consist of single track, and the rest of double, or more.

There was an addition of about 100 miles of single track line during the past year, and of about 125 miles of double, or more. The following table of gross earnings, reduced to American currency, shows that the earnings from third-class traffic are over eight times as great as from either first or second (second-class, however, is found on relatively few trains).

There was a slight gain in the receipts from all branches of passenger traffic, except first-class, which was somewhat smaller than it was last year. The total freight earnings have also showed what we, in this country, would call a small but steady increase since 1901. Expenses have kept to a moderate ratio of increase, and in the item of locomotive power have shown quite a notable decrease, in view of the traffic gains, so that net earnings make a good showing.

But the favorable net earnings are subject to a certain modification before they can be in any way compared with American practice, for a large betterment charge, which in this country would quite universally be charged against earnings, is here piled up on the other side of the account. The English shareholder insists on receiving a full division of the balance of what is left after

| | 1901. | 1902. | 1903. (Prelim. figures.) |
|---|---|---|---|
| Total capitalization, paid up | $5,810,443,363 | $5,913,946,506 | $6,049,888,380 |
| Gross receipts: | | | |
| From passenger traffic: | | | |
| 1st class | $17,111,880 | $17,297,984 | $17,146,080 |
| 2d class | 15,073,110 | 16,015,829 | 16,208,100 |
| 3d class | 140,455,210 | 141,203,893 | 141,848,820 |
| Season tickets | 17,366,617 | 18,048,738 | 19,051,200 |
| Excess luggage, parcels, etc. | 31,394,152 | 32,419,602 | 33,354,180 |
| Mails | 5,220,175 | 5,342,015 | 5,438,340 |
| Total from passenger traffic | $226,621,144 | $230,328,060 | $233,046,720 |
| From goods traffic | $257,412,665 | $265,689,197 | 267,834,600 |
| Total gross receipts | $518,152,560 | $532,301,030 | $539,095,500 |
| Working expenditure: | | | |
| Maintenance of way, works, etc. | $48,239,242 | $49,603,760 | $51,117,480 |
| Locomotive power | 94,789,503 | 90,790,209 | 89,895,420 |
| Repairs and renewals of carriages and wagons. | 26,024,050 | 26,730,349 | 27,143,100 |
| Traffic expenses | 96,620,284 | 98,236,171 | 98,964,180 |
| Rates and taxes | 19,343,577 | 20,546,101 | 21,811,680 |
| Other | 43,260,191 | 44,079,918 | 44,362,080 |
| Total | $328,276,850 | $329,986,510 | $333,293,940 |
| Net receipts | $189,875,709 | $202,314,519 | $205,810,560 |

operation costs and a very limited charge against earnings to maintain the property. Even if we are extremists in the other point of view—that property which is merely maintained is in a constant state of depreciation or of stagnancy, and that it should be substantially better every year before anything is divided—the American reader stands rather aghast at the accumulated capitalization which has been created by the English practice. In 1901 the total paid-up capital per mile of road was $263,178; in 1902 it was $266,971, and in 1903 $270,326. The American critic, although he understands fully the difference in conditions, the populous country through which the lines pass, and the stringent board of trade regulations, which cost the companies annually a pretty sum of money over and above that from the expenditure of which any increase in public safety is visible, is disposed to ask where the thing is going to end. If earnings can increase fast enough to pay interest and at the same time provide always for dividends on the augmented stock, well and good; but it would seem that this could hardly be expected in a country already so densely populated as the British Isles. It seems to the American observer, who simply sees British conditions from afar and gets a perspective instead of an intimate knowledge of traffic conditions, that in Great Britain the time cannot be far off when the increases in fixed charges will overtake the increases in net earnings.

## Railroad Gross Earnings for May.

Although railroad gross earnings for the month of May show a decrease over the same month last year, this decrease is not so large as was expected after the appearance of the reports of April earnings. Eighty-one roads report a decrease in gross from May, 1903, of $2,811,823. Of 56 of the more important railroads reporting gross earnings for the month, 36 show decreases. But while the decreases in April were found in all parts of the country, those for May are marked only in the Northwest, Southwest and Middle West. The factors which worked toward the decrease in gross for May may be summarized as follows: The presidential election making trade very quiet; labor troubles, especially in Colorado; and late rains in the Southwest. And it should be taken into consideration that gross earnings in May, 1903, were abnormally heavy.

In the Middle West the movement of general merchandise has been extremely sluggish. In certain cases the decrease can be traced more specifically, as in the loss of $218,610 reported by the Hocking Valley Railroad, due directly to the suspension of the movement of soft coal toward the lower lake ports, owing to the lake strike. This strike was also felt by the Illinois Central, the Toledo & Ohio Central and the Wheeling & Lake Erie. This trouble on the lakes is now ended. The continued suspension of lake navigation, on the other hand, has undoubtedly helped the May earnings of the Pere Marquette, the Wabash, the C. C. C. & St. L. and the Grand Trunk.

In the Southwest the traffic movement has been in general fair, but the strike in Colorado and heavy floods in Arkansas and Texas have caused some serious shrinkages. Among the railroads showing decreases in this section are the Colorado & Southern, with a loss of $141,708; the International & Great Northern, with a loss of $111,560; the Denver & Rio Grande, $102,400, and the Texas & Pacific, $114,311.

In the Northwest the situation is similar to that in the Middle West, with the exception that the lake tie-up has not been so severely felt. The movement of merchandise is, however, very light compared with the volume carried last year at this time.

Gross earnings for May, when divided geographically, show decreases summarized as follows: Southwest and South Pacific group (ten railroads), decrease $395,270; Middle and Middle West group (13 railroads), decrease $369,876; Northwest and North Pacific group (13 railroads), decrease $1,089,744; Trunk Lines (six railroads), decrease

$1,223,903; Southern group (ten railroads), increase $168,248. As some of the railroads in the Trunk line and anthracite groups have not as yet reported earnings, the showing may yet be improved.

Of the separate roads, several have reported fair increase over May, 1903. The most noteworthy of these are the Canadian Pacific, which shows an increase of $209,000; the Mobile & Ohio, with an increase of $128,711; the Atchison, Topeka & Santa Fe, with $123,346, and the Central of New Jersey, which shows an increase of $85,639 for the month. In direct contrast to this, however, the New York Central & Hudson River and the Baltimore & Ohio show decreases for the month of $342,480 and $475,903 respectively. The Chicago and North Western and the Illinois Central also show losses of $500,946 and $284,474 respectively.

In general it may be said that as the losses are mostly in the Middle West and Southwest where the trouble is due to strikes, it may be assumed that the root of the trouble is not permanent. As soon as these strikes are over, the products of the mines will again move.

## May Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of May, printed in another column, contains accounts of 14 collisions, 25 derailments, and 5 other accidents. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | Killed. | Injured. |
|---|---|---|
| 1st. Dayton, Tex. | 0 | 0 |
| 2d. Shevlin, Minn. | 0 | 8 |
| 8th. Huachuca, Ariz. | 2 | 2 |
| 10th. Port Chester, N. Y. | 2 | 0 |
| 11th. Rock Fish, Va. | 2 | 0 |
| 17th. Moorcraft, Wyo. | 1 | 3 |
| 22d. Pine Bluff, Ark. | . | . |
| 25th. Haughton, La. | 2 | 6 |
| 26th. Alton, Ill. | 0 | 1 |

Eight of these nine accidents are notable, from the standpoint of our record, only on account of their magnitude; the causes, so far as appears from the details given, are not different from those of scores of other collisions and derailments to be found in the current reports. The ninth accident, that at Pine Bluff, Ark., is notable mainly by reason of its insignificant cause, a hot box. Butting collisions, costly in property loss and disastrous to lives are prominent in the record, as usual, but none of them appears to be exceptional. The derailment at Portchester, N. Y., has given rise to some speculation as to the best way of arranging signals at the approach to crossovers, on four-track lines, in situations where it is desirable to run trains from one track to another at full speed, or at the highest speed practicable. The view is expressed that unless the signal arm for indicating the highest-speed is always fixed highest on the post the engineman's difficulties are unnecessarily increased; and it is also argued that if the arm which is second in importance is at some places cleared for a fast train (the crossover being safe at say 40 or 50 miles an hour) the practice will lead enginemen (receiving a precisely similar signal) to run fast through some other crossover where the curvature is not so favorable. Costly derailments of passenger trains have occurred in this way. While these are interesting questions, it is important to bear in mind that they do not relieve the superintendent of the old, hard and persistent problem of training his enginemen to carefulness and vigilance; to the combination of cautiousness and the spirit of hustle which is necessary to make time and still be safe. Enginemen who run past a given signal every day may and ought to become so familiar with it that no amount of different circumstances at other places can confuse them concerning it. Theoretical discussions in the office sometimes seem to ignore this element of the problem. While it is the duty of the signal engineer to simplify signal indications for the benefit of enginemen, it is the duty of the superintendent to have runners who are equal to all difficulties. Simplifying signals paves the way for the employment of runners with poorer brains; but will any superintendent say that he should take advantage of the opportunity thus offered? Of course not; the quest for better brains remains a duty.

The number of electric car accidents reported in the newspapers in May was 22, in which four persons were killed and 99 injured.

According to the Chicago *Record-Herald* the Railway Protective Bureau, the organization which has been established by the cooperation of many railroads to do what it can to stamp out the ticket-scalping industry, has found rottenness in its own constituency. Many irregularities attending the issue of Exposition tickets to St. Louis have been disclosed, and the bureau, therefore, sends a plainly worded circular letter to the railroads in the association, reminding them that some of them are not dealing fairly with the courts. In securing an injunction a few weeks ago forbidding Chicago brokers to deal in non-transferable tickets, the railroad lawyers enlarged upon the excellence of the protective features of their tickets and gave the court to understand that these protective features had been universally adopted. The courts accepted these features as proper and reasonable and have prohibited the fraudulent representation which their transfer to other than the original purchaser involves. "If, therefore," says the circular, "the lines refuse to avail themselves of these protections by issuing the tickets in blank or by negligent execution of the contracts, they are in contempt of the tribunals of whom they have asked protection and redress, and have nullified the efforts of the courts in their behalf. . . . Connivance at fraud and complicity with questionable transactions on the part of lines which have pledged themselves to connections and competitors, have already resulted in material loss to the carriers generally and in profit and encouragement for the ticket scalpers. . . ." And the hope is expressed that, before it is too late, the evils will be remedied. The salient feature of this circular is that the facts stated are very like the facts which have been reported in so many other cases for 25 years past. The ticket scalper's nature seems never to change, even when he becomes a general passenger agent. It will be interesting to see what, if any, notice is taken of this situation by the judge who granted the recent injunction. Failure to keep faith with a rival railroad is one thing; failure to keep faith with a United States Court may prove to be quite another. It would help to clear the atmosphere if passenger men who do not keep their word could be brought before the courts now and then; the light of publicity would be beneficial.

## TRADE CATALOGUES.

*The Chicago Pneumatic Tool Co.* has issued a 72-page catalogue of air compressors built at its Franklin, Pa., works. All types of compressors built by the company are illustrated and described, including the new type G. Lists of sizes with full descriptive details accompany each class shown. A general description of the compressors is given, and several pages are devoted to constructive principles, the different important features being illustrated and described in detail. The volume also includes information of various sorts, of interest in connection with compressors and compressed air. The company is also sending out a small circular relative to the Duntley air-cooled electric drill. It is wound for 110 or 220 volts, and is made in sizes corresponding to the "Little Giant" pneumatic drills. The size illustrated in the circular weighs 12 lbs., drills up to ½ in. diameter in iron and ¾ in. in wood, and runs at 850 r.p.m. They are fitted with breast plate and feed screw when desired.

*The Union Pacific* issues a folder containing particulars of the U. S. Government grant in Nebraska; also a map of its road and connections and a map in colors of that part of Western Nebraska showing the public lands opened for distribution by the Government and those for sale by the company.

## British Precautions Against Subway Disasters.

The British Board of Trade has issued the following circular of precautionary standard specifications and instructions to be observed by underground electric railways. Further comment on these regulations will be found in the editorial columns:

STATIONS AND PERMANENT WAY.

1. Sleepers to be of hard wood, not creosoted, and to be laid in concrete or ballast, and covered with a layer of gravel or finely broken stone free from dust, the ballast to be finished to a level surface, so as to form a convenient roadway for passengers in case of emergency. If ballast is not used, the space between the rails to be covered with granolithic slabs, or slabs of a similar material, to form as wide a roadway as possible for passengers. No timber planks to be used.

2. Tunnels to be provided with lights capable of being turned on from the stations at either end of each section, and, if necessary, at some intermediate points. The lighting circuits to be independent of the traction supply.

3. Separate entrances to and exits from each platform of the stations to be provided, and to be situated as nearly as possible in the middle of the platforms.

4. All stairways, passages, and exits from the stations to be conspicuously lighted. Not less than 25 per cent. of the lights in these places to be supplied from independent source. If necessary, the exits to be made more conspicuous by the use of colored lights, in addition to white lights.

5. Platforms not to be made of wood, and woodwork to be eliminated as far as possible from signal boxes, lifts, offices, etc., below ground.

6. Efficient hydrants, hose and fire prevention appliances to be provided.

7. Ventilating ways to be provided wherever possible from the station and the tunnels to the surface.

EQUIPMENT.

8. Cars to be constructed of metal; woodwork to be reduced to a minimum, and to be noninflammable. Hard wood to be used in preference to soft. Interior fittings, panels, seats, etc., to be of incombustible material.

9. No main electric cable to be carried through the train, and motors to be placed on the front and rear carriages only. No motor to be situated in the middle of the train.

10. Means to be provided at both ends of every train to enable passengers to alight from the cars in case of emergency. Oil lamps to be carried in every train.

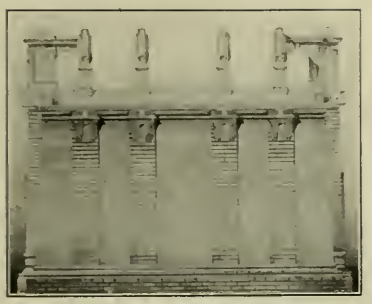
11. India rubber or other inflammable insulating materials to be avoided as much as possible, and the outer covering of cables to be uninflammable material that will not give off smoke.

12. Means to be provided for enabling a driver at any part of the tunnel to put himself into telephonic communication with the adjacent stations.

HERBERT JEKYLL.

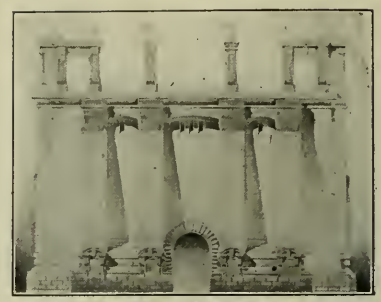
Board of Trade (Railway Department), May, 1904.

## Architectural Features of the Manhattan Bridge.

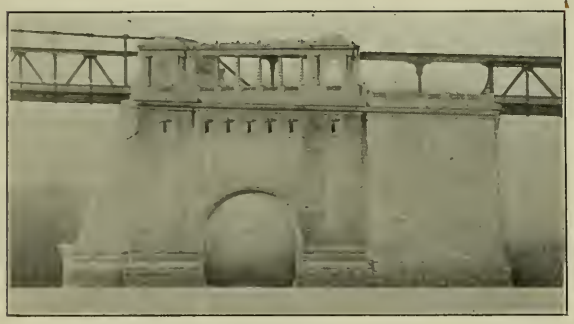


Front Elevation of Anchorage.

The accompanying illustrations are from photographs of the architect's drawings for the new Manhattan Bridge across the East river just above the Brooklyn Bridge. Officially this bridge is known as No. 3 and is a part of the extensive plans made shortly after the Brooklyn Bridge was built for connecting the then independent cities of New York and Brooklyn. The Williamsburgh Bridge, or No. 2, was opened for foot and wagon traffic last December, and No. 4 or the Blackwell's Island Bridge is almost ready for the erection of the superstructure. The first plans for the Manhattan Bridge were prepared some years ago by Mr. R. S. Buck, Chief Engineer under Bridge Commissioner Shea. They called for a three-span suspension bridge with straight carbon steel wire cables and a suspended stiffening truss, hinged at the towers and anchorages and continuous over the centers of all three spans. The clear span was fixed at 1,470 ft., with two identical shore spans, each 725 ft. long. The towers were steel, each comprising eight braced legs, self-contained and fixed at the base. This design was fully developed and a large number of drawings made when Mr. Gustav Lindenthal came into the office of Bridge Commissioner and undertook to redesign the entire bridge, using the same spans on account of the fact that work on the masonry foundations of the piers had already been begun. His substitute design called for a three-span suspension bridge with nickel-steel eye-bar chain cables instead of wire cables and with spandrel trussing connected directly with the chain cables instead of the suspended stiffening truss. The towers consisted of four massive legs braced transversely but hinged at the bottom to rock longitudinally. The trussed chains were hinged at the top and bottom. The general features of this design were fully described in the *Railroad Gazette*, December 4, 1903.

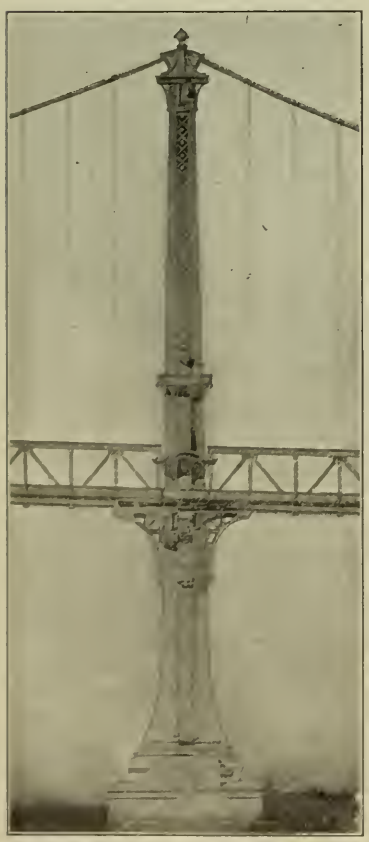


Back Elevation of Anchorage.



Side Elevation of Anchorage.

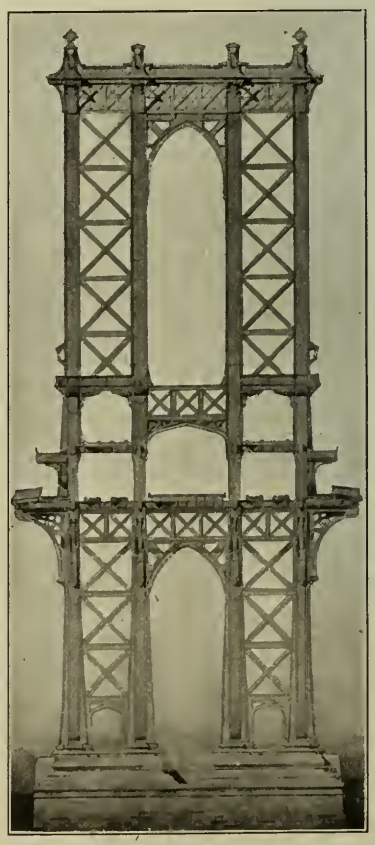
Section through Anchorage.



Side Elevation of Tower.

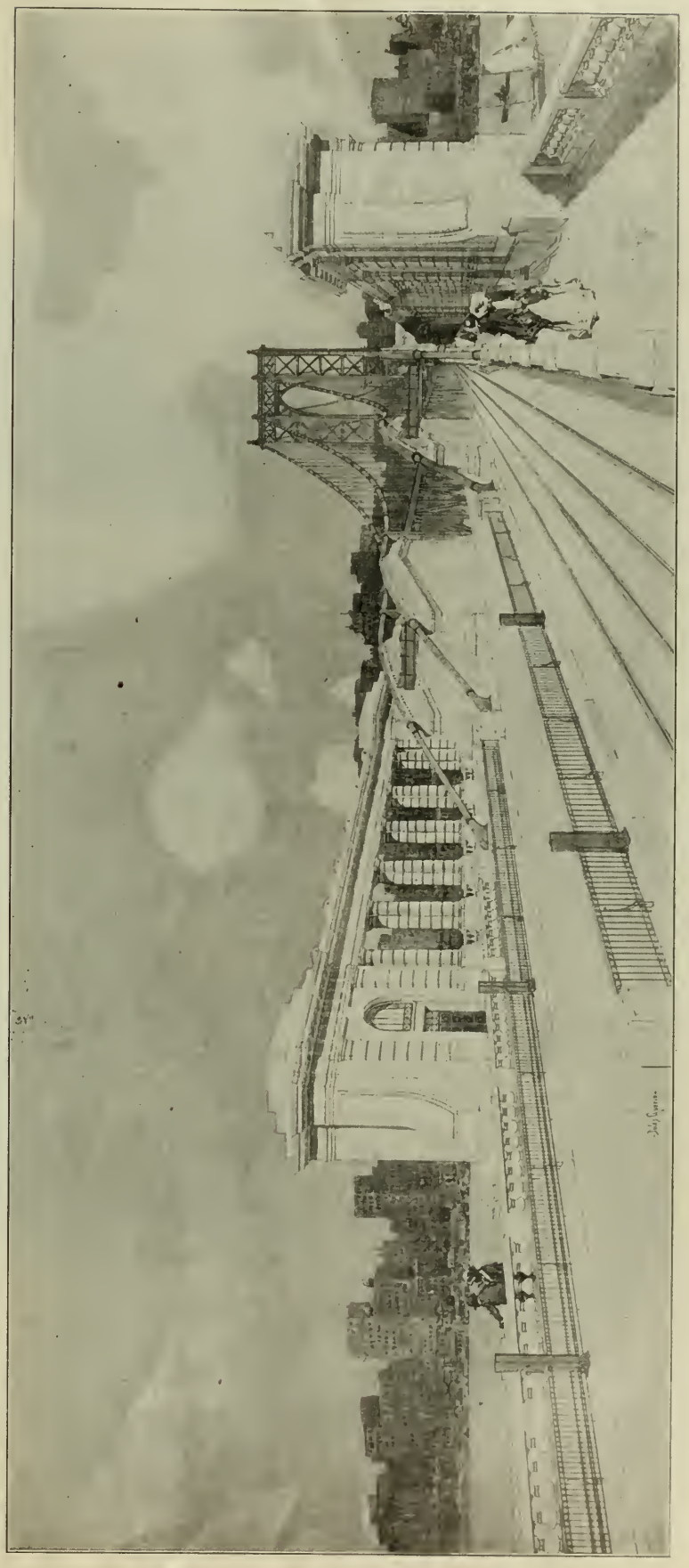
When the present Bridge Commissioner, Mr. Best, took office, last January, the original plans were again taken up and revised with the view of soon beginning work on the superstructure. Several changes were made in the original plans while still preserving the general features of wire cables, steel towers and suspended stiffening truss. The plans were then submitted to Messrs. Carrere & Hastings to be studied and embellished architecturally. The result of their work, which has the approval of the Municipal Art Commission, is shown in the accompanying illustrations. A report which they recently submitted to the Bridge Commissioner in connection with the studies which they have made says in part:

If the two existing bridges, the Brooklyn



Elevation of Tower from Roadway.

General View of the Manhattan Bridge from the River.



Roadway over the Anchorage, Showing Colonnades.

Bridge and Williamsburgh Bridge, were compared without thought or architectural study or detail, attention would be strongly drawn to the impressiveness and charm of stone and iron combined in the construction as seen above the roadbed on the Brooklyn Bridge, No. 1, and which is wanting in the other.

From the engineering and practical point of view it is a mistake to build the main towers of such a bridge of stone, because the openings in the towers must be so diminished in size in order to be made of masonry as to materially curtail the volume of traffic over such a thoroughfare. It is, therefore, impossible to obtain any effect of masonry above the roadbed by building the towers of stone, but it is necessary for the sake of harmony that there should be some expression in stone above the roadbed of the immense amount of masonry necessary under the roadbed for the construction of the anchorage. This affords an opportunity of bringing stone construction in contact with the great amount of necessary iron construction, and, on the other hand, makes it evident to all crossing the bridge that they are on the anchorage, by some other visible signs than by the mere change in the pavement material. In such a bridge any mere matters of architectural detail in the ironwork are lost in such a forest of structural steel work. The first and most important feature in design is the stone work over the anchorage. This anchorage is about 225 ft. long x 175 ft. wide and nothing could be more impressive than the court treatment 120 ft. above the water level. This treatment of the anchorage has made it possible to obtain an extra width at this part of the thoroughfare and has given places off from the general circulation where people can rest under cover on their way over the bridge and obtain a view of the distant city and the surrounding waters.

An endeavor has been made to utilize the necessary masonry supports for the anchorage saddles in making them a part of the architectural scheme connecting the colonnade; one of the pavilions of the colonnade on either side of the anchorage is devoted to staircases, which connect with the interior of the anchorage and which will be finally connected with the street. The architecture of this anchorage as seen from the street is one of the most interesting portions of the bridge which has been treated, and it has been the endeavor to avoid any unnecessary ornament, using only structural decoration and obtaining the artistic effect by the large masses of material and stone jointing. All of the enrichment has been concentrated upon that portion of the anchorage which comes under the colonnade and which expresses an interior void. That portion of the anchorage which carries the principal amount of the real load has been kept simple and massive in contrast with the other.

The perspective which is shown gives an idea of the relation of a mass of stone to the iron work over the roadbed; it also shows the court, which it is believed will be the most impressive feature of the bridge. Money will be better spent there than by spreading detail over so large a construction. The lines of the towers as given to the architects by the engineers are the expression of an economic and mathematical construction; these lines in themselves are most beautiful and need but little decoration, and such decoration as has been given has been concentrated to accentuate in every way the lines of the construction. Another opportunity has been afforded here to obtain covered resting places on the way over the bridge, and at the same time by making an iron and copper hood to enrich and obtain a shadow at this point. Another and most important feature from the architectural point of view is the crowning of these steel towers. Any mere decorative treatment on top of these towers and above the cables, coming against an open sky and on so large a construction would be at best inadequate and undignified. It has therefore been the endeavor to simply crown them with a cornice effect and to keep this crowning under the lines of the cable, like the cap of a column under an architrave. This cornice has been made of heavy iron with a large projection and all the decorative features have been concentrated in a gallery effect the whole width of the tower. The main lines of the cables and suspended trusses as given by the engineers are beautiful in themselves, expressing, as they do, the rational and simple solution of the problem from the engineering point of view.

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The Austrian government thought it necessary to increase its income by imposing a tax on railroad tickets. One of the principal private railroads reports as follows what it had to do in order to collect this tax during the year 1903, when it amounted on its lines to a little more than $400,000: 8,376,000 new tickets had to be printed, distributed and placed on sale, some 210,000 other kinds of printed papers provided, and 5,000,000 old tickets, no longer usable, called in, counted and destroyed. It is quite convenient for the State to use the railroad companies as tax gatherers, but not so agreeable to the companies.

## Railroad Shop Tools.

(*Continued.*)

(WHEEL LATHES.)

Only a few builders of machine tools make wheel lathes. This is due to the fact that this class of tools is special and is used only by railroads and locomotive builders, and hence the number sold is relatively small, as compared to other classes of tools.

The Niles-Bement-Pond 80-in. driving wheel lathe (Fig. 1) was recently built for the Louisville & Nashville, and one of these machines is also exhibited at the St. Louis Exposition. The swing of this lathe is 80 in. over the bed and 72 in. over the carriages. The face-plates are 80 in. in diameter and are driven by a steel pinion engaging in an internal gear on the face-plate. The pinions are attached to auxiliary shafts in the headstock, and on the opposite end of each auxiliary shaft is mounted a spur gear driven by a pinion on the main driving shaft, which traverses the length of the bed. Heretofore in driving wheel lathes one of the sources of weakness has been the long driving shaft, causing chattering in the machine by its torsion. The method adopted in this machine of gearing and driving shaft into the face-plates relieves the shaft of a very large part of the strain found in the usual construction.

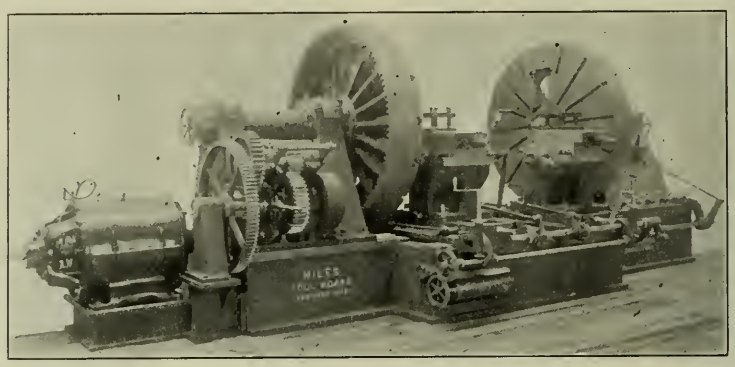


Fig. 1—Niles-Bement-Pond 80-in. Wheel Lathe.

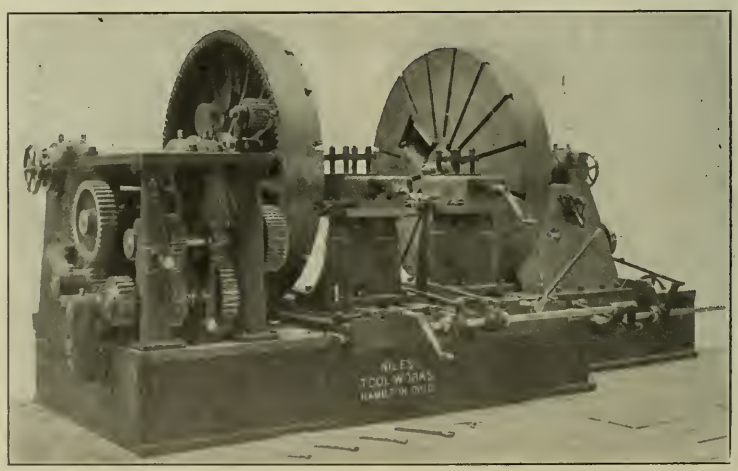


Fig. 2—Niles-Bement-Pond 90-in. Wheel Lathe.

The main driving motor is placed at the left-hand end of the machine and, by gearing, transmits motion to the face-plates both for tire and journal turning. The face-plate speeds for tire turning are designed to give cutting speeds ranging from 10 to 22 ft. per minute on diameters ranging from

48 in. to 68 in. on the tread. The motor has a speed range of 1:3. The axle is put into the machine on centers, each headstock has a sliding spindle in which the centers are inserted. Each face-plate has an opening for the crank-pins, so that the wheels can be brought close to the face-plates.

The right-hand headstock is moved into position by a 3½ h.-p. motor. The carriage and tool-rests engage with an adjusting screw lying lengthwise in the bed by an opening and closing nut operated by a 3½ h.-p. motor. This enables each carriage to be moved on the bed by power in either direction, making the adjustment of each carriage independent of the other. The feeds are operated by an adjustable crank-plate driven by gearing on the right-hand headstock. From here the motion is conveyed to the feed-screws by a rock-shaft placed on the front of the bed and connected by ratchets to the screws.

The face-plate spindles are gun-iron castings. Both the front and the rear bearings of the spindle are fitted with heavy bronze bushings made in halves. All the driving shafts have bronze bearings. All the smaller pinions are forged steel and the larger gears and the gears on the face-plates are made of gun-iron or semi-steel castings. The 90-in. wheel lathe shown in Fig. 2 was built for the Canadian Pacific by the Niles-Bement-Pond Company and is similar in design to the 80-in. lathe just described. An induction motor is used to drive this machine. This accounts for the rather complicated gearing, as the speed changes had to be made by gearing instead of electric control.

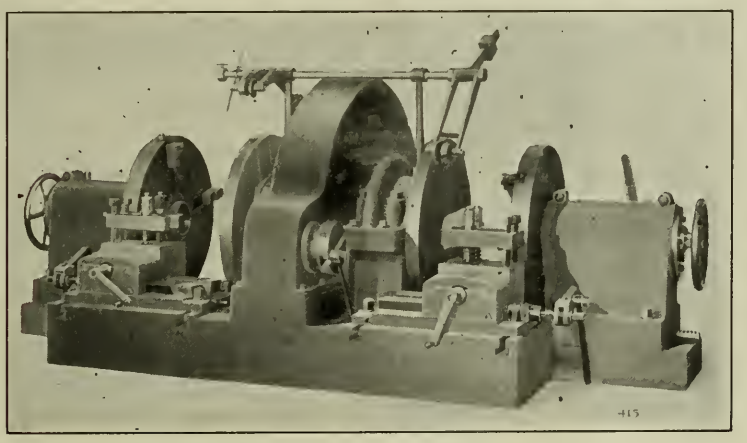


Fig. 3—Niles-Bement-Pond Car Wheel Lathe.

The Pond car wheel lathe shown in Fig. 3 will turn car wheels up to 42 in. in diameter. Self-centering chucks to grasp the axle journals, and chuck jaws to engage the tires, are provided. There has always been more or less difficulty in holding the wheels sufficiently rigid to allow the full power of the machine to be used at the tool without straining the axles. This machine is provided with a special device by means of which the wheels are securely wedged between the face-plates and the driving-plates. This prevents the axles from being strained when the machine is worked at its full capacity. The tool slides are operated either by hand or by positive power feed, and can be set to give any desired coning to the tread of the wheels. This lathe has a record for turning from 5 to 7 pairs of wheels per day.

The quartering machine shown in Fig. 4 is designed for quartering wheels with either right of left hand lead up to 80 in. in diameter on the tread. The maximum distance between centers is 9 ft. The saddles have angular adjustment for any length of stroke from 12 to 34 in. The boring spindles have 15 in. traverse, two changes of power feed and rapid hand movement. The motor drive feature of the machine is rather a novel design. In order to change from right to left hand quartering, the base on which the motor stands is placed on the other side of the machine, and the part which now forms the base for the motor is placed in contact with the slide of the machine, and the part which now is in contact with the slide forms the base for the motor. The tension in the chain drive is regulated by an adjusting-screw.

Fig. 4—Niles-Bement-Pond Quartering Machine.

The Putnam Machine Company's 92-in. driving wheel lathe is shown in Fig. 5. A novel feature of this machine is the arrangement of the tool carriages, each of which is in two sections. The front and rear sections of the carriages are fitted upon separate sets of ways, and when the tool blocks are in the forward position for turning the tires the rear sections are placed together between the driving wheels, so as not to interfere with them. After the tires are turned, the front carriages are set over, so that their T-slots come into line with those of the rear carriages. The tool blocks are then moved up, automatically connecting the front and rear carriage sections so that the operator can proceed to turn up the journals. The lathe is fitted with the Putnam standard quartering attachment on both the head and the tail stock for boring crank-pin holes. On the head stock the boring attachment is placed vertically above the main spindle, while on the tail stock it is placed horizontally at the rear. The boring attachment is adjusted for boring crank-pin holes for the different strokes of piston by means of the hand wheel shown. The main driving shaft of this lathe is steel, 7⅛ in. in diameter, and is supported in the middle to prevent vibration. The internal spindles are 50 in. long and 8 in. in diameter; they are fitted with tool steel center points, which are 4 in. in their largest diameter. Outside reinforcing hold-fasts are provided, and these are bolted directly to the face plates. The diameter of the primary face-plate gears is 90 in. The face of the cogs is 7½ in. and the circumferential pitch is 2½ in. The feed mechanism is arranged to give tool feeds ranging from .002 to 0.1875 in. per revolution of the work. The maximum swing of the lathe is 92½ in. The greatest distance between centers is 8 ft. 1 in., and the bed is 20 ft. 4 in. long by 6 ft. 9 in. wide. The weight of the machine is 77,500 lbs.

*(To be continued.)*

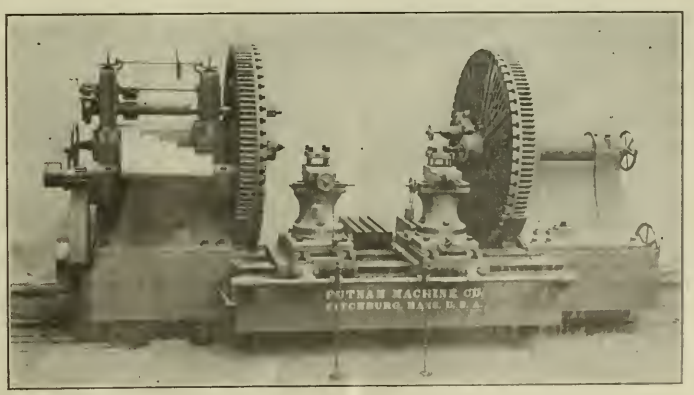



Fig. 5—Putnam Machine Company's 92-in. Wheel Lathe.

## Master Car Builders' Convention.

The 38th Annual Convention of the Master Car Builders' Association was held at Saratoga Springs, N. Y., June 22, 23 and 24. The attendance was larger than ever before and more than the usual interest was taken in the discussions. President F. W. Brazier, New York Central, presided. The first meeting was called at 10 a. m. and after a prayer and an address of welcome Mr. H. H. Vreeland, President of the New York City Railway Company, made a brief address. He said, in part:

"A few years ago I made an address before a body of railroad men which I termed a prophecy of the advance of long-distance electric traction. To-day that prophecy has come true and I now stand before you, not as a prophet, but as herald. . . . In and about New York there is now in progress of installation a practically new means of propulsion as applied to steam railroads. With the introduction of electricity at the New York termini of the New York Central, and possibly the Pennsylvania, there will come into use a new class of vehicle each with individually contained power apparatus, and the intimate association between the vehicle and the mechanism of its propulsion is so close as to make the divorcing of them practically impossible. The day when the motive power was sent to a roundhouse and the inert rolling stock to a yard or shop is at an end. A young man who aspires to shop efficiency must in the very nature of things find himself equipped to handle both. The safety and maintenance of the new appliances by which light and heat and power are furnished have been suddenly thrown, as a new responsibility, on the craft of car-building.

"See how much higher is the demand that will be made upon you in the immediate future. When I say you, I include the journeymen car builders, forming that valuable recruiting arm from which men for important stations can be graduated. This great revolution in motive power will not only tax you, but every man down the line. Tracks, switches, roundhouses and repair shops will need, under these new conditions, men with considerably more than the rudimentary knowledge that has heretofore sufficed, and it is the duty of all of us to drive this truth home in order that it may be fully appreciated and that we may recognize the new necessity that is upon us.

"That there is a revolution going on, might be profitably insisted on with a slight note of alarm. Every other revolution that has taken place in railway equipment has been a gradual one, and men have had time to slowly adapt themselves to altered conditions. The basis has been all along practically the same, and the successive revolutions have been mere modifications and improvements along a given line. This is not the case with the present change. There is an absolute annihilation, not only of the present means of power, but the substitute for that power instead of being centralized and capable of isolation, is so associated with the rolling stock as to make it an integral part of it, to be given into your charge. There has been very little preparation for this change which adds to the requirements of your craft the elements of an art that none of us are any too familiar with.

"All your roads, and particularly the two great corporations that I have mentioned, as soon as they have installed electric traction in New York, will be handling in their shops these new hybrid combinations, which are neither all cars nor all locomotives, but something of both, and it will take more than an expert carpenter or blacksmith to keep them in order.

"The magnitude of the change is shown in tabulated form below, the total electric generating capacity located at New York being so divided as to show at a glance the amount in operation at the present moment and that contracted for for near future delivery.

| | In Operation. | | Contracted for. | |
|---|---|---|---|---|
| | K. W. | Equivalent H. P. | K. W. | Equivalent H. P. |
| Manhattan Ry.... | 48,000 | 72,000 | 6,000 | 9,000 |
| Brklyn. El. lines.. | *20,000 | 30,000 | .... | .... |
| Interboro. subway. | .... | .... | 48,000 | 72,000 |
| L. I. R. R. | .... | .... | 16,500 | 24,750 |
| N. Y. C. R. R. | .... | .... | 40,000 | 60,000 |
| Total. | 68,000 | 102,000 | 110,500 | 165,750 |

*Estimated.

"It is proposed to substitute for steam on the Interborough, the Long Island and the New York Central, 156,750 horse-power units, or 54,750 units more than the Brooklyn elevated lines and the Manhattan Railway are at present developing. Within the next two or three years you are to have turned over to your care much of the machinery by means of which this tremendous volume of energy is to be transformed into work, for adjustment on the vehicles you make and repair.

"Academic and scientific men have done their work. Their problem has been solved; yours is yet to be. Into your keeping is to be handed over the adjustment and disposition of the machinery which the scientific men have invented and adapted, and on your efficiency depends the validity of the investment of millions of dollars and virtually the whole responsibility of reforming the method by which the most important part of the business of any civilized people—that of transportation—is conducted. There is to be made upon you, gentlemen, a sudden demand affording small opportunity for the gradual acquirement of efficiency. The demand must be answered at once, or the man failing to answer must inevitably fall back. I want to point out that what the situation needs is preliminary preparation, so that when the demand arises the men may be already equipped. The great necessity in all kinds of railroad work is preparedness. Slowly, year by year, with the enlargement of the necessities of a great businesslike transportation, its demand upon the individuals employed becomes more and more exacting. The burning question is 'Where can we get a man who can go into a carhouse and take care of the electrical equipment of a car?' He must be a combination man, for there can be no separation of forces.

"The displacement of the engine on suburban branches of steam roads will be absolute as from time to time electricity is developed and applied. There will be no change from the car builder's standpoint except the addition of the electro-mechanical principles of electrical operation which will come under his supervision. There will be no other special features of the work connected with the car other than the special electrical motor work which will go to the central machine shop. You must be prepared to take not only your car, but to take the intricate motive power and mechanical working parts of the car and care for it in the car shop and turn it out for service the following day."

President Brazier then addressed the Association. After commenting briefly on the progress in car building since the organization of the Master Car Builders' Association, he pointed out some of the unsolved problems in car work and suggested some possible lines of profitable investigation for the future. In part, he said:

"The expensive parts of freight and passenger equipment to maintain to-day are the draft rigging, couplers, uncoupling levers and running parts. One of the greatest expenses is maintaining so large a number of different makes of couplers, which each road is compelled to carry in stock, thus necessitating the carrying of many different kinds of knuckles and other parts of couplers to maintan cars running over its system. It would be desirable if all the roads could adopt one standard M. C. B. steel coupler, or have the number reduced to at least three or four makes. The whole subject of automatic couplers is so completely covered with over 8,000 patents that it would probably be exceedingly difficult to get up a new coupler that would be acceptable to a majority of the railroads without incurring much trouble and inconvenience due to these patents. I would suggest that a committee be appointed to report upon the desirability of having a coupler designed, if one is not already in existence, which our association could take as a standard; a coupler which would consist of the following parts: 1st, coupler body; 2d, knuckle, so designed that in the event of a knuckle pin breaking the knuckle will not pull out; 3d, a knuckle pin; 4th, a knuckle lock.

"I desire to call attention to the importance of a closer inspection of couplers and attachments to prevent break-in-twos of freight trains. Some roads have adopted the plan of having trains stretched at terminals and the couplers gaged with a small gage which can be handily carried by inspectors. In case this gage will slip in between the knuckle and the face of the coupler the car is set out and the trouble remedied. It is not always a worn knuckle that causes an uncoupling; sometimes other wearing parts become so worn that they allow the knuckle to open sufficiently to uncouple the train.

"The suggestion has been made that new couplers should have a bushing in the pin hole, so constructed that it can be removed when worn too large, and a new bushing applied or some means provided to take up the wear. In some new couplers it has been found the pin hole was from ⅛ to ¼ in. too large, and in some cases the pins too small. Knuckles received from manufacturers should be gaged to see that they are made according to the standard contour lines. Many knuckles on the market to-day are not standard to the make of coupler in which they are intended to be used. When two knuckles not made according to the M. C. B. contour lines are placed in adjacent couplers, trains will part without either of the knuckles opening. Consequently particular attention should be paid to see that all new knuckles are probably gaged when received. The coupler committee should also take up the question of coupler side clearance. With our long freight cars we should give more side play in our coupler yokes.

"There has been considerable discussion as to whether an 80,000 and 100,000 lbs. capacity box car is an economical vehicle of transportation for merchandise. The average lading of even our 60,000 lbs. capacity car is much less than its capacity, which would indicate that it is rather expensive to haul the additional weight of the larger cars. However, this its a question for the operating and traffic departments to determine, but there are features connected with it in which the car department is interested.

"Since the adoption of the rule providing for the per diem charge on freight cars there is no question but that the extent of repairs made to freight cars on foreign lines has greatly diminished, the tendency being to make only such repairs as are absolutely necessary to put the car in safe condition for movement over the road on which the repairs are made and get rid of the car as quickly as possible, in order to avoid the penalty prescribed by the per diem rule.

The result is that in neglecting to make some slight repairs to a car very extensive repairs are often necessary by the time the car reaches its home road. On the other hand when cars were handled on the mileage basis (there being no penalty for holding a car the requisite time in which to make the necessary repairs), more repairs for which owners were responsible were made and the cost thereof billed against the owners. While it is important that each railroad should release foreign cars which are held for repairs as promptly as possible, still many repairs are neglected which, if made at the time the defect is discovered, would possibly prevent subsequent damage and obviate the necessity of making heavier repairs.

"In all branches of mechanical activity there is great need for improving systems of apprenticeship. This is particularly true of car departments of railroads. Car builders have been rather remiss in this matter and it is exceedingly important that we should encourage young men of the right sort to become apprentices in car building and to properly provide such apprentice regulations as are necessary to attract young men of the kind we need. We have talked about apprenticeship for years; let us now do something.

"The Master Car Builders' and Master Mechanics' associations should be brought together as one organization. The work of the Master Mechanics' Association is largely educational, and as locomotives are not interchanged it has not the legislative function of the Master Car Builders' Association in the matter of interchange rules. It would seem that the interests of the two associations are not now sufficiently far apart to warrant maintaining separate organizations. Conventions may be arranged so that car and locomotive subjects will be grouped together and discussed at separate sessions, special days being set apart for the rules of interchange and other subjects specially pertaining to cars. The time for seriously considering this question has arrived."

The suggestions of the president may be summarized as follows:

1. The adoption of a standard coupler.
2. Standardizing the pivot pin and the material to be used in its manufacture.
3. Investigation of coupler side clearance.
4. A standard formula for journal bearings and linings.
5. Improvement in the quality of waste for use in freight and passenger service.
6. An addition to be made to the requirements of the standard brake beam, calling for test across line of fulcrum.
7. The standardization of steel freight cars.
8. The use of 40 and 50 ton capacity box cars, from an economical standpoint.
9. Improvements in uncoupling arrangements on couplers.
10. Adoption of standard archbar truck.
11. An adequate apprenticeship system.
12. The consolidation of the Master Car Builders' and Master Mechanics' associations.

The secretary's report showed a total present membership of 581, composed of 335 active, 217 representative, 10 associate and 19 life members. The total number of cars represented in the association is 1,755,682.

The report of the treasurer, John Kirby, showed a balance on hand on June 15, 1904, of $3,469.38.

The Executive Committee recommended that the annual dues be $4 per vote instead of $3, and this was approved by the association.

Mr. Appleyard (Pullman Company) read the committee report on standards and recommended practice. The discussion was on the individual recommendations of the committee and action was taken on each as it was read. The first subject considered was a standard length of brake beam and the recommendation that a committee be appointed to report on standard dimensions of brake beams was adopted. The suggestion that the standard diameter for knuckle pins be made 1⅝ in. was referred to the committee on couplers. Sections 2, 3, 4 and 5 of the committee report relating to limit gages for couplers and yoke and drawbar straps for couplers were referred to the proper standing committees. The suggestion that buffer blocks on freight cars be left off in the future was adopted after some discussion, several members being strongly in favor of retaining them as valuable aids in preventing undue slack in trains. A change in dimensions of the wheel defect gage was referred to the committee on wheels. The proposed adoption as standard of 1¼ in. bolts for 5 in. x 9 in. journal boxes was approved. The recommendation that a committee be appointed to prepare a design for a filled bearing for 5½ in. x 10 in. journals was approved, as was also the recommendation that a committee be appointed to prepare designs for standard arch-bars for 100,000 lb. trucks. A committee was authorized to prepare designs for a standard ladder for box cars and to determine upon the location of the ladder and also the handholds on the roof. Committees were ordered appointed to consider recommended practice for attachments of draft gear to steel cars, design of a flush car door to replace the present sliding door, and the location of airbrake parts on steel cars. The location of air pipes and angle cocks now embodied in the Recommended Practice was advanced to standard, subject to letter ballot. Safety chains for freight cars, the advisability of abandoning short draft sills, revision of the present design of twist gage for couplers, and changes in the drawings shown of the M. C. B. drop test machine, were all referred to the respective standing committees.

Mr. E. A. Moseley, secretary of the Interstate Commerce Commission, then addressed the convention. An abstract of his address was printed last week in the *Railroad Gazette*, p. 64.

The report of the committee on triple valve tests was included in the joint committee report on revision of air brake and signal instructions. The report was not read, but was referred to letter ballot for adoption.

The committee on brake shoe tests reported that no brake shoes had been submitted to it for test during the last year. Prof. W. F. M. Goss, Purdue University, a member of the committee, called attention to the inactivity of this important standing committee and suggested that it should again resume the investigations of brake shoe efficiency carried on some years ago. Mr. Garstang (Big Four) moved that any railroad using brake shoes which have not been previously tested, send a sample of the shoe to the committee with an analysis of the shoe's composition, and that the reports of such tests be submitted as the committee's report next year. The motion was carried.

The committee report on tests of M. C. B. couplers was read by Mr. Appleyard (see *Railroad Gazette*, June 24, p. 78). There was some discussion on the recommendation that there be 1-16 in. clearance between the knuckle pin and the hole, some of the members being of the opinion that this was too much. Mr. W. T. Bentley (B. & O.) agreed with the recommendation in the President's address that some form of pin hole bushing be used or that the hole be machined in order to reduce the lost motion at that point. The recommendations of the committee were ordered submitted to letter ballot.

The committee report on standard location of third rail was read, accepted and the committee discharged without further discussion. (See *Railroad Gazette*, June 24, p. 70.)

The committee on stenciling cars asked to be continued for another year, and made no report.

Mr. R. P. C. Sanderson (Seaboard Air Line) read the report of the committee on coupling chains (see *Railroad Gazette*, June 24, p. 69). Mr. R. L. Cline (P. R. R.), a member of the committee, presented a minority report. Mr. Sanderson called attention to the idea that seems to prevail that permanent safety chains will take the place of wrapping chains in double loads. The large amount of slack in the permanent safety chains will not permit cars to be properly blocked apart. Wrapping chains are essential for this purpose. With the permanent chains, if the couplers part, the two cars carrying a double load can move apart from 18 in. to 20 in., and this might cause serious disarrangement of the load. On motion, the committee was continued for another year, that it might make a unanimous report. The meeting then adjourned for the day.

SECOND DAY'S PROCEEDINGS.

The first order of business was the reading and discussion of the report of the committee on air brake hose specifications. Mr. Le Grand Parish (Ind., Ill. & Ia.), read the report by abstract. (See *Railroad Gazette*, June 24, p. 71.) Mr. A. M. Waitt moved that the committee be continued for another year, with instructions to carry out further tests at Purdue University, and that in the meantime the clause in the Rules of Interchange requiring all cars to be equipped with M. C. B. standard hose after July, 1905, be thrown out until the committee can frame a more satisfactory specification. The motion was carried. Mr. G. R. Henderson referred to the damage caused to hose by the machines used in mounting the nipples. An examination of several thousand hose after they had been removed showed that more than three-fourths of them had been damaged in forcing the nipples into the coupling, due largely to the rough and irregular shape of the fittings. Another cause of burst hose are the machines for stripping, some of which have a chisel to split the hose around the fitting. This chisel is often forced into the nipple and forms a sharp burr which cuts the lining when a new hose is applied.

Mr. Sanderson was of the opinion that the proposed requirements for trainmen going between cars and uncoupling hose on arrival of a train in yards, could not be enforced, because it would mean putting up a blue flag every time it was done, and this would congest traffic too greatly. He believed the pulling apart of hose could not be stopped altogether or even in great part. As a business proposition it would not pay the railroads to buy expensive hose when nearly 90 per cent. of hose removed was removed for causes not attributable to poor quality. Several others sustained his position on that point. It was finally agreed to abrogate the present M. C. B. standard recommendations and substitute, subject to letter ballot, the new specifications as recommended practice.

The committee report on draft gear was read by Mr. Parish (see *Railroad Gazette*, June 24, p. 72). Mr. Sanderson and Mr. Parish were both of the opinion that the round back yoke was a good design, but that perhaps better results could be obtained with a round back construction made of malle-

able iron in preference to using a wrought iron flat follower 1⅝ in. or 2¼ in. thick with a filling piece. Roads should have the option of using either form. Mr. Hennesey (C., M. & St. P.) was in favor of increasing the size of the yoke rivets from 1⅛ in. to 1⅜ in. in view of the many failures of draft gear at that point. He advocated doing away with the gibs or turned down ends that fit over the liner blocks and also widening the yoke from 4 in. to 4½ in. over the liner blocks. His recommendations were referred to the committee on standards. The report of the committee was accepted.

Mr. J. S. Chambers (Atlantic Coast Line) read the committe report on stake pockets (see *Railroad Gazette*, June 24, p. 73). Mr. Kiesel (P. R. R.) objected to using only ½ in. metal at the top of the pocket because it would be too weak. He also objected to the recommendation of 4 in. x 5 in. temporary stakes on the ground that the clearances for large numbers of cars now in service would not allow more than 4 in. x 4 in. stakes to be used. Mr. Ball (Lake Shore) suggested that a minimum instead of a maximum weight be specified, because the tendency was always in making malleable iron castings too light. The report was referred to the committee on standard.

Mr. H. S. Hayward (P. R. R.) read the report of the committee on prevention of rust on steel cars (see *Railroad Gazette*, June 24, p. 70). In presenting the report he explained that it was based largely on the recommendations of roads having large numbers of steel cars in service. On the Pennsylvania, coal tar placed between the joints had proved an excellent preservative. Most of the graphite paints used were mixed with linseed oil. Mr. W. T. Gorell (P. & R.) said that some time ago a car which had been in the shop had been thoroughly cleaned and coated with linseed oil. After three months' service it appeared to be in excellent condition, showing that the supposed cracking of linseed oil when dried out is not a serious defect. Mr. Sanderson (Seaboard Air Line) suggested the use of tar paper for protecting steel underframe, wood body cars from the effects of acid leaching through the load, the paper to be laid over and around the sills under the floor. Mr. McIntosh (C. R. R. of N. J.) thought the secret of success in painting steel cars lay in thoroughly painting the cars when new, and having a good foundation for successive coats. The report of the committee was accepted and placed on file.

The report of the arbitration committee was taken up next in order. Contrary to the usual custom, it was accepted without reading or discussing the several proposed changes. The decisions in the arbitration cases brought before the committee were formally approved by the association.

The committee report on prices for repairs to steel cars was read by abstract and opened for discussion (see *Railroad Gazette*, June 24, p. 69). Mr. Hennesey (C., M. & St. L.) suggested that the price for bodies of 80,000-lb. cars be fixed at $100 less than those of 100,000-lb. cars, but both Mr. Stark (Pitts. Coal Co.) and Mr. McIntosh thought this too much and that $30 less would be a fair valuation. Mr. W. T. Bentley (B. & O.) thought that the price recommended for scrap at ¾ cents per lb. was too much, and that ½ cent would be a fairer price. Mr. Mord Roberts (K. C. So. Ry.) spoke of the injustice to roads situated a long distance from the source of steel supplies which the rule regarding charges for material at market prices, presumably f.o.b. shipping point, would involve. Mr. Schroyer (C. & N. W.) thought this would involve but little hardship, as on his road the average annual cost of repairs to foreign steel cars was $1.62. The splice for center sills shown in a sketch in the report was severely criticised by several members as not being strong enough for the shocks it is required to resist. The committee was continued to submit another design next year. A committee of five was appointed to draw up a satisfactory set of interchange rules covering passenger equipment, on motion of Mr. H. F. Ball (Lake Shore) after Mr. J. T. Chamberlain (B. & M.) had read a communication from the New England Railroad Club.

The committee report on outside dimensions of box cars was read by Mr. Appleyard (see *Railroad Gazette*, June 24, p. 71). Mr. Sanderson questioned the possibility of running cars of the proposed dimensions through certain tunnels on the B. & O. and the Pennsylvania, but Mr. Appleyard stated that these roads had both approved the dimensions as satisfactory. The report was referred to letter ballot for adoption as recommended practice.

Mr. William Forsyth followed with an individual paper on steel for passenger car construction (see *Railroad Gazette*, June 24, p. 74). In introducing the subject he said:

"My object is to call attention to the increasing weight of passenger cars and the unequal distribution of strength in passenger trains. Twenty years ago passenger coaches weighed 50,000 lbs.; they now weigh 110,000 and 112,000 lbs. The weight has been more than doubled and the capacity has not been increased more than 30 per cent. Pullman cars now weigh as much as a passenger locomotive and tender weighed then. They have been increasing in weight at the rate of 5,000 lbs. a year for the last six or eight years. This great weight in passenger trains creates not only a big expense in hauling heavy passenger trains, but the weight prevents an increase in schedule time. The Master Car Builders should make some effort to prevent this constant increase in the weight of equipment. The use of steel would increase the safety of the equipment, without increasing the weights. It is usually claimed that, weight for weight, wood is as strong as iron, but when disposed in the form of a deep plate flanged girder with thin web, there is quite a difference in favor of steel as compared with the rectangular wooden beam."

Mr. G. R. Henderson suggested that a committee be appointed to consider not only a design of steel frame for passenger cars, but also a suitable and harmonious list of non-combustible interior and exterior trimmings. Mr. M. K. Barnum (C., R. I. & P.) thought that postal cars as well, should be considered, and that the association should take some action along this line before it was compelled to do so by the Government, which was seriously considering a safer construction of postal cars. Mr. F. H. Clark (C., B. & Q.) said that his road has a number of cars built with the Challender truss similar to the girder side frame proposed by Mr. Forsyth, and that a good deal of trouble had been experienced on account of corrosion. The plates are not easy to get at for inspection and painting, and rust eats them out rapidly. Mr. Ball suggested that the committee consider not only an all-steel design but should also prepare an alternative design with wood body and steel underframe. The committee was so instructed.

The report of the committee on cast-iron wheels elicited much discussion (see *Railroad Gazette*, June 24, p. 68). Mr. Garstang read the report and recommended that it be submitted to letter ballot for adoption as recommended practice. Mr. Hennessey objected to the clause requiring wheels for acceptance in interchange to weigh not less than 585, 635 and 685 lbs. for the three classes of cars respectively. Mr. McIntosh suggested that the clause be made to read so as to include only wheels cast after December 1, 1904. Mr. J. E. Muhlfeld (B. & O.) said that experience on that road had shown that the form of wheel proposed had not given as satisfactory service as some other designs. One in particular, which has given excellent results under hard service conditions, originated in the B. & O. foundry some 18 years ago, and it is a great improvement over the old M. C. B. standard. In the proposed design of wheel there are different stresses that tend to work against one another. In the design of wheel referred to there is a harmony and a unison in the contractive and expansive efforts. The proposed design of wheel would have a tread contour which is liable to create flange friction. Flange friction results in cracks at the throat of the flange and eventually in the breakage of the flange. The proposed wheel has an increased depth of the metal at the tread in order to relieve the chilling action at the flange, and it has not added strength at that point. The other design referred to has the advantage of backing up the flange with more metal; the tread is deepened at that point and tends to reduce the chilling action; and the plates are of such design as to prevent the cracking. While they have had cracked plates with that design of wheel, they have not had, in proportion to the number of wheels of the different types used, anywhere near the same number. Under severe service conditions on heavy grades and where heavy, severe braking power is required, and with heavy equipment it will sooner or later result in the condemnation of the cast-iron wheel. This seems to be the concensus of opinion on the Baltimore & Ohio from the practical results of the last ten years. The railroads to-day are not, however, in a position to increase operating expenses by adopting a very expensive wheel unless they are forced to. Mr. Fowler (Can. Pac.) said that on the Southern Pacific, where the curves and grades were probably as severe as anywhere in the country, they had used a design somewhat similar to the one mentioned by Mr. Muhlfeld, and that it had given poor service. They had then adopted a design similar to the proposed new design and obtained very satisfactory results. Mr. Whyte (B. & O.) did not see how the Association was justified in adopting the proposed wheel when for the last 18 months wheels of almost identical design had been giving so much trouble from the very causes which it was proposed to remedy. Mr. Garstang told of the committee's meeting with the wheel makers and of the final adoption of the proposed design as satisfactory to all concerned. He said he believed that the time for adopting a standard wheel was never so opportune as at present. Mr. Onderdonk (B. & O.) referred to a test started some years ago in order to determine the cause of the development of seams in the throat of cast-iron wheels. A number of wheels were put under 100,000 lb. cars, one truck having the regular brake applied and the other truck being free from brakes. This was to determine whether the seams were developed in the throats of the wheels where no brake shoes were applied. After being in service for between 18 months and two years, two or three of the wheels on which a brake shoe had never been applied developed these seams and broke. These were cars operated in the eastern end of the B. & O., where the curves are quite severe. Other wheels under heavy equipment that had not been operated on grades, but simply around curves, developed the same

seam. He had never found that seams are not directly due to braking. The cracking of the plates, however, is due to the heat from the brakes and expansion. This has been overcome to a certain extent by the design of the wheels. The wheel recommended by the wheel makers at the present time was, he thought, a wheel that is easy of manufacture; that is, a wheel that can be cast or molded more readily than some of the other wheels that have been found to give better service.

The committee's report consisting of drawings of wheels and specifications was ordered submitted to letter ballot for adoption as recommended practice.

Mr. J. J. Hennessey opened the first topical discussion on the advantages or disadvantages of a 2-in. main steam pipe with 1⅝-in. steam hose. Mr. Ball quoted a test made last winter on a 16-car train, which showed that it could be properly heated with 30 lbs. steam pressure if the 2-in. pipe was used, and that it required 80 lbs. pressure with the 1½-in. pipe. Practical tests in heating trains running over the road with 1⅝ coupling hose showed better results than had ever before been attained, despite the severity of the winter. The Lake Shore is equipping its trains as fast as possible with 2-in. pipe and 1⅝-in. hose. Mr. F. W. Chaffee (N. Y. C.) said that all the cars on that road had been equipped with 2-in. pipe and large hose, and the results were uniformly satisfactory. The hose coupling has a lock on it which is considered essential. The opinions of Mr. McIntosh and Mr. Schroyer were at variance with the other gentlemen. They could not see the advantage of using a 2-in. pipe when the 1½-in. pipe will carry off all the steam that can be spared from the engine. It is essential, of course, to have a straight, clear opening through all the pipes, fittings, hose and couplings throughout the train; otherwise trouble will occur with any size pipe which may be used. The consensus of opinion seemed to be that the larger pipe and hose were advantageous, and that their use should be encouraged.

*Topical Discussions.*

Mr. E. B. Gilbert opened the next topical discussion on the subject, "To what extent does friction draft gear reduce expenses for repairs, etc.?"

Friction draft gear does reduce repairs and expenses below that of spring draft gear, though it is difficult to obtain detailed statistics showing the actual relations between the two. The points to be considered in comparing the two are:

First. The cost of repairs to the draft gear itself, taking into consideration the original prices of the two gears.

Second. Cost of repairs to couplers, yokes, draft lugs, draft sills, end sills and other adjacent parts which depend largely upon the draft gear.

Third. Expenses connected with switching and operating cars on road.

On the B. & L. E., which has heavy grades, the actual cost of repairs to friction draft gear on 6,800 steel cars of 100,000 lbs. capacity, purchased at various times from 1897 to the present, has been 4¼ cents per car per year. We are unable to find anything giving the cost of maintaining spring gear on a similar car, but from our experience with wooden cars it must be considerably greater.

Considering the cost of repairs to couplers, yokes, etc., records were kept by two connecting western railroads for a period of a year of all their coupler failures on two series of 100,000 lb. capacity steel cars, built exactly alike with the exception of the draft gear, one series being equipped with a friction gear and the other with a twin spring gear. The ratio was all in favor of the friction gear, as follows:

| | |
|---|---|
| Coupler failures—car mile per failure... | 4.8 to 1 |
| Knuckle failures—car mile per failure.. | 26.2 to 1 |
| Yoke failures—car mile per failure..... | 61.1 to 1 |

According to statistics which have been compiled, over 30 per cent. of the cost of maintaining freight cars is due to repairs to draft rigging and adjacent parts. With less repairs to make we save not only the cost of the repairs but we keep the cars in service, a matter of vital importance to the transportation department.

In these days, when the great problem is to keep the freight moving, yard men in drilling cars and making up trains, in order to save time, keep the cars moving at higher speeds and bring them together with greater force in order to expedite handling and insure coupling. In order to be able to do this and save the time, we should have a draft gear that will absorb considerable energy in itself. From the report of tests of the 1902 committee on draft gear, the best test of spring gear showed the total work absorbed to be 6,852 ft. pounds, while on the best test of friction gear the work absorbed was 18,399 ft. pounds, 90 per cent of this being absorbed by friction. This cannot help but keep down repairs when you can absorb this large amount of energy which otherwise would result in broken draft sills, etc.

High capacity spring gear has great recoil, giving back a large percentage of the blow it receives. This damages the cars and often causes break-in-twos, with their disastrous results.

In double spring gears with a maximum capacity of 40,000 lbs., the recoil is 16,000 lbs., while in friction draft gear a force of from 150,000 to 175,000 lbs. is required to compress the draft gear solid, yet the reaction is less than 7,000 lbs. It cannot be emphasized too strongly the possibility of preventing break-in-twos by the use of the friction gear, the attendant results of such breaks being well known.

On one of our allied roads two 167-ton locomotives were equipped with spring gear, which required repairs about every 10 weeks, the cost averaging 83 cents per thousand miles. Subsequently, friction gear was applied and no repairs were made for over 15 months.

The topical discussion, "To what extent will a more rigid inspection of car couplers at terminal points reduce accidents and repairs?" was opened by Mr. James Macbeth (N. Y. C.), as follows:

In view of the large number of break-in-twos of trains, it would appear imperative to arrange for close inspection of couplers and attachments not only at large terminals, but at all points where inspectors are located and where it is found possible to do so.

On one road they have been averaging about 50 break-in-twos on freight trains per month, which were directly traceable to worn coupler parts; fully 60 per cent. being due to worn couplers or knuckles, the balance being due to worn knuckle locks, lock pins and knuckle pins. In order to overcome this trouble some roads have adopted the practice of stretching trains before detaching the engines, i. e., setting brakes on a few rear cars, then taking out all the slack and setting the brakes on several cars at the head end, thereby leaving all the strain on the couplers and giving inspectors an opportunity to gage them with a small gage provided for that purpose. This gage is constructed upon the basis of the M. C. B. limits and can be handily carried by inspectors in their pockets. If the gage will slip in between the knuckle and face of coupler, the cars are parted and a close examination is made to ascertain the part at fault and either remedy the trouble on the spot, or if it is found impracticable to make the opening in the train, condemn the car to the repair track. This practice undoubtedly has a beneficial effect in reducing the number of break-in-twos and consequent damage to cars.

Mr. W. E. Fowler said that on the Canadian Pacific they had been using as a substitute for this gage, a straight flat piece of steel 5¼ in. long and ⅞ in. wide, which the inspector could easily slip into his pocket. If necessary, he was in favor of taking the radical step of increasing the labor charge for knuckle renewals, so as to force owners to keep the couplers up to standard. Mr. McIntosh said he had experimented to some extent with bushings placed in the coupler head around the knuckle pin on passenger equipment and the results had been so satisfactory that he contemplated trying the same remedy on freight equipment.

The topic, "The advantages and disadvantages of the different varieties of side bearings now in use," was opened by a contribution from Mr. L. H. Turner (P. & L. E.), as follows:

"Fully one-half of the wheels removed from under cars are taken out for sharp flanges, due entirely to improper construction and failure to use devices that will remove in a great degree, side rail wear. Reduction of train resistance presents greater possibilities in reducing cost of train movement than any other factor, and the construction of body bolsters and trucks can be so improved as to admit of a greater train load with higher rate of speed, less consumption of fuel, at no increase of locomotive energy, or, in other words, an application of power where it belongs, to the movement of freight and not consumed in needlessly wearing out wheel flanges and rails. Build the body bolsters of such material and strength as will enable them to carry the load upon the center bearing; and make the center plates so as to offer the least possible resistance to the rotative movement of the truck. Give side bearings of whatever type used sufficient clearance so as to not come in contact except on curves with high elevation. A dynamometer test, with a train with trucks and bolsters arranged and constructed as recommended, will show startling results in comparison with one as usually found with weak bolsters with one-half or more often nearly the whole of the load carried upon side bearings. There are no advantages in using side bearings, when considered alone, except that they support the side of the car, which the poor and improperly designed body bolster fails to do, and for this purpose one type is as good as another. The disadvantages are numerous. The greatest is the increased cost without corresponding benefits. We are striving to correct evils with wrong remedies. Patented devices have come into the market without number and none have accomplished what was claimed for them, and none will until center plates receive intelligent attention. When this is done the cost for transportation per ton mile will be greatly reduced, due to increased train tonnage per unit of power, trains will be moved faster, with an all-round improvement in service. Frictionless side bearings with frictionless center plates, or as nearly so as can be made, in connection with properly constructed body bolsters, are sorely needed. Mr. George L. Fowler gave some results of an interesting experiment made some time ago to determine the cause of unequal wear on curves.

Mr. Gorrell (P. & R.) opened the discussion on the present method of securing spring

pockets to couplers on freight cars. Mr. Ball suggested that possibly some form of pocket and attachment could be devised that could be removed from broken couplers and reapplied to new couplers at any small interchange or repair point with the labor at hand. He also thought that with the long pockets used in connection with friction draft gears, some form of flexible connection between the coupler and spring pocket would be advisable. He showed a drawing of such a connection in which the coupler is made with an enlarged end at the rear of the shank, which will take a 2½-in. pin. The coupler is also provided with a bushing. The pocket is made of 1-in. x 5-in. iron with the ends upset to form a circular lug concentric with the center of the pin. This gives additional bearing surface for wear. The M. C. B. pocket has 100 per cent. strength through the rivets; this design has 125 per cent. through the pin hole and 116 per cent. through the pin for resisting shear. With this form of pocket the coupler could be detached at any small repair point and a new one easily applied. The design also permits of greater lateral motion of the coupler, a very important consideration. On motion of Mr. F. H. Stark, the subject was referred to a committee for report next year.

Mr. W. E. Fowler opened the discussion on brake-beams and the proper method of hanging them to secure brake-shoe clearance. At least one-half of all the brake-shoes on most of the freight trains on this continent drag on the wheels when the cars are in motion. The retarding effect of this, or the additional power required to overcome the necessary friction, has been estimated to be as high as 5 per cent. No relief has so far appeared for brakes when hung to the body, and none that is practical and effectual when hung to the trucks. The only proper place for attachment of the brake hanger is to the truck, and to that part of it not affected by spring movement, this being necessary to secure uniform piston travel and braking power. Inner hung brakes applied in this way are, however, almost, if not always, so hung that the top (if not all) of the brake-shoe drags on the wheel, creating friction, which is costly, both in brake-shoes and power. The trussed brake-beam, unless supported at the lower fulcrum by a suspension spring or hanger, will produce friction, as will attachment of hanger too low on the brake head, a brake hanger too nearly vertical, a brake lever fulcrum which carries the lever too far forward, a bottom connection too short, etc. The suspension spring at the fulcrum, a bottom rod of proper length, a truck wheel base long enough to permit brake hanger to assume an angle of about 110 deg. with a line drawn through the center of the brake head and center of the wheel—all these are factors in the problem. The suspension spring is neither durable nor reliable, and it adds considerably to the cost of the truck. The brake head should be so re-designed that with a wheel base of 5 ft. 3 in. or 5 ft. 4 in., and brake-beam center 14 in. from top of rail, the contour of the face of the brake-shoe will coincide with the section of the wheel tread presented to it, and the angle of the brake hanger should be sufficient to withdraw the brake-shoe from the wheel evenly—top and bottom—when brakes are released. It would also be well to have the brake hanger as long as possible, so that the difference in position of brake levers, caused by wear of shoes, would have the minimum effect on the hanging of the shoe.

Tests made indicate that a reliable release spring requires to overcome ft a pressure as great as 10 lbs. per sq. in. in the cylinder, and as it also requires more attention than it is likely to receive in the way of adjustment, we should look for a way of overcoming the difficulty by gravity. Mr. G. R. Henderson pointed out that when retardation due to braking takes place the weight is thrown on the forward wheel of the truck, and the weight is decreased on the rear wheel. If the hangers are placed inside, the effect of the angle of the hanger will be to reduce the braking power on the rear wheel, which has the weight decreased, and to increase it on the front wheel, which has the increased weight, so that the full benefit of the brakes is had without slipping. If, however, the brakes are hung outside, then the angle of the hanger tends to effect an increased braking power on the rear wheel, which has the diminished weight, and to reduce the braking power of the front wheel, which has the increased weight. In order to prevent wheels from slipping a smaller co-efficient must be used for braking if brakes are outside hung than if they are inside hung.

Mr. J. J. Hennessey was of the opinion that theoretically the correct position for a brake is inside and hung from the spring plank or some part of the truck that does not vary in height, yet a brake that is not relieved at all by the spring is shut out of good working action so very often that in practice it becomes a serious matter to hang a brake where it is not relieved by the spring, either inside or outside. There would be little trouble with outside hung brakes if a hanger long enough was hung at such an angle that as soon as the brakes are released it would draw the shoe off and not drag on the front end.

Mr. Fowler in reply said that inside-hung brakes are hung to parts of the truck not affected by the truck spring movements and that this insured uniform piston travel in the brake system under all conditions. This is one of the most important points in connection with the subject.

The next topic, "Stronger Draft Gear for Passenger Cars," was opened by Mr. H. La Rue (C., R. I. & P.). He said that two years ago they began to strengthen the draft arrangement on certain classes of equipment with the wooden draft timbers. A tandem arrangement was not used for the reason that very often this equipment was placed in a three or five car train and the draft springs were too stiff. The main trouble was to hold the draft lugs to the timbers and keep them from splitting.

A special casting was designed, which has been applied on all old cars brought into the shop for over a year and they have never had to renew one for any cause. The casting is made in two parts and is securely blocked between the horn on the front of the casting and the end sill; also it is securely blocked between the back of the casting and the body transom. This arrangement has been applied to use on all classes of cars with wooden draft timbers without changing the standard extension of the drawbars and has given excellent results.

About three years ago they increased the standard draft arrangement under the heavier equipment that have steel platforms, by making the spring follower 1⅝ in. thick and the distance between the pulling lugs or draft beams 11 in., but still using the standard 6 in. x 8 in. draft spring.

Some companies are using the tandem springs, but in most cases this necessitates different lengths of drawbars to suit the different equipment, possibly making two or three different lengths, which is a very serious objection upon a large system on account of the large stock carried at so many different points.

The ideal arrangement should operate so that the first ¾ in. of the travel of the drawbar should be comparatively easy or about the same as the present 8-in. spring. The balance of the travel should go up in strength very quickly and much stronger, to suit both light and heavy trains, and also the space occupied by such an arrangement should be but a very little more than the present single spring arrangement, so that the same length of drawbar can be maintained on all classes of cars. Mr. E. M. Herr (Westinghouse A. B. Co.) said that greater yielding resistance is rather difficult to obtain in the very limited space available. It is exceedingly difficult to bring in yielding resistances without having considerable space. In order to absorb the energy which must be done in the starting, you must have space in which to do it. He doubted very much if any successful device could be arranged that would only occupy 8 in.

Mr. G. R. Henderson—The subject of tandem springs in passenger equipment is important. It was referred to by the speaker as not being entirely satisfactory. The last road I was connected with hauled heavy trains, up to 15 and 18 cars, and we found with the single springs that it was impossible to keep the platforms together, and they would stand apart as much as 2 inches. We adopted the policy of placing two springs —tandem springs—and we found quite a benefit in reducing the shock.

Mr. La Rue—What I had reference to as the tandem spring not being entirely satisfactory was in the length of space occupied. My object in bringing this matter up was to stimulate some one to devise an arrangement steady enough to do the work to occupy a space of about 17 inches. If it cannot be brought inside these figures, as I stated before, it will necessitate different lengths of extensions of the drawbars, and that is something we would rather not go to, unless it is absolutely impossible to get something which will answer the purpose. I realize that the tandem spring would be satisfactory for the baggage cars, and such as that, and I believe it would be all right for the forward cars, but I do not think it is right for all coaches, because I think there is too much resistance in the spring.

Mr. J. J. Hennessey (C., M. & St. P.) thought the ideal passenger car spring or attachment should be constructed for an ordinary spring, and that possibly the M. C. B. spring of the present strength could be used. Give that an opportunity to yield 1½ in. and then have a friction come in that would take the severe shocks. The friction would not act at all except when the jerks or the shocks are more than are usually found in ordinary service. The objection to large spring power is that a recoil that is very objectionable cannot be avoided.

Mr. La Rue said his idea in venturing the suggestion that the first ¾ of an inch would be the ordinary spring was on account of the switching of the passenger cars and throwing them together at the present time with the knuckles closed, and also to give the ordinary spring resistance with the 1¼-in. movement that is had on the buffers at the present time on passenger equipment. After that was absorbed then the power should all come in the next inch, running up on the car to a resistance of probably 50,000, 55,000 or 60,000 lbs.

Mr. Herr said there is no difficulty whatever in obtaining exactly what was described in existing friction gears, but not in the

small space. It would require more than 8 in. of space in which to put it.

The meeting then adjourned.

THIRD DAY'S PROCEEDINGS.

The first business of the third session was the supplementary report of the Arbitration Committee on the questions submitted to it for action during the two previous sessions. The committee reported against placing a minimum weight on wheels for acceptance in interchange; fixed the price for 40-ton box car bodies with wooden bodies and steel underframes when 36 ft. long and under 40 ft. at $675; approved the suggestions of the committee on prices of repairs to steel cars in all their important points except the price of ¾ cent for scrap credits, which was recommended to be changed to ½ cent. The supplementary report was adopted without discussion and the convention proceeded to the report of the committee on loading long materials. After much discussion, especially on the recommendation that ties and fence posts loaded on flat cars be not accepted for shipment, the report was ordered referred to letter ballot for action on each rule. A standing committee was ordered to be appointed to take up this question each year.

The next report was on steam and air line connections. The committee was unable to make anything but a progress report and asked to be continued another year. The report of the committee on subjects was received and adopted. (See *Railroad Gazette*, June 24, p. 68.) Mr. C. M. Bloxham read the report of the committee on tank cars and Mr. A. W. Gibbs asked that it be received as a progress report and the committee continued another year. The American Railway Association will not take definite action on the subject of rules for tank car movements in trains until next fall and the committee has still a number of important tests to make before any definite action is taken looking toward a standard. The committee was continued. After hearing the report of the committee on resolutions and the nominating committee the annual election took place. The following officers were elected for the coming year: President, W. P. Appleyard (The Pullman Company); 1st Vice-President, Joseph E. Buker (Illinois Central); 2d Vice-President, W. E. Fowler (Canadian Pacific); 3d Vice-President, George N. Dow (Lake Shore); Treasurer, John Kirby. The executive committee for the coming year is composed of James Macbeth (N. Y. C.), A. E. Mitchell (Lehigh Valley), H. D. Taylor.

The retiring president and incoming president made suitable speeches and after Mr. Appleyard took the chair the meeting adjourned.

## Additional Exhibits at Saratoga.

The following list of exhibits at the Saratoga Conventions completes the partial list printed last week, p. 79:

American Balance Valve Co., Jersey Shore, Pa.—American balanced slide valves, American balanced piston valves, the J. T. Wilson high-pressure balanced valve, American metallic piston rod and valve stem packing, Nixon safety stay-bolt sleeve.

American Machinery Co., Grand Rapids, Mich.—Oliver woodworking tools, wood trimmers, hand jointers, saw benches, band saws, wood lathes and pattern shop tools.

American Nut & Bolt Fastener Co., Pittsburg, Pa.—Samples of nut locks and bolt fasteners.

American Steel Foundries, New York.—The "R. E. Janney" cast-steel coupler.

American Stoker Co., Erie, Pa.—Model of a reverberatory furnace with stoker attachment and a stoker forge stand.

Andrew Ventilator Company, New York—Showing car ventilator.

Ashton Valve Co., Boston, Mass.—Exhibit in a room at the Grand Union Hotel of locomotive muffler and pop safety valves, blow-off valves, air and steam gages, gage testers and chime whistles.

Aurora Metal Co., Aurora, Ill.—Samples of the Lewis & Kunzer metallic piston packing.

Baltimore Railway Specialty Co., Baltimore, Md.—Norwood ball-bearing center-plates and side bearings.

Barnett Equipment Co., Newark, N. J.—The Barnett connector for automatically coupling the steam, air and signal pipe lines between cars.

Beard, Andrew J., Birmingham, Ala.—The Beard coupler.

Berlin Machine Co., Beloit, Wis.—Photographs and drawings of woodworking machinery.

Charles H. Besly & Co., Chicago, Ill.—Gardner grinding machines, taps, parallel clamps, spiral grooves.

Best International Calorific Company, Los Angeles, Cal.—Showing locomotive, stationary and blacksmith furnace burners.

Herman Boker & Co., New York.—Samples of "Novo" steel twist drills, cutters and other tools.

L. J. Bordo Co., Philadelphia, Pa.—The Bordo blow-off valve and Bordo swing joints.

Buchanan, Dr. A. T., Chicago, Ill.—Showing the Fay Manilla Roofing Company's insulating paper.

Cambria Steel Co., Johnstown, Pa.—Exhibit of locomotive forgings and two steel cars placed on the D. & H. tracks.

Camel Co., Chicago, Ill.—Hose clamps and car doors.

Car Builders' Supply Co., Chicago, Ill.—McIntosh ventilated hatch cover, freight and passenger car side bearings, oil box.

The Philip Carey Manufacturing Co., Lockland, Ohio.—Samples of 85 per cent. magnesia locomotive lagging and steam pipe covering.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I.—Exhibit of taps, dies and other small tools.

Case Manufacturing Co., Columbus, Ohio.—Crane trolleys, electric hoists and controlling apparatus for crane motors.

Chicago Railway Equipment Co., Chicago, Ill.—"Creco" automatic frictionless side bearing, "Diamond" special brake-beam for high-speed brakes, "Diamond" adjustable brake-beam.

Cling-Surface Mfg. Co., Buffalo, N. Y.—Samples of belt dressing.

Coburn Trolley Track Mfg. Co., Holyoke, Mass.—Exhibit of overhead trolley track with traveler and hoist fitted with an automatic hoisting rope lock.

Columbus Steel Rolling Shutter Co., Columbus, Ohio.—Samples of steel rolling shutters.

Corkery Door Hanger Co., East Cambridge, Mass.—Model of car door hung on Corkery door hangers.

Corrington Air Brake Co., Matteawan, N. Y.—Air brake equipment for engines and cars and the Corrington alternate-continuous brake system apparatus.

Crandall Packing Co., Palmyra, N. Y.—Samples of steam, air and hydraulic packings.

Creasor, J. H., Wabigoon, Canada.—Showing the Creasor roller bearings.

Curtain Supply Co., Chicago, Ill.—Attractive booth fitted with several styles of car curtains with Burrowes and Forsyth "Roller Tip" fixtures.

Damascus Brake Beam Co., St. Louis, Mo.—Damascus brake-beams.

Davis Expansion Boring Tool Co., St. Louis, Mo.—Davis expansion car wheel boring tools.

Detroit Lubricator Co., Detroit, Mich.—Exhibit of several sizes of locomotive sight-feed lubricators of the original "bull's-eye" type.

The J. Dixon Crucible Co., Jersey City, N. J.—Samples of Dixon graphite paints and lubricants.

Dressel Railway Lamp Works, New York.—Locomotive headlights, signal lamps.

G. Drouvé Co., Bridgeport, Conn.—Models of the Lovell window operating device for shops and other buildings.

Economy Locomotive Sander Co., Baltimore, Md.—Exhibit of locomotive sanding devices.

Edgar Car Lock & Seal Co., Kansas City, Mo.—Car locks and seals for refrigerator car doors and sliding doors.

The Electric Storage Battery Co., Philadelphia, Pa.—Chloride accumulator storage batteries for train lighting.

Empire Safety Tread Co., Brooklyn, N. Y.—Samples of carborundum safety treads for car steps.

The Fairbanks Co., New York.—A large exhibit of gas engines, valves, scales, trucks, pumps, leather belting, Dart unions and flanges, power hacksaws, power hammers, copy presses, pipe-threading machines and other miscellaneous railroad tools and appliances.

Federal Co., Chicago, Ill.—Railroad water closets and toilet fixtures.

Flannery Bolt Co., Pittsburg, Pa.—Tate flexible stay-bolts.

Garlock Packing Co., Palmyra, N. Y.—A full line of air, steam and hydraulic hose, packings and rubber goods, including the Garlock throttle and air-pump packings.

General Manifold Co., Franklin, Pa.—Samples of manifold sheets, requisition blanks, defect cards, etc.

Goldschmidt Thermit Co., New York.—Samples of pieces welded by the Alumino-Thermic process.

Goodwin Car Co., New York.—Catalogues and photographs of the Goodwin dump car.

A. Morris Hall, Philadelphia, Pa.—Drop forgings made by the Transue & Williams Co., Alliance, Ohio, including car and locomotive forgings, ball-bearing center-plates, Buckeye track jacks, drop-forged keys and wedges.

Hall Signal Co., New York.—A two-blade electro-gas signal in operation and illuminated by the Commercial Acetylene Co.'s system.

Hanlon Locomotive Sander Co., Winchester, Mass.—Working model of locomotive sander.

Harris Manufacturing Co., Greenville, S. C.—Showing a train signal device operated through an independent line of ¾-in. pipe.

Harrison Dust Guard Co., Toledo, Ohio.—Exhibit of four sizes of Harrison dust guards for 20, 30, 40 and 50-ton cars; also a car journal lubricator.

N. L. Hayden Mfg. Co., Columbus, Ohio.—Samples of Downing metallic packing, Tippet locomotive safety valve and Hercules malleable pop safety valve.

Helwig Manufacturing Co., St. Paul, Minn.—Pneumatic tools.

Hill, Clarke & Co., Boston, Mass.—One No. 2 plain milling machine, one No. 2 Universal milling machine, one No. 2 Lucas boring machine, one 4-ft. Western radial drill, one 24-in. wet tool grinder, motor driven.

Hess-Bright Mfg. Co., Philadelphia, Pa.—Exhibit of ball bearings.

Hoffman Grain Door Co., Battle Creek, Mich.—Model of the Hoffman grain door.

Home Rubber Co., Trenton, N. J.—Samples of "N. B. O." packing, sheet packing and steam and air hose.

Industrial Water Co., New York.—Full size model of a chemical regulating device for a water-softening machine in operation.

International Text-Book Co., Scranton, Pa.—Complete sets of the "Library of Technology," electrical and mechanical engineering courses and law course and one of their instruction cars on the D. & H. tracks.

Jenkins Bros., New York.—Full line of angle and globe valves for high and low pressures and samples of Jenkins' "96" packing.

Kennicott Water Softener Company, The, Chicago, Ill.—Showing water-softening apparatus.

Keystone Drop Forge Works, Philadelphia, Pa.—Drop forgings for car and locomotive work, including Keystone connecting links, safety shackle hooks and crocodile wrenches.

Kindl Car Truck Co., Chicago, Ill.—Models of Kindl and Cloud trucks.

Locomotive Fuel Saving Company, New York.—Catalogues, records and photographs of fuel-saving device.

McGuire, Cummings Mfg. Co., Chicago, Ill.—A model of a new grain door with safety door brackets.

Mann, McCann Co., Chicago.—The Bruyn smoke jack, Northwestern locomotive air sander, McCann grader and spreader car, the Young locomotive valve gear, the Ravlin system of electric wiring for roundhouses and shops.

Manufacturers' Railway Supply Co., Chicago, Ill.—Plain and pocket faced interlocking brake shoes for cars and locomotives, samples of shoes taken direct from service from several large roads. Display showing difference between amount of scrap from interlocking and other types of brake-shoes. Brake-beams for demonstrating the application and working of the shoes.

Modern Tool Co., Erie, Pa.—"Magic" chucks, self-opening dies, taps, mills, grinders and Wallace chaser.

Monarch Supply Co., Chicago, Ill.—Roller side bearing.

Moran Flexible Joint Co., Louisville, Ky.—Moran flexible joints for steam and air connections between engine and tender.

Nathan Mfg. Co., New York.—Exhibit of injectors, lubricators and Klinger reflex water glass.

Nernst Lamp Company, The, Pittsburg, Pa.—Showing the Nernst lamp, in the Westinghouse joint exhibit.

New Jersey Tube Co., Newark, N. J.—Cor-

rugated boiler tubes and a hydraulic machine for testing their expansion.

Page Car Company, Winterport, Me.—Models of dumping cars.

Peck, Stow & Wilcox Company, New York.—Wrenches, braces and chisels.

Peckham Manufacturing Company, The, New York.—Taylor non-chattering brake hanger, photographs and blue prints of electric and steam railroad trucks.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.—Chipping, calking and riveting hammers, yoke riveters, rotary drills, breast drills, foundry rammers, air hoists and complete pneumatic equipments; also a Herron & Bury compressor.

Post & Co., E. L., New York.—Post "Zero" metal for car and locomotive bearings.

Pyle-National Electric Headlight Co., Chicago, Ill.—See exhibit of Commercial Acetylene Co.

Railway Appliances Co., Chicago, Ill.—Oldsmobile railroad inspection car.

Rostand Manufacturing Company, New Haven, Conn.—Model of extension hat and bag rack for passenger coaches.

Schoen Steel Wheel Co., Pittsburg, Pa.—Exhibit of Schoen solid rolled and forged steel wheels.

Charles R. Silkman, New York.—An exhibit of samples of "Pluviusin," an artificial leather.

Smart Car Door Co., Nashua, N. H.—Model of Smart flush car door.

Spiral Journal Bearing Co., New York.—Exhibit of new and worn journal bearings.

Standard Brazing Co., Boston, Mass.—Brazing process.

Standard Paint Co., New York.—Refrigerator car models showing insulation sheeting and insulating paper, iron and wood preservative paint, car flooring and "Ruberoid" roofing.

The Standard Steel Works, Philadelphia, Pa.—The Standard rolled steel wheel.

Stannard & White, Racine, Wis.—Exhibit of locomotive cab seats.

Star Brass Manufacturing Co., Boston, Mass.—Steam gages, pop safety valves, lubricators, renewable seat and disc globe valves, angle valves, blow-off cocks, water gages, recording gages patent cylinder relief and vacuum valves.

Templeton, Kenly & Co., Ltd., Chicago, Ill.—Simplex jacks.

Traminell, E. R., Lakeland, Fla.—Safety device for holding up drawheads where pulled out.

Underwood, H. B., Philadelphia, Pa.—Catalogue of special tools, boring bars and valve seat facers, and a quartering level.

Washburn Company, The, Minneapolis, Minn.—Freight couplers, flexible head passenger couplers and switch engine couplers.

Watters, J. H., Augusta, Ga.—Automatic pneumatic track sanders.

Waugh Draft Gear Company, Chicago.—Full size model of spring cushion draft gear.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. The Wellman-Street cast-steel bolsters.

Wheel Truing Brake Shoe Co., Detroit, Mich.—Samples of wheel truing brake shoes.

J. T. Williams & Sons, New York.—Exhibit of fancy woods for interior finish and decoration of cars.

## Performance of Automatic Signals Under Unfavorable Conditions.*

BY H. S. BALLIET.

### IV.—Batteries and Their Enclosures.

The gravity cell is the most common type of battery in use for working track circuits, being best adapted to heavy discharges and frequent short circuits. Generally speaking, two such cells are placed in multiple; this is done in order to keep the voltage as low as is practicable (about one volt being available). This arrangement of cells is considered necessary in order to avoid the possibility of failure to operate the relay in case one jar breaks.

This cell is easily maintained, it being necessary to renew the sulphate of copper about once every four weeks. A 4-lb. zinc of good quality will wear three months. These zincs

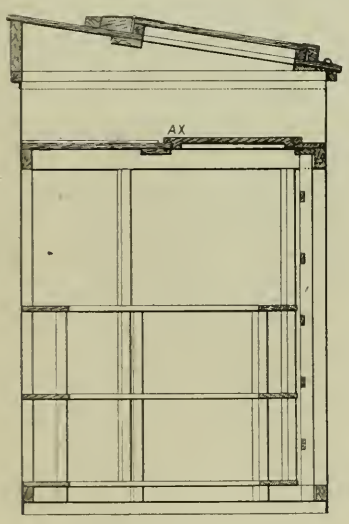



Fig. 1—Iron Battery Well.

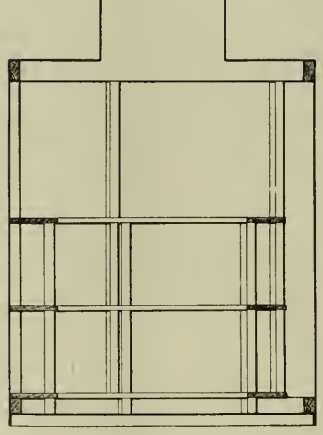


Fig. 2—Battery Well with Small Opening.

should not be used after they are worn thin; for the internal resistance of the cell is then increased and in case of heavy rain or poor track insulation from any cause there are likely to be numerous interruptions, due to the insufficient voltage. Practice indicates that no zinc should be kept in service for a track circuit if it weighs one pound or less.

In some sections these cells are kept in good condition by the frequent use of a hydrometer, the density of the zinc solution being maintained at a specific gravity not to exceed 1.15, which is equivalent to about 24 per cent. of zinc sulphate plus 7 molecules of water. While this may work out to a nicety, a better way is to adopt stated periods for renewing the cells, say, once in four weeks, if the traffic is reasonably heavy and once in six weeks if it is not over 30 train movements in 24 hours. It can be said, however, that when working under such conditions cells should be inspected at least once between renewals. If there is too much zinc solution it should be diluted with water. Care should be taken to thoroughly screen and wash all sulphate of copper in a cell when it is renewed, also to remove all collections of copper so as to discourage the so-called "caking." Zincs should be kept scrupulously clean, so that there may be free action. This battery, being made of a solution of sulphate of copper, freezes when the temperature falls below 32 deg. F. To anticipate this condition, the cells are kept in iron pipes called "chutes," set in the ground, which brings the lowest cell about 7 ft. below the surface; deep wooden wells are also used and sometimes surface battery houses. With these precautions, generally speaking, there have been no interruptions to the continual flow of current, but the last winter made new disclosures, and it will be necessary to try new preventives.

A number of gravity cells were frozen for the first time because frost penetrated the earth farther than ever before—from six to eight feet. These conditions have been met successfully by using a liberal amount of mineral wool about 10 in. thick around the chute for a depth of four feet. One very trying case of frozen track battery was that where the temperature remained at from 28 deg. F. to 32 deg. F. below zero for several days. It was impossible to keep the circuits in service without the aid of heat, which was supplied by putting kerosene lamps within the chutes. In another instance the thermometer registered from 10 deg. F. to 20 deg. F. below zero for a period of ten days, the frost penetrating to a depth of five feet. This cold spell was followed by a rising temperature for a period of three days, the thermometer on the third day reaching 50 deg. F.; then there was a steady thermometer

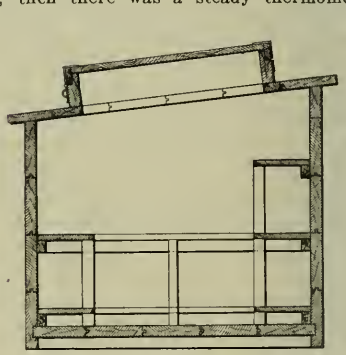


Fig. 5—Wooden Battery Well.

ranging from 32 deg. F. to 40 deg. F. for a period of three days at the end of which the cells in six chutes were frozen solid. The failure of the track section due to this freeze-up occurred on the ninth day following the breaking up of the cold spell. It is proposed to meet this condition by putting a liberal quantity of manure around and over the tops of these chutes. It is believed this will be an absolute protection. This conclusion seems warranted from experience gathered on another section of the same road, where under parallel conditions, the cells worked without interruption, having been protected by piling manure around iron battery wells in which were cells of several different designs. In the case of the six chutes frozen, it is known that the earth was not closely packed when the chutes were set.

The gravity cell is also used for operating signal magnets, clutches and locks. When used for this purpose, the cell need not have so close inspection as when it is used for track circuits. The cells are connected in series; with the higher voltage and freedom from polarization under a heavy and continued current output the cell is popular. The labor involved in making renewals when the cells become exhausted is somewhat greater than for cells using soda or potassium. The objections to the cell are briefly: 1, liability to freeze; 2, expense of renewals. To anticipate freezing, many designs of cellars or wells have been devised. Those made of iron are generally like Fig. 1. In this design, boiler iron ¼ in. thick is used. The

*Previous articles on pages 137, 242, 287 and 382.

well is circular with the bottom riveted in so as to guarantee a water-tight enclosure. The shelves on which the cells are set, the "frost-breaker" and the top are made of wood. These wells are usually 7 ft. deep and 5 ft. in diameter.

There is also a design of cellar, or "tub," as it is usually termed, made of wood of the same general appearance as the iron well just described. In both designs of cellars, it is necessary to provide frost doors or breakers, A X Fig. 1. Where this is not sufficient protection manure must be piled around and over the top of the well.

There is in service a cellar constructed on lines corresponding closely with Fig. 2; in this design, it will be seen that the opening is only 2 ft. square. I have never heard of a frozen gravity cell in such a well; a number are in service in the west and northwest.

Where, because of quicksand, rock or swamp, it is not expedient to use the cellar, it is advisable to build shelters on the surface. Of this type of shelter the most common is a small frame building with double thickness wall and an air space of 3 in. filled with sawdust; double floor and double ceiling lined in same manner. The roof is gen-

Fig. 3—Brick Battery House.

erally of shingle. This box has withstood temperatures as low as zero, but where the thermometer drops below that point, artificial heat must be provided. This is usually done by burning a kerosene lamp within the shelters. Several railroads have surface enclosures built of concrete. This has been found to meet the conditions quite well. Fig. 3 shows a circular brick shelter with a concrete roof; this is of recent design and is believed to be one of the best shelters in service.

Cells in surface house shelters are renewed with less labor than cells in cellars or wells, for with the latter all materials must be carried to the bottom or the cells must be carried to the surface of the ground. When gravity battery is used, these interruptions may cause delay to trains, unless they are quickly anticipated, and then only at an increased cost for both labor and material.

Of the second objection, it might be briefly stated that the amount of labor employed to keep in operation 3,000 cells of gravity battery on a certain road originally cost 30 per cent. more than it does at the present time with more improved designs of battery.

The gravity cell is gradually giving way to the more improved types of so-called "acid primary batteries," of which there are two distinct classes; those consisting of a solution of potassium hydrate and those consisting of a solution of sodium hydrate. It is probable that there are in service more cells of the former type than any other except the gravity. The most prominent type of this class is the "Edison Primary Cell." Its general design is too well known to require description. Of the second class there are now four prominent types in the market—Waterbury, Gordon, Nungesser and Gladstone-Lalande. In the first three, the cathode or copper element is in the form of scale instead of a compressed plate as in the Edison. The use of scale makes it necessary to use a perforated basket or cylinder.

In the Gladstone-Lalande, the mechanical construction compares favorably with the Edison Primary, differing from that principally in its solution, which is a 20 per cent. solution of caustic soda. Gravity cells are being replaced by cells of the acid type and frequently they are placed in the enclosures

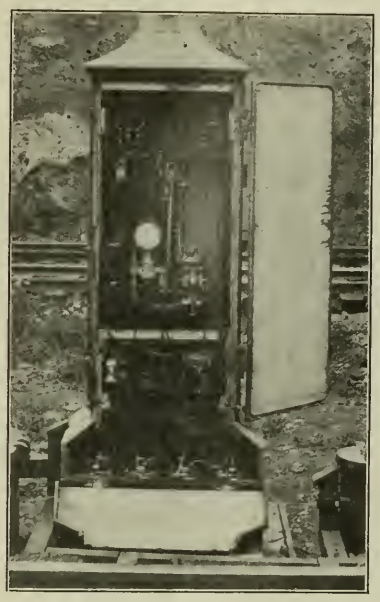


Fig. 4—Iron Battery Enclosure.

formerly used for the gravity. In many cases it is deemed necessary to keep them underground, so that their solutions can be kept from congealing, which action reduces the e.m.f. Carefully compiled records show a diversity of opinion as to best practice in this direction. During the past winter the potash solution, when used underground, *i. e.*, below the frost line, did not congeal enough to cause a noticeable decrease in e.m.f. This appears to be true of all cells, whether they had recently been renewed or had been in service for a year. These cells had the best protection possible short of applying artificial heat.

There are, however, on record, a large number of failures of this type where the cells were installed within iron enclosures like Fig. 4. The drop in e.m.f. varied in different localities and under different temperatures. In a region where the temperature ranged from 10 deg. F. to 20 deg. F. below zero, many of these cells were frozen into a solid mass and ceased to deliver current; in other localities, the thermometer went as low as 36 deg. F. below zero, but not enough congealing took place to cause the flow of current to cease, although the signals moved slowly; where, under favorable conditions, a signal will move from the stop to the proceed position in 3 to 6 seconds, the time was increased to 30 and even 45 seconds.

As to the cause of this congealing, there is a diversity of opinion. Some claim that it is due to the age of the solution and advocate the renewal of all cells in the fall, so that in cold weather the benefit of the new solution may be had; others think it is the very nature of the solution and that unless heat is applied it cannot be prevented; still another opinion is advanced that the solution is not properly prepared by the men who do the recharging—that they use too much water for the quantity of potash.

A number of cells having a solution of 20 per cent. potassium hydrate with a specific gravity of 1.175 show a decrease of .1 volt per cell in 24 hours with the thermometer at 20 deg. F. below zero. When this drop in voltage was noticed, the specific gravity of the cells was 1.25, they having been in service about six months. As to the renewal of the cells in the fall, opinion differs very much, some claims being made that there is no difference. Cases are cited where renewed cells were placed within the same enclosure with old cells and they all suffered alike. Tests carried through two winters indicate that the trouble is traceable to the density of the solution, principally. It is likely that most of this trouble can be anticipated if the proper strength of solution is used; the trouble with a weak solution being its lia-

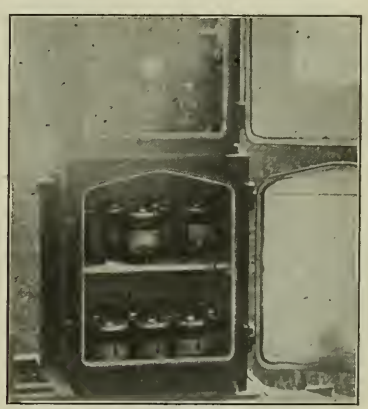


Fig. 6—Iron Battery Enclosure.

bility to freeze and with a strong solution to crystallize out.

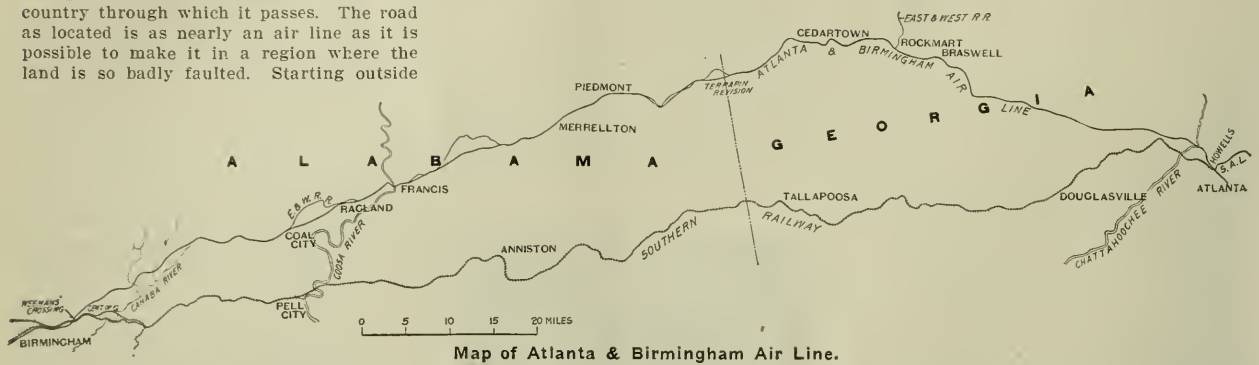
The cells in which a solution of sodium is used have shown remarkable qualities to withstand severe declines in temperature. On a large installation where all of the cells are in enclosures like Fig. 6 and in wooden battery wells like Fig. 5, no case is recorded where there was congealing sufficient to reduce the e.m.f. more than one volt for every 20 cells installed. The temperature ranged from zero to 42 deg. F. below; the specific gravity was 1.25, the cell having been in service about five months. These figures apply to a 25 per cent. solution with a specific gravity of 1.29 when installed.

This record is from sections separated many miles and the solutions had been in service anywhere from a few days to about three years; in one exceptional case the cells had delivered current uninterruptedly for a period of 43 months. This particular battery is still in service and operates a home and a distant enclosed disk signal with an average train movement of 30 trains every 24 hours.

Of the cells using sodium over 100 were in service during the past winter for track batteries in exposed places and no failures occurred. Many were in tunnels and on bridges where the gravity cell could not be kept from freezing even by the use of lamps. But to convey the impression that such cells will not congeal, and even freeze, would be wrong; they are thus affected when too much water is used in the solution.

## The Atlanta & Birmingham Air Line.

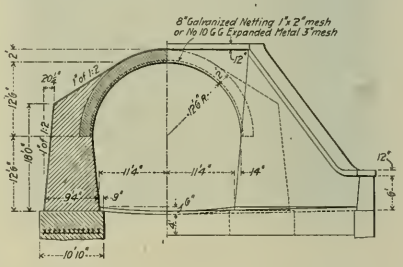
The Birmingham extension of the Seaboard, or the Atlanta & Birmingham Air Line, as it is commonly known, now building between Atlanta, Ga., and Birmingham, Ala., presents many interesting features owing to the natural characteristics of the country through which it passes. The road as located is as nearly an air line as it is possible to make it in a region where the land is so badly faulted. Starting outside of Atlanta at Howells, the line passes in a northwesterly direction through Fulton, Cobb, Paulding and Polk counties, in the State of Georgia, into the Red Mountain district of Alabama, where it runs through the Counties of Calhoun, St. Clair and Jefferson, encountering many coal measures and ridges of limestone. This latter region is noted for its brownstone, iron ore, red hematite, coal and limestone, and these natural features should eventually prove of immense value to the railroad passing through the district. According to the present estimates, the Atlanta & Birmingham Air Line, when completed, will be 166 miles long, the air-line distance between the two cities being about 146 miles.




Map of Atlanta & Birmingham Air Line.

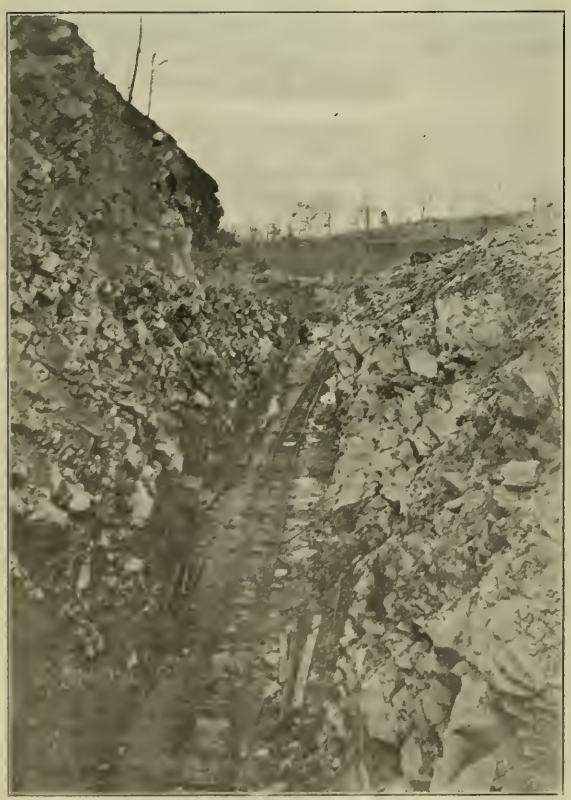
The Atlanta & Birmingham Air Line is being built under the general specifications of a 1 per cent. grade and a maximum curvature of six degrees, compensated with easements. Seventy-five-lb. rails are used throughout and passing tracks are built every five miles. There will be 16 depots, ten water stations and three coaling stations on the line. The coaling stations will be located at Howells, Rockmart and Coal City and will have a capacity of 800 tons, 250 tons and 200 tons, respectively. They will be equipped with Fairbanks, Morse & Company's gasoline engines and hoisting machinery and the old car-dumping system now in vogue will be abandoned. The water stations will each have a tub capacity of 50,000 gallons. The terminal points on the line will be at Howells, just outside of Atlanta, and at Nineteenth street in Birmingham. At Howells, several new shops and a yard have been built, and at Birmingham a new freight house is now going up.

The work on the main line has been divided into three divisions, the first one extending from Howells to Rockmart, a distance of 45 miles, where connection is made with the old East & West Railroad. This division which is practically a cross country line through a very rugged country, has necessitated a number of heavy cuts and fills and the removal of about 2,750,000 cu. yds. of earth. The heaviest work is at Braswell, thirty-six miles out of Atlanta, where there is a tunnel 700 ft. long, built through solid rock. The rock cut approach at the eastern end of this tunnel is shown in the acccompanying photograph. The work on this division also includes a deck truss bridge with two spans, each 135 ft. long, over the Chattahoochee River, four miles out of Atlanta. This bridge has two deck plate girder trestle approaches, the eastern one of which is supported on eight steel bents and the western on four bents. These bents rest on concrete piers and connect the two concrete abutments at either end. Just to the west of this bridge the Atlanta & Birmingham Air Line encounters the Atlanta & West Point Railroad, and a concrete skew arch culvert has been built under the latter road, as shown in the accompanying photograph. This culvert has been made sufficiently broad for the building of a second track, as it is the intention of the company to eventually make this line double track for the entire distance. Work on this division is well advanced; grading is all completed except on a few short sections and track has been laid for over two-thirds of the distance.




Twenty-five Foot Arch Culvert.

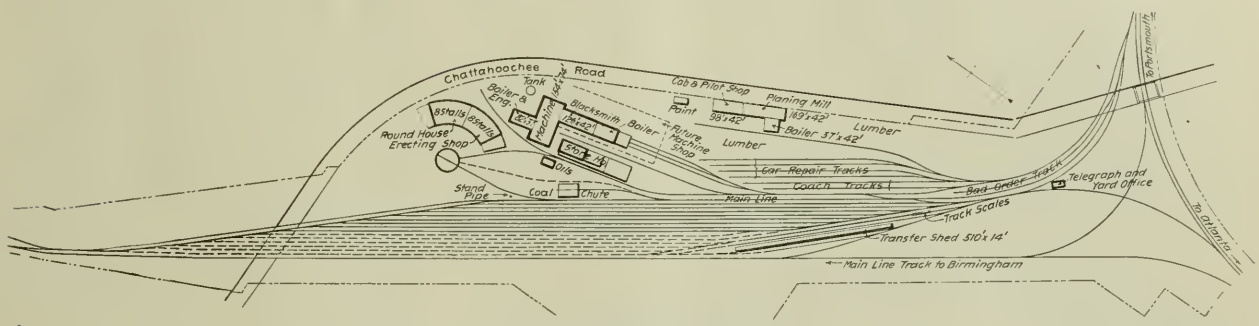
The second division, running from Rockmart, Ga., to Coal City, Ala., is practically a revision of the old East & West Railroad and the work has consisted principally of reducing the alinement from 14-degree



Approach to Braswell Tunnel, Looking West.

Skew Arch Culvert West of Chattahoochee River.

curves on the old line to six-degree curves on the new, and the grades, from 2 per cent. to a maximum of 1 per cent., compensated. The distance on the old line between these points is 86 miles, while the new location is only about 80 miles long, saving approximately six miles. The new line generally follows the grade of the East & West roadbed, except between Merrellton and Francis, in place of the wooden structures in the old line. The largest bridge is over the Coosa River, about 15 miles east of Coal City. This bridge is of plate-girder construction, with three fixed spans and a draw. Smaller bridges have also been erected over Fish Creek, Terrapin Creek and Ohatchee Creek. After passing the Coosa River, the new line diverges sharply from the East & West Coal City to Birmingham, about 40 miles. It is on this division that the numerous ridges of the Blue Ridge Mountains are encountered, running northeast and southwest, making it impossible in some places to avoid tunneling and necessitating a large number of very heavy cuts and fills. Shortly after leaving Coal City, the line encounters the first ridges in these mountains. As it was




New Receiving Yard at Howells—Atlanta & Birmingham Air Line.

where an entirely new location has been made. In all cases where the old line is followed, the roadbed has been entirely reballasted and relaid with 75-lb. rails to make it suitable for the heavier class of rolling stock which will pass over it. The work on this division has also included the building of a number of plate-girder bridges

roadbed at Ragland and passes to the southeast of the old alinement until within a few miles of Coal City. Grading on the second division is completed and track has all been laid.

The heaviest work on the Atlanta & Birmingham Air Line is on the third division, which runs from a point 1½ miles east of

found impossible to cut through these ridges, the Hardwick tunnel, which is 1,100 ft. long, was built. This tunnel is already headed and the reinforced timbering is being removed. After leaving the Blue Ridge Mountains, the line passes through the Beaver Valley north of Anderson Mountain and comes to the Black Creek Valley. Three

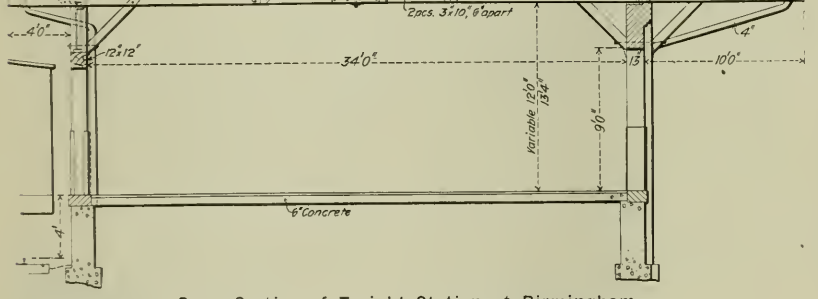
Deck Bridge Over Chattahoochee River—Atlanta & Birmingham Air Line.

creeks run through this valley and over each of these a bridge 75 ft. high has been built. From there on coal measures are again encountered until the Cahaba River is reached. At this point there is a steel viaduct 500 ft. long and 124 ft. high supported on concrete pedestals. The foundations of this bridge are finished and the work on the steel superstructures will soon be begun. After leaving the Cahaba River, the line again encounters a number of ridges and at Roper Gap another tunnel 850 ft. long is being built. The line then runs through a region that is fairly level to a point called Weeman's Crossing, ten miles out of Birmingham. Here the roadbed is elevated, as it crosses over the tracks of the Southern and the Central of Georgia railroads. The terminal point in Birmingham is at Nineteenth street. Grading on this division is now finished and both the tunnels have been headed. Track laying will probably be finished early in the fall.

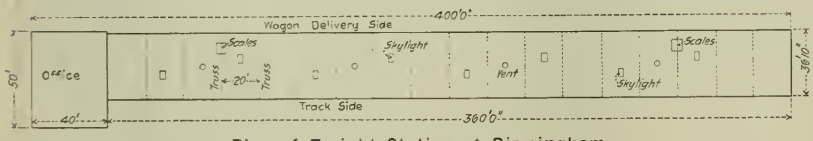
The general features at the terminal consist of a new yard and shop at Howells and a freight station at Birmingham. The buildings at Howells are now all under roof and include a roundhouse and erecting shop, each containing eight stalls. These buildings are built of fireproof construction with walls of brick and concrete. The turntable is 70 ft. in diameter and is 100 ft. from the outside door of the roundhouse. The other buildings in the yard are a boiler and engine shop 37 ft. x 82 ft., machine shop 74 ft. x 154 ft., blacksmith and boiler shop 42 ft. x 252 ft., planing mill 42 ft. x 169 ft., cab and pilot shop 42 ft. x 98 ft. and a storehouse 42 ft. x 154 ft. with a platform 54 ft. x 100 ft. The new receiving yard at Howells has nine receiving tracks and six car repair tracks. The two main-line tracks to Birmingham run just south of the yard, but the arrangement is such that the cars may easily be switched into the receiving yard without disturbing the main-line traffic. The new freight station at Birmingham, on which work is well under way, is located between Nineteenth and Twentieth streets, and will be 360 ft. long on the track side and 400 ft. long on the street side, the extra 40 ft. being devoted to an office building which connects with the end of the freight station. The station is sectioned off by truss spans into 18 divisions, each 20 ft. wide x 34 ft. long. Each of these divisions is provided with a rolling steel door on the track side, which can be pushed to one side when cars are being loaded or unloaded. The top of the rail is 4 ft. below the floor level. Two scales of 5,000 tons capacity each are conveniently located at either end of the building, and light is obtained by means of skylights 4 ft. x 6 ft. cut in the roof at intervals of every 40 ft. The floor is made of 6-in. concrete, with a 3-in. surface mixture of Portland cement and sand, and is supported on 18-in. concrete walls resting on the foundations of the building.

One of the interesting features of the Atlanta and Birmingham Air Line is the number of culverts which have been built along the route. Most of these are of the usual arch design, with heavy abutments. The largest one is on the third division and has a 25-ft. span. This culvert is made of concrete reinforced by corrugated bars. The concrete is 1:3:6 mixture. In order to make the load per square foot on the foundation as nearly uniform as possible, the bottom of the culvert is cut out in the form of a V from each end. The arrangement of the bars at the base of the culvert is clearly shown in the accompanying drawing.

We are indebted to R. H. Jones, engineer in charge of construction; Thomas B. Lee, engineer of the third division, and T. W. Cothram for the data furnished and for the line drawings.




Cross Section of Freight Station at Birmingham.




Plan of Freight Station at Birmingham.

## Train Accidents in the United States in May.[1]

eq, 1st, Texas & New Orleans, Dayton, Texas, a freight train was derailed by a broken wheel while passing over a trestle bridge, and 17 loaded cars, most of them oil cars, were derailed and fell to the ravine below. A large part of the bridge was also destroyed.

rc, 2nd, Pennsylvania road, Van Dyke, Pa., rear collision of freight trains, wrecking the engine and 20 cars. The engineman was badly injured.

*unf, 2nd, Great Northern, Shevlin, Minn., passenger train No. 13 was derailed at a bridge which had been weakened by fire, and several cars were damaged. The engine, tender and most of the cars crossed the bridge in safety. The rear car stopped on the bridge and took fire and was burnt up, but the passengers riding in it escaped in safety. Eight passengers were slightly injured.

o, 2nd, Missouri Pacific, Bushong, Kan., the locomotive of a passenger train was wrecked by the explosion of its boiler, and the engineman and fireman were blown out of the engine and badly scalded; but their injuries were not expected to prove fatal.

xc, 4th, 8 p.m., Delaware, Lackawanna & Western, Hoboken, N. J., a westbound passenger train ran over a misplaced switch and into the head of an eastbound passenger train. Both trains were moving slowly. Two passengers and two trainmen were injured.

eq, 4th, St. Louis, Iron Mountain & Southern, Newport, Ark., freight train No. 80 was derailed by a broken journal and nine cars were ditched. Two tramps were killed.

4th, Missouri, Kansas & Texas, Wirth, Ind. T., a freight train was derailed and 11 cars were ditched; one fireman killed. It is said that the derailment occurred at a switch which had been left unfastened.

bc, 5th, International & Great Northern, Phelps, Tex., butting collision between freight train No. 51 and an empty engine, badly damaging both engines. The conductor and fireman of the freight were killed and two other trainmen were injured. It is said that the conductor of the freight overlooked a meeting order.

bc, 5th, 9 p.m., Baltimore & Ohio, Stanley, Ohio, butting collision between a passenger train and a freight, badly damaging both engines and six freight cars. One engineman and six passengers were injured, the engineman fatally.

o, 6th, Pennsylvania road, Ship Road, Pa., the locomotive of a freight train was wrecked by the exnlosion of its boiler; a brakeman and the fireman were scalded, the brakeman fatally.

unf, 8th, Sonora Railroad, Huachuca, Ariz., a passenger train broke through a bridge which had been weakened by fire, and the engine and all of the cars but one fell 15 feet to the ravine below. The engineman and fireman were fatally injured and one passenger and the express messenger were seriously hurt.

o, 8th, 11 p.m., Denver & Rio Grande, Colorado Springs, Col., one of the two locomotives of passenger train No. 4 was wrecked by the explosion of its boiler, and the engineman and fireman were injured.

xc, 9th, Norfolk & Western, Bristol, Va., a freight train drawn by two engines became uncontrollable on a steep descending grade and ran at high speed to the junction with the Southern Railway, where it collided with an engine on that road. Two engines and several cars were badly damaged. One fireman and two enginemen were injured.

dn, 10th, 1 a.m., New York, New Haven & Hartford, Port Chester, N. Y., a westbound train of Adams Express Company's cars was derailed by running through a crossover at high speed, and the engine was overturned and fell down a bank. The engineman was killed and the fireman fatally injured. The engineman appears to have disregarded a distant and a home signal set against him.

eq, 11th, Illinois Central, Dixon, Ill., a passenger train was derailed by the breaking of a truck of a refrigerator car in the front part of the train, and three cars were badly damaged. Two trainmen and several passengers were injured.

eq, 11th, Southern Railway, Rock Fish, Va., passenger train No. 39 was derailed at or approaching a steel trestle bridge, by the breaking of a side rod of the engine. Two sleeping cars broke through the bridge floor

[1] Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defect of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

and fell part way down to the ground below, crushing the members of the bridge as they fell. Two tramps were killed.

unx, 12th, Illinois Central, Middleburg, Tenn., passenger train No. 5 was derailed and the engine was overturned. The engineman was killed and the fireman and two other trainmen were injured.

unf, 12th, Pennsylvania Railroad, Trenton, N. J., a freight train was derailed by sand which had been washed on the track by water overflowing from a canal, and two main tracks were blocked. A second freight train ran into the wreck and 20 cars were badly broken up. A fireman was injured.

unx, 12th, Union Pacific, Carter, Wyo., passenger train No. 2 was derailed and five cars were ditched. Three passengers were injured.

unx, 12th, Atlantic Coast Line, Hope Mills, N. C., a freight train was derailed and the engine and many cars were wrecked. The engineman was killed and the fireman injured.

bc, 13th, 4 a.m., Cincinnati, New Orleans & Texas Pacific, Danville, Ky., butting collision of freight trains, wrecking both engines and several cars. It is said that the northbound train ran past a station at which it had orders to wait for the southbound.

unx, 15th, Chicago, Burlington & Quincy, Plattsmouth, Neb., a freight train was derailed and the engine and four cars were ditched. The fireman, engineman and one brakeman were injured, the fireman fatally.

xc, 16th, Great Northern, Monroe, Wash., a westbound passenger train ran over a misplaced switch and into some freight cars standing on a side track, wrecking the engine and several freight cars. One brakeman was killed and the fireman was fatally injured.

xc, 17th, night, Southern Railway, Proffit, Va., passenger train No. 39 ran over a misplaced switch and collided with a freight car standing on the side track, and the engineman was injured. It is said that the switch had been maliciously misplaced and that the light was fixed so as to indicate all-clear.

†eq, 17th, Chicago, Burlington & Quincy, Moorcraft, Wyo., passenger train No. 42 was derailed by a brake-beam falling to the track, and the engine and three cars fell down a bank. One passenger was killed and three were injured.

bc, 19th, Delaware & Hudson, Lanesboro, Pa., butting collision of freight trains, making a bad wreck; one fireman killed and five other trainmen injured. It is said that contradictory orders had been given by the despatcher.

bc, 19th, St. Louis, Iron Mountain & Southern, Piedmont, Mo., butting collision between a passenger train and a freight; one engineman killed and 10 passengers injured.

xc, 19th, 4 a.m., Erie road, Avon, N. Y., a freight train broke in two and the rear portion afterward ran into the forward one, wrecking several cars. Three trainmen were injured.

19th, Pennsylvania road, Philadelphia, Pa., the rear truck of the rear car (a combination baggage and passenger car) of the Pennsylvania Limited express was derailed at a switch, and the baggageman, the barber, and a porter were injured. The car ran against a support of an overhead bridge and was broken in two; it took fire from a heater in the buffet but the flames were soon extinguished.

unx, 21st, Denver & Rio Grande, Salida, Colo., a passenger train was derailed; engineman killed and 38 passengers injured.

o, 22d, St. Louis Southwestern, Pine Bluff, Ark., a car in a freight train took fire from a heated journal, and, with 13 other cars and a trestle 900 ft. long, was burnt up.

dn, 23d, Atlanta, Knoxville & Northern, Knoxville, Tenn., a train consisting of a switching engine and 30 coal cars descending a steep grade was turned on to a spur track by a misplaced switch and ran off the end of the spur and was wrecked. Twenty of the cars fell down a bank.

unx, 23d, Southern Railway, Harrodsburg, Ky., a passenger train was derailed and one passenger car was overturned. A brakeman was injured. All of the 20 passengers in the overturned car escaped without serious injury.

o, 23d, Philadelphia & Reading, Pottstown, Pa., the locomotive of a passenger train was badly damaged by the explosion of its boiler and the road foreman of engines and the fireman were fatally injured.

eq, 24th, Missouri Pacific, Kansas City, Mo., a freight train was derailed by a brake-beam which fell on the track, and 12 cars were ditched. Of two trespassers who were riding in the ice box of a refrigerator car one was killed and the other was badly injured.

unf, 24th, Pennsylvania road, Manor, Pa., a freight train was derailed at a misplaced switch and the two engines drawing it fell against and knocked down two buildings. The fireman was killed. The switch is said to have been maliciously misplaced.

xc, 25th, Pennsylvania Lines, East Liverpool, Ohio, a passenger train collided with some freight cars which had escaped control on a side track and had run on to the main track, and 15 passengers and three trainmen were injured.

dn, 25th, Vicksburg, Shreveport & Pacific, Haughton, La., a passenger train was derailed by running over a misplaced switch, and the first three cars were wrecked. Two mail clerks were killed and six other persons were injured.

dn, 25th, Atlantic Coast Line, Thomasville, Ga., passenger train No. 23 was derailed at a misplaced switch and the engine was overturned. The engineman was injured.

eq, 26th, Chicago, Burlington & Quincy, Alton, Ill., freight train No. 12 was derailed by the breaking of a truck of an oil tank car while running at high speed on a descending grade, and about 20 cars fell through a bridge over Apple Creek. The conductor fell 50 ft. with his caboose to the stream beneath the bridge, but was not badly injured.

rc, 28th, Pennsylvania road, Lancaster, Pa., the westbound St. Louis express, standing at the station, was run into at the rear by a following express train, damaging the engine and one sleeping car. It is said that the second train had been admitted to the block section by a clear signal given by mistake.

unx, 29th, Chicago, Rock Island & Pacific, Trenton, Mo., freight train No. 95 was derailed and seven loaded cars were ditched. An unknown man was killed.

xc, 30th, Grand Rapids & Indiana, Grand Rapids, Mich., collision between a passenger train and an empty engine, one of the engines being overturned. One engineman was severely scalded.

unx, 30th, St. Louis & San Francisco, Denison, Texas, a passenger train was derailed and several cars were badly damaged; one express messenger and one postal clerk were injured, the former fatally.

## Master Mechanics' Reports.

### SUBJECTS.

*Committee Work.*—(1) What can and should be done to reduce locomotive terminals to the basis of a machine for treating and handling engines, apart from the question of housing, the object being prompt handling of power, greater efficiency in service and less detention at terminals, while affording more time and better facilities for care and repair of engines. (2) The best practice in ash-pan construction, with special reference to wide fire-box engines having trailing wheels. To embrace best design of trailing wheel arrangement. (3) Merits of the balanced compound locomotive. (4) Investigation of design and material for locomotive fronts and front doors, with a view to affording relief from leaky front-ends. (5) Investigation of the subject of stay-bolts —committee to consider the material, iron, bronze and copper, as well as the form of the bolt under the conditions and temperatures met in service. (6) Modification in design of wide fire-boxes of locomotives, with a view of limiting injury in case of low water. Committee to consider the question of fusible plugs as to number, location and size, and also the application of water circulating pipes from throat to crown sheet, and other devices which will localize the damage. (7) The practicability of water softening for locomotive use by means of chemicals or the application of heat and the maximum cost per 1,000 gallons permissible. (8) The value of superheated steam for locomotive work. (9) The advisability of a 4-4-2 Atlantic-type locomotive for light passenger service and a 4-6-0 locomotive for fast freight service. (10) Committee appointed to act as an advisory committee to the Pennsylvania with reference to the locomotive testing plant at St. Louis Fair to present to Master Mechanics' Association summarized statement of important results which are obtained. (11) Best method of heating and ventilating roundhouses. (12) Best method of fire protection for railroad shops.

*Individual Papers.*—(1) The strict observance of the golden rule in management of workshops. (2) The most efficient organization for the mechanical department. (3) The average engine hours locomotives are in service, in shop under repairs, or waiting to get in shop, per annum, and the percentage of total time locomotives are actually in and out of service per annum. (4) Shop layouts for roads having 350, 500, 750 and 1,000 locomotives.

*Topical Discussions.*—(1) For lubricating main, side-rod and driving-box bearings, which is the better practice, to use grease or oil? (To be opened by T. S. Lloyd.) (2) With the large modern engines equipped with power brakes, is not screw reverse mechanism preferable to present hand lever arrangement, and is quick reversal a vital consideration? (To be opened by James McNaughton.) (3) What is the best practice with reference to providing air spaces under locomotive grates, especially with wide fire-box locomotives? (To be opened by F. J. Cole.) (4) What is the best method of caring for exterior of locomotive front ends, from the standpoint of cost and appearance? (To be opened by W. O. Thompson.) (5) Packing for air pumps for high-speed brakes. (To be opened by A. J. Cota.) (6) The advisability of reducing the diameter of stay-bolts and shortening the space between the stay-bolts proportionately. (To be opened by G. R. Henderson.) (7) Leaky flues in wide fire-box engines. (To be opened by M. K. Barnum.) (8) Limit of width of soft-coal-burning fire-boxes, with reference to higher evaporation efficiency. (To be opened by S. M. Vauclain.)

The report is signed by Henry Bartlett, Chairman; J. F. Deems, A. W. Gibbs.

### LOCOMOTIVE FRONT-ENDS.

The committee consisting of H. H. Vaughan, G. M. Basford, F. H. Clark, W. F. M. Goss, A. W. Gibbs and R. Quayle reported that further tests cannot be made until funds are provided. An outline of proposed tests is given.

### VARIABLE SPEED MOTORS.

*(From a paper by C. A. Seley.)*

Complete tests of all motors and controllers have been made at the East Moline shops of the Rock Island and certain typical ones are selected for this report. The tests were made by Mr. S. B. Seaman, of the General Electric Company and Mr. C. H. True, assistant superintendent at the shops.

The variable speed motors at these shops may be subdivided into four types:

(1) Variable speed motors having a controller to operate on a three-wire system, enabling the maching-hand to operate the motor on either of the two voltages. Further speed variation is obtained on each voltage by introducing or cutting out resistance coils in series with the motor field. This motor field is always across the outside wires of the three-wire system, and therefore, on the maximum obtainable voltage. The rheostat governing the field current is operated through the controller. (2) Variable-speed motors having a controller to

*Test 1—69-inch Driving Wheel Lathe, Turning 62½-inch Tires; Motor, Type CK. 8-15-150/600.*

| Rheostat. | Field Amps. | Armature. Amps. | Armature. Volts. | Elec. H. P. | Cutting Speed F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 00 | 5.55 | 5 | 118 | 1.6 | ... | |
| 0 | 4.70 | 22 | 104 | .. | 7.5 | |
| 3 | 4.00 | 23 | 116 | 4.0 | 8.0 | |
| 4 | 3.90 | 23 | 116 | .. | ... | |
| 5 | 3.30 | 26 | 116 | .. | ... | |
| 6 | 3.10 | 25 | 116 | .. | ... | |
| 7 | 2.90 | 27 | 116 | 5.1 | ... | Motor running light. Two chips, 3 16x¼ deep x .089 per revolution. |
| 9 | 2.90 | 25 | 116 | .. | ... | |
| 10 | 2.45 | 28 | 116 | .. | ... | |
| 11 | 2.20 | 30 | 116 | 5.3 | ... | |
| 12 | 1.95 | 30 | 116 | .. | 11.45 | |
| 14 | 1.95 | 30 | 115 | .. | ... | |
| 16 | 1.50 | 38 | 113 | 6.3 | 12.90 | |
| 0 | 4.60 | 36 | 230 | 12.5 | 14.60 | |

*Test 2—Speed Variation, Wheel Lathe Without Load.*

| Rheostat. | Field Amps. | Volts. | R. P. M. | Remarks. |
|---|---|---|---|---|
| Off. | 3.00 | 114 | 0 | |
| 1 | 5.55 | 114 | 150 | |
| 2 | 4.80 | 113 | 158 | |
| 3 | 4.15 | 113 | 165 | |
| 4 | 3.75 | 113 | 170 | |
| 5 | 3.25 | 113 | 175 | |
| 6 | 3.00 | 112 | 185 | |
| 7 | 2.75 | 111 | 195 | |
| 8 | 2.50 | 114 | 205 | |
| 9 | 2.30 | 113 | 215 | |
| 10 | 2.15 | 114 | 225 | |
| 11 | 2.00 | 113 | 230 | |
| 12 | 1.90 | 113 | 240 | |
| 13 | 1.80 | 113 | 250 | |
| 14 | 1.70 | 113 | 265 | |
| 15 | 1.60 | 114 | 275 | |
| 16 | 1.55 | 114 | 295 | |
| 1 | 5.45 | 227 | 290 | |
| 16 | 1.55 | 227 | 630 | |

*Test 3—18-inch Slotter; Motor, Type CK. 8-15-150/600.*

| Rheostat. | Amperes. | Volts. | El. H. P. | Remarks. |
|---|---|---|---|---|
| 8 | 1 to 10 | 115 | 1.4 | Chip 5/16 x 3/64. |
| 8 | 1 to 24 | 115 | 3.7 | Chip ⅝ x 3/64. |
| 8 | 1 to 30 | 115 | 4.6 | Chip ¾ x 3/64. |
| 12 | 1 to 28 | 115 | 4.3 | Chip ½ x 3/64. |
| 16 | 4 to 10 | 115 | 1.4 | Chip 1/16 x 3/64. |

Slotter was making 22 cycles on the 12th point of rheostat on work about 5 inches deep.

*Test 4—72-inch Boring Mill, Boring Steel Tire, 52 Inches Inside Diameter; Motor, Type CK. 6-10-275/1000.*

| Amps. | Volts. | El. H. P. | Cut F. P. M. | Remarks. |
|---|---|---|---|---|
| 17 | 115 | 2.6 | 17.7 | |
| 23 | 115 | 3.1 | 18.5 | |
| 26 | 115 | 3.5 | 18.5 | |
| 30 | 115 | 4.0 | 19.4 | One chip ¼ x 3/64. |
| 33 | 115 | 4.4 | 20.4 | |
| 39 | 115 | 5.2 | 22.2 | One chip 3/16 x 3/64. Chips of dark blue. |

The following readings were taken at intervals of approximately three seconds:

| | | | | |
|---|---|---|---|---|
| 44 | 115 | .. | 22 | |
| 48 | 115 | 4.8 | 22 | Two chips, ¼ x 3/32 each. |
| 37 | 115 | .. | 22 | Cutting tools would not stand up under this work. Although there was an excessive ampere overload there was no sparking or heating at any point about the motor. |
| 39 | 115 | .. | 22 | |
| 38 | 115 | .. | 22 | |
| 52 | 115 | .. | 22 | |
| 50 | 115 | .. | 22 | |
| 50 | 115 | .. | 22 | |
| 48 | 115 | .. | 22 | |
| 49 | 115 | .. | 22 | |

*Test 5—Driving Axle Lathe; Motor, Type CK. 8-15-150/600.*

| Rheostat. | Field Amps. | Arm. Amps. | Volts. | El. H. P. | Cut F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 0 | 5 | 29 | 114 | 5.9 | 17 | Two cuts on 8-inch axle, 3/16 x 5/64. |
| 2 | .. | 31 | 112 | .. | .. | |
| 3 | 4 | 32 | 111 | .. | .. | |
| 4 | 3.9 | 33 | 112 | 6.15 | .. | |
| 5 | 3.3 | 35 | 112 | .. | .. | |
| 6 | 3.1 | 36 | 112 | .. | 18.7 | |
| 7 | 2.9 | 39 | 112 | 6.85 | .. | |
| 8 | 2.8 | 42 | 112 | .. | .. | |
| 9 | 2.6 | 44 | 112 | .. | 21.9 | |
| 10 | 2.4 | 47 | 114 | 8.0 | .. | |
| 11 | 2.2 | 48 | 116 | .. | .. | |
| 12 | 1.9 | 52 | 118 | 8.7 | 25 | |

Did not get over on to 230-volt side.

*Test 6—36-inch Triple-Geared Lathe; Motor, Type CE. 8-5-400/1600.*

| Rheostat. | Arm. Amps. | Volts. | El. H. P. | Cut F. P. M. | Remarks. |
|---|---|---|---|---|---|
| 0 | 1 | 117 | 5 | .. | Motor light. |
| 0 | 16 | 117 | 1.5 | 42 | Back gear in with heavy-cut, cast iron, 11 inches diam. |
| 0 | 22 | 117 | 3.5 | 42 | |
| 4 | 1.5 | 118 | .7 | 48 | Back gear in, light. |
| 4 | 8 | 118 | 1.3 | 48 | Back gear in with heavy cut, cast iron, 11 inches diam. |
| 4 | 23 | 118 | 3.7 | 48 | |
| 4 | 30 | 118 | 4.9 | 48 | |
| 4 | 40 | 117 | 6.3 | 48 | |

*Test 7—42-inch Steel-Tire Lathe; Motor, Type CE. 6-10-550/1100.*

| Rheostat. | Field Amps. | Arm. Amps. | Volts. | El. H. P. | Cut in F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 0 | 3 | 7 | 236 | 3.1 | ... | Lathe running light. |
| 0 | 3 | 12 | 229 | 4.7 | 9.6 | Starting 2 cuts 30-inch wheels, 3/32-inch feed |
| 4 | 1.9 | 13 | 231 | 4.6 | 15 | 2 cuts, 3/32 x 3/32. |
| 5 | 1.75 | 23 | 231 | 5.5 | 15.2 | 2 cuts, 3/16 x 3/32. |
| 6 | 1.12 | 30 | 230 | 9.7 | 15.7 | 2 cuts, 3/16 x 3/32. |
| 8 | 1 | 34 | 230 | 10.7 | 16.1 | 2 cuts, ¼ x 3/32. |
| 10 | 1 | 36 | 229 | 11.3 | 17.2 | 2 cuts, ¼ x 3/32. |
| 12 | 1 | 38 | 230 | 12 | 21.8 | 2 cuts, ¼ x 3/32. |

*Test 8—Speed Variation, 42-inch Steel-Tire Lathe Without Load.*

| Rheostat. | Field Amps. | Volts. | Spindle R. P. M. | Remarks. |
|---|---|---|---|---|
| 1 | 3 | 230 | 1.22 | |
| 2 | 2.55 | 230 | 1.33 | |
| 3 | 2.20 | 230 | 1.43 | |
| 4 | 1.95 | 230 | 1.53 | |
| 5 | 1.75 | 230 | 1.62 | |
| 6 | 1.62 | 230 | 1.62 | |
| 7 | 1.45 | 230 | 1.66 | |
| 8 | 1.35 | 230 | 1.71 | |
| 9 | 1.25 | 230 | 1.81 | |
| 10 | 1.25 | 230 | 1.87 | |
| 11 | 1.15 | 230 | 1.93 | |
| 12 | 1.12 | 230 | 2.00 | |
| 13 | 1.05 | 230 | 2.20 | |
| 14 | 1.00 | 230 | 2.40 | |
| 15 | .95 | 230 | 2.50 | |

*Test 9—Special Rod Planer; Motor, Type CK. 8-15-275/550.*

| Rheostat. | Field Amps. | Arm. Amps. | Volts. | El. H. P. | Cut in F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 0 | 4.8 | 5 | 227 | 3 | .. | Planer running light. |
| 0 | 4.8 | 20 | 225 | 7.5 | 17 | 2 cuts, 3/16 x .083. |
| 2 | 3.1 | 21 | 224 | 7.2 | 20 | Cutting. |
| 2 | 3.1 | 6 | 224 | .. | .. | Returning. |
| 3 | 2.2 | 25 | 225 | 8.2 | 24 | Cutting. |
| 3 | 2.2 | 5 | 225 | .. | .. | Returning. |
| 4 | 1.8 | 30 | 228 | 9.7 | 28 | Cutting. |
| 4 | 1.8 | 6 | 228 | .. | .. | Returning. |
| 5 | 1.5 | 32 | 226 | 10.1 | 32 | Cutting. |
| 5 | 1.5 | 9 | 226 | .. | .. | Returning. |
| 6 | 1.2 | 36 | 225 | 11.2 | 35 | Cutting. |
| 6 | 1.2 | 10 | 225 | .. | .. | Returning. |
| 7 | 1.1 | 36 | 226 | 11.2 | 38 | Cutting. |
| 7 | 1.1 | 11 | 226 | .. | .. | Returning. |
| 8 | 1. | 36 | 224 | 11.1 | 40 | Cutting. |
| 8 | 1. | 12 | 224 | .. | .. | Returning. |
| 9 | .85 | 44 | 225 | 13.5 | 45 | Cutting. |
| 9 | .85 | 16 | 225 | .. | .. | Returning. |

*This planer has done work on Babbitt metal at the rate of 70 feet per minute, the motor running cool and sparkless at 1,300 R. P. M., although the maximum rated R. P. M. is but 550.*

*Test 10—48 by 48 by 6 Planer; Motor, Type CK. 8-15-275/550.*

| Rheostat. | Field Amps. | Arm. Amps. | Volts. | El. H. P. | Cut in F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 0 | 4.8 | 12 | 224 | 5 | .. | Cutting 7/16 x 1/32 C. I. |
| 0 | 4.8 | 14 | 224 | 5.7 | .. | Returning. |
| 6 | 1.2 | 12 | 224 | .. | 18 | Cutting. |
| 6 | 1.2 | 14 | 224 | .. | .. | Returning. |
| 10 | 1 | 13 | 224 | .. | 22.5 | Cutting. |
| 10 | 1 | 14 | 224 | .. | .. | Returning. |
| 14 | .8 | 18 | 224 | 5.7 | .. | Cutting. |
| 14 | .. | 20 | 224 | 6.3 | .. | Returning. |
| 15 | .8 | 20 | 224 | .. | .. | Cutting |
| 15 | .8 | 21 | 224 | .. | .. | Returning. |
| 16 | .75 | 26 | 224 | 7.9 | .. | Cutting. |
| 16 | .. | 28 | 224 | 8.5 | .. | Returning. |

In order to show the variation in load on the motor, the following readings were taken on one point of the rheostat:

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | .. | 12 | 224 | 5 | .. | Bed returning. |
| .. | .. | 32 | 224 | 9.6 | .. | Reversing to cut. |
| .. | .. | 14.5 | 224 | 5.7 | .. | Cutting. |
| .. | .. | 54 | 224 | 15.6 | .. | Reversing from cut. |
| .. | .. | 12 | 224 | 5 | .. | Returning. |

*Test 11—54 by 54 by 34 Frame Planer; Motor, Type CL. 6-20-375/750.*

| Rheostat. | Field Amps. | Arm. Amps. | Volts. | El. H. P. | Cut in F. P. M. | Remarks. |
|---|---|---|---|---|---|---|
| 0 | 5.6 | 12 | 230 | 5.4 | 12.8 | Planer running light. |
| 0 | 5.6 | 18 | 228 | 7.2 | .. | Returning. |
| 4 | 2.7 | 12 | 230 | .. | 16.75 | Two cuts ⅜ x 5/32 C. I. |
| 4 | .. | 18 | 232 | .. | .. | |
| 8 | 1.6 | 14 | 230 | .. | 22.66 | |
| 8 | .. | 20 | 232 | .. | .. | |
| 12 | 1.1 | 18 | 230 | .. | 28 | |
| 12 | .. | 24 | 232 | .. | .. | |
| 16 | .82 | 22 | 230 | 7 | 31.4 | |
| 16 | .. | 28 | 230 | 8.9 | .. | |

In order to show the variation in load on the motor, the following readings were taken on the 12th point of the rheostat:

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 | 1.1 | 24 | 230 | 7.7 | 28 | Cutting. |
| .. | 1.1 | 56 | 230 | 17.6 | .. | At reverse from cut. |
| .. | 1.1 | 22 | 230 | .. | .. | Returning. |
| .. | 1.1 | 30 | 230 | 9.5 | .. | Reversing to cut. |

*Test 12—Motor, 15-h.p.; Semi-Enclosed Constant Speed, Shunt Wound. Silent Chain Drive, Short Centers.*

| Reading. | Amps. | Volts. | El. H. P. | Remarks. |
|---|---|---|---|---|
| 1 | 5 | 235 | 1.6 | Motor running light. |
| 2 | 6 | 238 | 1.9 | Motor running line shaft. |
| 3 | 11 | 226 | 3.3 | Motor line and counters of following tools. |
| 4 | 12 | 226 | 3.6 | No. 3 B-B milling machine, fluting tap. |
| 5 | 13 | 227 | 3.95 | No. 3 LeB milling machine, fluting reamer. |
| 6 | 18 | 226 | 5.4 | 24 x 24 Planer at reversing point. |
| 7 | 20 | 227 | 6.1 | 14-inch lathe, boring 1⅜-inch hole. |
| 8 | 26 | 228 | 7.0 | 10-inch lathe, 1-16 cut. |
| 9 | 26 | 229 | 7.9 | 14-inch lathe running to capacity. |
| 10 | 30 | 229 | 9.2 | 21-inch drill press drilling 1-inch hole in steel. |
| 11 | 37 | 228 | 11.3 | Tool dresser. |
| 12 | 38 | 228 | 11.6 | Power hack saw. |
| 13 | 44 | 227 | 13.4 | Two aut. tool grinders. |

*The above test was made on a motor driving a group of machines in a tool room. These tools were added one at a time after readings had been taken on the power required for the motor alone, motor and line shaft, and also with the countershafting. The final reading is the total power required, but it is not generally the case that all of the tools of a group are running full at one time.*

operate on a two wire system. Speed variation is obtained by means of a bank of resistance coils in series with the motor field, and operated through the controller. (3) Variable-speed motors having separated starting boxes with an auxiliary rheostat in the field circuit and operated by a hand wheel. (4) Variable-speed motors having a reversible controller similar to those in use in street-car service and to reverse the direction of motion of the motor when desired.

Type 1 is used on boring mills, slotters, driving wheel and engine lathes. Type 2 is used on car-wheel borer and car and truck-wheel tire-turning lathes. Type 3 is used on planers and cylinder-boring machines. Type 4 is used on bending rolls.

The following tests were made on motors on the various tools mentioned above, each being tabulated, giving the kind of machine, class of work and the electrical horse-power. Tests 1 to 6 were made on motors of type 2. Column 1 shows the position of the rheostat arm. There are for each voltage 16 successive steps, giving 16 different speeds on each voltage. These positions are given by numbers indicating the number of contacts from the O point to where the rheostat arm is set. Column 2 gives the field current and column 3 the armature current. Column 4 gives the armature voltage, which is about 115 volts over the first range of speed, and 230 volts over the second. Column 5 gives the electrical horse-power delivered to the motor. Column 6 gives the cutting speed in feet per minute. In the headings are given the maker's classification and the speed range of the motors. Intermediate speeds between the limits given are obtainable by operation of the controller handle.

Tests 7 and 8 are of motors of Type 2 and tests 9 to 11 are of motors of type 3. Test 12 is of a group of tools on a motor-driven line shaft.

### BOILER DESIGN.

The lowest visible part of the water glass and lowest gage cock should be not less than 3 in. above the highest point of the crown sheet for curved and flat crown sheets, and the water glass and gage cocks should be as near the vertical center line of boiler as possible without having gage cocks out of reach of the engineer. It is also recommended that 8 in. exposed length of water glass and three gage cocks with vertical spacing 3 in. centers is desirable. Crown sheets sloped 3/8 in. per foot is general practice and has proved satisfactory. An automatic low-water detector seems not to be a desirable attachment to locomotive boilers. The best form of radial stay shown herewith appears to be general practice and is recommended.

In order to obtain information as to the temperatures inside a boiler as related to leaky flues and burned side sheets, the committee made temperature tests with fusible metal in the water leg, between the flues, and inside of flues plugged up. While the tests show temperatures considerably above saturated steam temperatures in most cases, the committee has concluded that the method of determining temperatures by means of fusible metal is not satisfactory and believes that temperatures should be determined by more delicate means, such as the thermopile, and that such determinations should be as numerous as possible in order to trace the direction of circulation in the boiler. On the other hand it is quite possible that the very high temperatures which are probably required to destroy sheets and cause leaky flues are confined to the sheets themselves, and that little if any higher temperatures exist in the water than have already been found by the fusible metal tests. It is essential that the circulation within the boiler shall follow such lines and proceed with such regularity that solid water may overlie all portions of the heating surface. Since circulation is due to the excess of weight of a comparatively cool column of water over a hotter and lighter body or a mixture of hotter water and steam, the design of boiler which least impedes the flow due to this head will permit of the most rapid circulation, and hence, most rapid carrying away of heat from sheets. It would follow also that the greater the depth of boiler the greater the head to produce circulation at the point where most needed, namely, just above the fire line. For a given boiler there is a maximum allowable steam generation without injury to the sheets, determined by a maximum possible circulation.

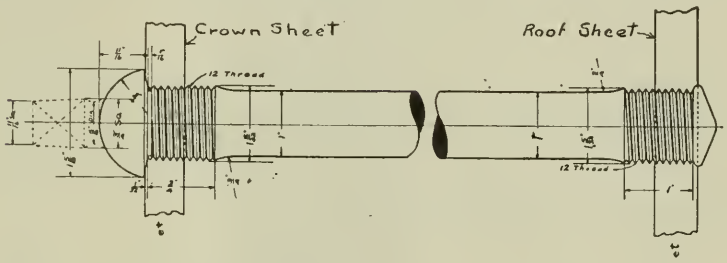
Through the courtesy of Mr. F. H. Clark, Superintendent of Motive Power, Chicago, Burlington & Quincy, the committee is permitted to present results of experiments made to determine the temperature of the water in various portions of the boiler when the locomotive is standing, no steam being used from the boiler excepting as required to supply the injector. The results of these experiments indicate that when the feed is delivered in the usual manner to the boiler, the water in the water-leg on the opposite side may have a temperature 100 degrees less than the normal temperature of the boiler, and that the intermixing is greatly improved by using a perforated pipe extending beyond the check within the boiler either longitudinally or transversely, and also, by the omission of a pipe, but by means of an orifice which opens upward. In the progress of the tests it was found, also, that when the intermixing was most complete, the drop in steam pressure was greatest, so that it may almost be said that the degree of intermixing in any given boiler may be judged by noting the rapidity with which the steam pressure falls under the action of the injectors when the locomotive is at rest. It is recommended that laboratory tests be made for the purpose of determining the rapidity of circulation in a boiler generating varying amounts of steam up to its maximum, and also for determining temperatures in the sheets where the greatest trouble is experienced.

The report is signed by David Van Alstyne, Chairman; W. F. M. Goss, C. E. Fuller, H. T. Bentley, O. H. Reynolds.

### AUTOMATIC STOKERS.

The only comparative test that the committee has been able to make shows that there is a saving of not less than 7 per cent. when using the stoker, as compared to the work done by a first-class fireman. This, of course, would indicate a considerably greater saving as compared with ordinary locomotive firemen. In the case mentioned, the engine equipped with the stoker was in service over its run 6 hrs. and 30 mins., while the engine that it was compared with was only 4 hrs. and 7 mins. going over the division. The saving in coal is no doubt largely due to the fact that the coal is evenly distributed, and the furnace door remains closed all the time. When using the stoker the smoke is very much lighter in color, indicating a more thorough consumption of the gases. The darkest color, when the stoker is used, is not more than brown.

When the stoker is used the fireman has to raise the coal from the level of the coal bin of the tender into the hopper of the stoker, a distance of about 30 ins. This is a higher lift than when firing directly into the furnace, but it must be remembered that when the stoker is used the fireman is not required to throw the coal. With the coal conveyor in service the labor of raising the coal into the hopper will be entirely dispensed with and the work of the fireman becomes simply that of an expert in charge of an efficient machine. With the stoker in use very much less trouble with leaky flues will be found on account of maintaining a more even heat in the fire-box. The sheets of the fire-box will last longer for the same reason. It has been proven that corrugation in fire-boxes is due largely to changes in the temperature. When using the stoker the steam pressure may be kept absolutely constant. This is due to the regularity and evenness with which the coal is placed on the grates.




Boiler Crown-Stay.

On the ordinary American type of engine there is no necessity for the stoker, as the work is such that an ordinary man can do it with ease, but with the long fire-box type of engine on a long run over a division comparatively free from grades, where the engine is loaded to its maximum capacity all of the time, is where the stoker will be found the most valuable. The present type of stoker will throw about 3,000 lbs. of coal per hour. A modern type of passenger engine with 46 sq. ft. of grate surface and burning 200 lbs. of coal per sq. ft. of grate per hr. will require about 9,200 lbs. of coal per hr. The stoker, as it is built at present, will not serve such a fire-box, but there is no reason why the speed can not be increased and the size of the trough be increased so that a larger amount of coal will reach the fire-box each stroke.

The report is signed by J. F. Walsh, Chairman, and J. G. Neffer.

### COST OF LOCOMOTIVE REPAIR SHOPS.

In selecting units on which to base cost figures the square foot and the cubic foot have generally been used for buildings; in power plants the engine horse-power, boiler horse-power and generator kilowatts have also been used; in roundhouses the stall has been taken as the proper unit. In computing the square feet of buildings, the outside dimensions have been used (giving the ground area covered); in computing the cubic feet of buildings, the average external height has been taken (giving the total volume occupied).

In the figures which follow, the differ-

ent items are identified by reference numbers only, with such explanatory notes added as will aid in interpreting the unit prices; shops built prior to 1895 are designated as "old," those built since 1895, as "modern"; in a few cases the notes are based on uncertain information and are followed by an interrogation mark (?).

It is believed that in most cases the cost of a proposed shop will be asked for as soon as the layout plan has been completed, and that the following is the best basis for making an estimate: List up all the buildings, with their ground area in square feet, all the miscellaneous structures, either on the square foot, the lineal foot, or the unit basis (as may appear best), all the track on the lineal foot basis, the turnouts on the unit basis, etc.; assign a unit price to each item, as determined by the special local conditions, carry out the cost extensions, and totalize; to the total thus obtained add a percentage to cover incidentals and items not shown by the layout plan; this percentage may vary from a minimum of 10 per cent. to a maximum of 25 per cent., according to the completeness of the layout plan

*Power Plants—Total Cost.*

| Item. | Cost per Engine H. P. | Cost per Generator K. W. | Cost per Sq. Ft. | Cost per Cu. Ft. | Notes. |
|---|---|---|---|---|---|
| 131 | 131.33 | 219.00 | 11.40 | .40 | Far West, modern; a substantial, effective plant devoid of ornamentation or refinements; coal dumped from trestle and shoveled, ashes shoveled. |
| 132 | 140.27 | 210.00 | 7.00 | .18 | Middle West, modern; building has considerable ornamentation inside and out, but the equipment auxiliaries are simple, overhead crane in engine room. |
| 133 | 115.00 | 167.00 | 12.20 | .28 | East, modern; building has considerable ornamentation alternating-current apparatus inside and out; principally with auxiliary direct current equipment. |
| 134 | 185.06 | 278.00 | 11.50 | .36 | Middle West, modern; includes (besides boilers, engine generators and air compressors), induced draft apparatus, coal and ash handling apparatus, hydraulic plant, etc. |
| 135 | 129.28 | 210.60 | 14.62 | .33 | Middle West, modern; a very complete plant both mechanically and architectually. |
| 136 | 123.00 | 191.00 | 14.30 | .36 | Middle West, modern; large enough to allow for a one-third increase in capacity of plant. |
| 137 | 129.00 | 225.00 | 10.40 | .58 | East, modern; fireproof construction throughout. |
| 138 | 90.90 | 151.50 | 10.40 | .24 | West, modern; a simple but effective plant limited to direct current, no coal or ash handling apparatus. |
| 139 | 128.60 | 211.00 | 10.55 | .31 | Middle West, modern; condensing equipment. |

*Erecting and Machine Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 140 | 3.50 | 1.08 | .71 | 5.34 | .076 | .115 |
| 141 | 1.03 | 2.49 | .187 | 3.70 | .034 | .123 |
| 142 | .706 | 1.78 | ... | ... | .029 | ... |
| 143 | 1.67 | 2.05 | .086 | 3.79 | .051 | .118 |
| 144 | 2.43 | .81 | ... | ... | .051 | ... |
| 145 | 1.65 | 2.69 | ... | ... | .041 | ... |
| 146 | 1.80 | 1.65 | ... | ... | .046 | ... |
| 147 | 1.82 | ... | ... | ... | .050 | ... |
| 148 | 3.08 | 1.63 | ... | ... | .073 | ... |

149. *East, modern; brick and steel transverse shop, erecting shop has both heavy and light cranes; machine shop has crane service throughout, saw tooth roof.*

141. *Middle West, old; brick and wood, transverse shop in two parts, one part one story with slate roof, the other part two stories with gravel roof.*

142. *Middle West, old; stone and wood, transverse shop, gravel roof supported by posts.*

143. *Middle West, old; brick with wood and iron roof trussing and shingle roof, longitudinal shop, machine shop on one side, traveling cranes in erecting shop.*

144. *Middle West, modern; brick and steel, transverse shop, high for two-thirds of width with heavy crane, the remaining one-third being low, with saw-tooth roof.*

145. *Middle West, three-fourths old, one-fourth new, brick and steel, transverse shop, new part two stories; no traveling cranes.*

146. *Pacific Northwest, modern; brick and steel, overhead crane.*

147. *Pacific Southwest, modern; brick and steel, overhead crane.*

148. *Far West, modern; brick and steel, overhead crane.*

*Machine Shop.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 157 | .952 | ... | ... | ... | .038 | ... |

157. *Middle West, old; brick and wood, gravel roof supported by posts.*

*Boiler and Tank Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 158 | 2.98 | .72 | .84 | 4.54 | .083 | .127 |
| 159 | 1.58 | .40 | ... | ... | .049 | ... |
| 160 | .84 | .94 | .076 | 1.87 | .033 | .075 |
| 161 | 1.66 | .48 | .083 | 2.24 | .059 | 0.80 |
| 162 | .99 | ... | .. | ... | .025 | ... |
| 163 | 1.53 | .96 | .. | ... | .095 | ... |

158. *East, modern; brick and steel, cranes cover entire floor, saw tooth roof.*

159. *Middle West, modern; brick and steel, one-half width high for crane service, the other half lower and without crane.*

160. *Middle West, old; brick and wood with slate roof.*

161. *Middle West, old; brick and wood, shingle roof, gallery along one side, cranes over part of floor space.*

162. *Pacific Southwest, modern; brick and steel, overhead crane, smith shop in one end.*

163. *Middle West, two-thirds old, one-third new; brick and wood, new part two stories, no overhead cranes (?)*

*Smith Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 164 | ... | .734 | .110 | ... | ... | ... |
| 165 | 2.63 | .982 | .171 | 3.78 | .080 | .115 |
| 166 | 1.79 | .144 | .. | ... | .049 | ... |
| 167 | .432 | 2.26 | .086 | 2.77 | .019 | .126 |
| 168 | 1.06 | 1.09 | .050 | 2.22 | .035 | .074 |
| 169 | 2.25 | ... | ... | ... | ... | ... |
| 170 | 1.43 | .665 | .435 | ... | .042 | ... |
| 171 | 1.50 | ... | .. | ... | ... | ... |
| 172 | 2.37 | 1.96 | .348 | 4.68 | .052 | .104 |
| 173 | 1.21 | ... | .. | ... | .041 | .055 |
| 174 | 1.38 | ... | .. | ... | ... | ... |
| 175 | .91 | .60 | .. | ... | .031 | ... |

164. *Middle West, old.*

165. *East, modern; brick and steel, high and light, thoroughly equipped.*

166. *Middle West, modern; brick and steel, one hundred feet wide, hip roof without posts.*

167. *Middle West, old; brick and wood with slate roof.*

168. *Middle West, old; brick and wood, shingle roof.*

169. *Southeast, modern; brick and steel, unusually high (thirty-three feet from floor to lower chord of roof truss). (These figures should be used with caution, as they are not official, but were taken from a published statement.)*

170. *Middle West, modern; brick and steel.*

171. *Middle West, modern; brick and steel, tile and gravel roof.*

172. *Middle West, modern; brick and steel, brass foundry and car machine shop under same roof, equipment very complete.*

173. *East, modern; concrete and steel, 80-foot span, no posts.*

174. *Northeast, modern; brick and wood, 60-foot span, no posts, simple construction.*

175. *Middle West, two-thirds old; one-third new; brick and wood. (?).*

*Iron Foundry.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 176 | 3.18 | ... | ... | ... | ... | ... |

176. *Brick and steel, modern; U. S. Navy Yard, Bremerton, Wash.*

*Pattern and Upholstery Shop.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 178 | .857 | ... | .131 | .988 | .043 | .050 |

178. *Middle West, old; modern building, two stories.*

*Passenger Car Repair Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 179 | 1.24 | ... | .016 | 1.25 | .042 | .043 |
| 180 | 1.20 | ... | ... | ... | ... | ... |
| 181 | 2.64 | .044 | .096 | 2.78 | .099 | .105 |
| 182 | 1.34 | ... | .015 | 1.35 | .056 | .057 |
| 183 | .68 | .003 | .057 | .74 | .026 | .028 |
| 184 | .83 | ... | ... | ... | .029 | ... |

179. *Middle West, modern; longitudinal shop, brick and wood.*

180. *Southeast, modern; transverse shop, brick and wood, has upholstery and cabinet shops under same roof. (These figures should be used with caution, as they are not official, but were taken from a published statement.)*

181. *Middle West, modern; transverse shop, brick and steel, includes upholstery and trimming shop and hot-air heating.*

182. *East, modern; transverse shop, brick and steel with cement foundations, saw tooth wooden roof.*

183. *Southeast, modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above, gravel roof, granolithic floor, used also for painting and varnishing. (Identical with Passenger Car Paint Shop No. 193.)*

184. *Middle West, old; brick and wood (?).*

*Passenger Car Paint Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 185 | 1.24 | ... | .044 | 1.24 | .04 | .04 |
| 186 | 1.94 | .055 | .092 | 2.09 | .072 | .078 |
| 187 | 1.02 | ... | ... | ... | .033 | ... |
| 188 | 1.20 | ... | ... | ... | ... | ... |
| 189 | 1.01 | ... | .039 | 1.05 | .035 | .036 |
| 190 | .35 | ... | ... | ... | ... | ... |
| 191 | 2.36 | .009 | .056 | 2.43 | .081 | .084 |
| 192 | 1.13 | ... | .009 | 1.14 | .051 | .052 |
| 193 | .68 | .003 | .057 | .74 | .026 | .028 |
| 194 | .89 | ... | .. | ... | .032 | ... |

185. *Middle West, modern; longitudinal shop, brick and wood.*

186. *East, modern; longitudinal shop, brick and steel, saw tooth roof, hot-air heating.*

187. *Pacific Southwest, modern; transverse shop, brick and steel.*

188. *Southeast, modern; transverse shop, brick and wood, has varnish room and pipe shop under same roof. (These figures should be used with caution, as they are not official, but were taken from a published statement.)*

189. *Northeast, modern; longitudinal shop, brick and steel, includes small paint, varnish and boiler rooms at one end.*

190. *South, old; wooden structure.*

191. *Middle West, modern; transverse shop, brick and steel, includes cleaning room, varnish room and hot-air heating.*

192. *East, modern; transverse shop, brick and steel with cement foundations, saw tooth wooden roof.*

193. *Southeast, modern; transverse shop, brick up to window sills, corrugated galvanized iron sheathing on wooden frame above; gravel roof, granolithic floor, used also for coach repairs. (Identical with passenger car repair shop No. 183.)*

194. *Middle West, old; brick and wood (?)*

*Freight Car Repair Shops.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 195 | .40 | ... | .016 | .415 | .022 | .023 |
| 196 | 2.12 | .123 | .047 | 2.29 | .075 | .080 |
| 197 | .29 | ... | .. | .29 | .015 | .015 |

195. *Middle West, old; wooden building, longitudinal, entirely enclosed.*
196. *Middle West, modern; brick and steel, longitudinal, includes cabinet shop and hot-air heating.*
197. *Middle West, old; large shop, longitudinal construction not known, but probably wood with partly open sides.*

*Car Smith and Car Machine Shop.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 199 | .77 | 1.06 | .. | ... | .028 | ... |

199. *Middle West, old; brick and wood.* (?)

*Wheel and Axle Shop.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 200 | 4.03 | 2.16 | .72 | 6.91 | .16 | .276 |

200. *West, modern; brick and steel, for car work only.*

*Car Repair Shop and Planing Mill.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 201 | .975 | ... | .. | ... | .031 | ... |

201. *Pacific Southwest, modern; brick and steel, has intermediate two-story section for sub-departments.*

*Planing Mills.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 202 | .487 | .54 | .010 | 1.04 | .026 | .056 |
| 203 | 1.15 | 1.18 | .25 | 2.58 | .045 | .102 |
| 204 | .76 | 1.21 | .292 | 2.26 | .033 | .098 |
| 205 | 1.85 | ... | .. | ... | ... | ... |
| 206 | .37 | ... | .. | ... | ... | ... |
| 207 | 2.54 | 1.44 | .082 | 4.06 | .095 | .153 |
| 208 | 2.53 | .358 | .. | ... | .057 | ... |
| 209 | .39 | .50 | .. | ... | .014 | ... |
| 210 | .74 | .485 | .239 | 1.47 | .037 | .073 |

202. *Middle West, old; wooden building, tools and equipment very light.*
203. *Southeast, modern; brick up to floor line, then corrugated galvanized iron on insulated wooden frame, basement and one story, gravel roof, mechanical power plant in annex, cabinet shop in wing.*
204. *Middle West, old; brick and wood, slate roof.*
205. *Southeast, modern; steel and brick. (These figures should be used with caution, as they are not official, but were taken from a published statement.)*
206. *South, old; wooden structure.*
207. *Middle West, modern; brick and steel, does not include cabinet shop, which is separate.*
208 *Middle West, old; brick and wood, includes pattern shop.* (?)
210. *West, modern; wooden.* (?)

*Storehouses.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 211 | 1.142 | ... | .168 | 1.31 | .044 | .050 |
| 212 | 3.60 | ... | .. | ... | ... | ... |
| 213 | 3.05 | ... | .67 | 3.72 | .073 | .089 |
| 214 | 2.40 | ... | .. | 2.72 | .110 | .124 |
| 215 | 2.00 | ... | .. | ... | .050 | ... |

211. *Southeast, modern, brick up to window sills, then corrugated galvanized iron on unsheathed wooden frame, two stories, gravel roof, platform, bins, shelves, etc., complete.*
212. *Southeast, modern; brick and steel, two stories and basement, extensive offices in one end on both floorss. (These figures should be used with caution, as they are not official, but were taken from a published statement.)*
213. *Middle West, modern; brick and wood, three stories.*
214. *East, modern; concrete construction, one end two stories, upper floor used for offices.*
215. *Middle West, old; brick and wood, two stories.* (?)

*Oil Houses.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 216 | 5.41 | ... | 1.43 | 6.84 | .208 | .263 |
| 217 | 3.52 | ... | 1.55 | 5.07 | .196 | .302 |
| 218 | 1.33 | ... | .. | ... | .089 | ... |
| 219 | 2.15 | ... | 1.34 | 3.49 | .097 | .159 |

216. *Middle West, modern; brick and steel, basement and one story, full equipment of tanks, etc.*
217. *East, modern; concrete walls and roof, one story with deep basement.*
219. *West, modern; brick and steel, tile roof, two stories.*

*Roundhouses.*

| Item. | Number of Stalls. | Cost Per Stall. Building Only. | Tools. | Misc. Eqpt. | Total. |
|---|---|---|---|---|---|
| 220 | 18 | 1,388.88 | ..... | ..... | ..... |
| 221 | 46 | 1,155.00 | ..... | ..... | ..... |
| 222 | 10 | 2,400.00 | ..... | ..... | ..... |
| 223 | 10 | 1,757.70 | ..... | ..... | 2,090.00 |
| 224 | 30 | ..... | ..... | ..... | 1,500.00 |
| 225 | 13 | 1,040.00 | ..... | ..... | ..... |
| 226 | 8 | 2,750.00 | ..... | ..... | ..... |
| 227 | 7 | 1,033.00 | ..... | ..... | ..... |
| 228 | 33 | ..... | ..... | ..... | 2,200.00 |
| 229 | .. | ..... | ..... | ..... | 1,845.00 |
| 230 | 44 | 1,998.00 | 133.00 | 328.00 | 2,459.00 |
| 231 | 30 | 4,150.00 | ..... | ..... | ..... |
| 232 | 25 | 1,950.00 | ..... | ..... | 2,455.00 |
| 233 | 48 | 2,480.00 | ..... | ..... | ..... |
| 234 | 25 | 1,719.00 | ..... | ..... | ..... |
| 235 | 18 | 1,011.00 | ..... | ..... | ..... |
| 236 | 23 | 1,065.00 | ..... | ..... | ..... |
| 237 | 44 | 1,740.00 | ..... | ..... | ..... |
| 238 | 40 | 1,875.00 | 87.50 | 787.50 | 2,750.00 |

220. *Middle West, old; 63-ft. span, brick and wood, slate roof, trussed (no posts.)*
221. *Pacific Southwest, modern;; 80-ft. span, brick and wood, roof supported by posts.*
222. *Far West, modern; part 75-ft. span, part 85-ft. span, brick and wood, gravel roof, supported by posts;*
223. *Far West, modern; 85-ft. span, brick and wood, gravel roof, supported by posts.*
224. *Middle West, old; 65-ft. span, brick and wood, gravel roof, supported by posts.*
225. *Middle West, old; 78-ft. span, brick and wood, gravel roof, supported by posts.*
226. *Middle West, modern; 89-ft. span, brick and wood, gravel roof, supported by posts.*
227. *Middle West, old; 80-ft. span, brick and wood, gravel roof, supported by posts.*
228. *East, modern; 81-ft. span, brick and steel, gravel roof, supported by flat truss (no posts), rolling steel doors, cost does not include heating equipment.*
229. *Northwest, modern; 84-ft. span, brick and wood, gravel roof, supported by posts, cost does not include heating equipment.*
230. *Northeast, modern; 80-ft. span, brick and wood, gravel roof, supported by posts, annex with boilers, heating apparatus (hot air), and air compressor.*
231. *East, modern; 90-foot span, brick and steel, slag roof, with crane runway covering outer half of span, has very heavy pile and stone foundation.*
232. *East, modern; 80-ft. span, concrete and wood, gravel roof, supported by posts.*
233. *Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.*
234. *Northeast, modern; 75-ft. span, brick and wood, gravel roof, supported by posts.*
235. *Northeast, modern; 72-ft. span, brick and wood, gravel roof, supported by posts.*
236. *West, modern; 80-ft. span, brick and wood, gravel roof, supported by posts.*
237. *Middle West, part old, part modern; 70-ft. and 85-ft. spans, gravel roof, supported by posts.* (?)

*Lavatory.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 239 | ... | ... | .. | 2.55 | .. | ... |

239. *Middle West, modern; average of three large lavatories (including water closets, urinals, wash room and locker rooms); buildings of concrete and brick with tile roofs on wooden trusses; cement floors, complete with contents, ready to use.*

*Office Buildings.*

| Item. | Cost per Sq. Ft. of Ground Area. Building Only. | Tools. | Misc. Eqpt. | Total. | Cost per Cu. Ft. Building Only. | Total. |
|---|---|---|---|---|---|---|
| 240 | .306 | ... | ... | ... | .030 | ... |
| 241 | 8.01 | .557 | .295 | 8.86 | .167 | .187 |
| 242 | 1.04 | ... | ... | ... | .034 | ... |

240. *Middle West, old; frame building with brick foundation, includes M. M. store department, steam heat.*
241. *Middle West, modern; brick and wood, basement, two stories and attic, ornamental architecture.*
242. *Middle West, old; wooden, two stories and basement.* (?)

*Track.*

| Item. | Cost per Lin. Ft. | Add. For Each Switch. | NOTES. |
|---|---|---|---|
| 243 | 0.70 | 170.00 | Based on use of "fit" (second hand), 67 lb. rail |
| 244 | 1.00 | 180.00 | Based on use of "fit" (second-hand), 85 lb. rail |
| 245 | 1.00 to 1.25 | 75.00 to 125.00 | Based on use of new rail, according to weight. |

*Turntables.*

| Item. | Diameter. | Cost. | Notes. |
|---|---|---|---|
| 246 | 70 ft. | $3,000 | Exclusive of pit. |
| 247 | 70 ft. | 5,091 | Including pit. (?) |

*Transfer Pits and Tables.*

| Item. | Cost per Sq. Ft. of Pit. Pit. | Table. | Total. | Notes. |
|---|---|---|---|---|
| 248 | .31 | .17 | .48 | Far West, modern; to handle the heaviest class of engines |
| 249 | .43 | .16 | .59 | East, modern; pit of concrete throughout; capacity of table, 200 tons. |

*Miscellaneous Structures.*

| Item. | Name. | Cost. | Notes. |
|---|---|---|---|
| 250 | Ash pit | $30.20 per lineal foot. | |
| 251 | Coal chute | .65 per sq. foot. | Two sided with trestle approach. (?) |
| 252 | Water tank | 1,900.00 total | 50,000 gal. capacity on timber trestle. (?) |
| 253 | Water pipe, underground laid. | 1.43 per lineal foot. | Large system, pipes from 12 in. down to 4 inch. |
| 254 | Sewer pipe, underground laid. | 2.88 per lineal foot. | Large system, pipes from 24 in. down to 12 inch. |
| 255 | Long lines of wrought iron pipe (for air, gas or water), with usual proportion of valves, fittings, etc., in place. | 25.00 per 100 lineal feet. | 1 in. diam. |
| | | 45.00 per 100 lineal feet. | 2 in. diam. |
| | | 85.00 per 100 lineal feet. | 3 in. diam. |
| | | 130.00 per 100 lineal feet. | 4 in. diam. |

Given by a large pipe contracting firm of Pittsburg.

*Minor Buildings.*

| Item. | Name. | Cost per Sq. Ft. | Cost per Cu. Ft. | Notes. |
|---|---|---|---|---|
| 256 | Iron storehouse | .24 | .011 | Old, wooden. (?) |
| 257 | Brass foundry | 1.96 | .098 | Old, brick and wood. (?) |
| 258 | Upholstery shop | .58 | .029 | Old, brick and wood. (?) |
| 259 | Paint mixing shop | .58 | .029 | Old, brick and wood. (?) |
| 260 | Paint storehouse | 1.75 | .087 | Old, brick and wood. (?) |
| 261 | Frght. repair shed | .11 | ... | New, wooden, open sides. (?) |
| 262 | Dry kiln | .79 | .039 | Old, wooden. (?) |
| 263 | Lumber shed | .21 | ... | Old, wooden, open sides. (?) |
| 264 | Storehouse shed | .31 | .015 | Old, wooden. (?) |
| 265 | Coal shed | .24 | .020 | Old, wooden. (?) |
| 266 | Coal shed | .25 | .021 | Old, wooden. (?) |
| 267 | Charcoal shed | .21 | .017 | Old, wooden. (?) |
| 268 | Ice house | .57 | .028 | Old, wooden. (?) |
| 269 | Ice house | .60 | .030 | Old, wooden. (?) |
| 270 | Crematory | 2.52 | .210 | |
| 271 | Small office building | .50 | ... | Old, wooden, one story. |

and the degree of confidence which may be felt in the unit prices assumed; the grand total should represent the approximate cost of the plant, exclusive of the cost of land and grading, which should be estimated separately, these two items not being susceptible of reduction to a unit basis. If the buildings have been designed in detail their cost may be checked upon the cubic foot basis.

The report is signed by R. H. Soule, Chairman; L. R. Pomeroy, T. H. Curtis, S. F. Prince, Jr., A. E. Manchester.

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PISTON VALVES.

On the Norfolk & Western Railway the method adopted for testing piston valves was to prepare a packing ring for each end of the valve chamber which could be brought up against the end of the valve, making it absolutely tight. This arrangement is shown in Fig. 1. The valve was then put on the central position on both sides of the engine and disconnected, and,

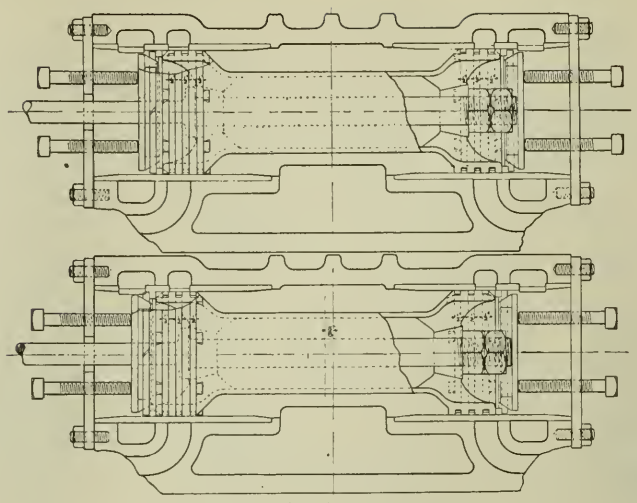

Fig. 1.

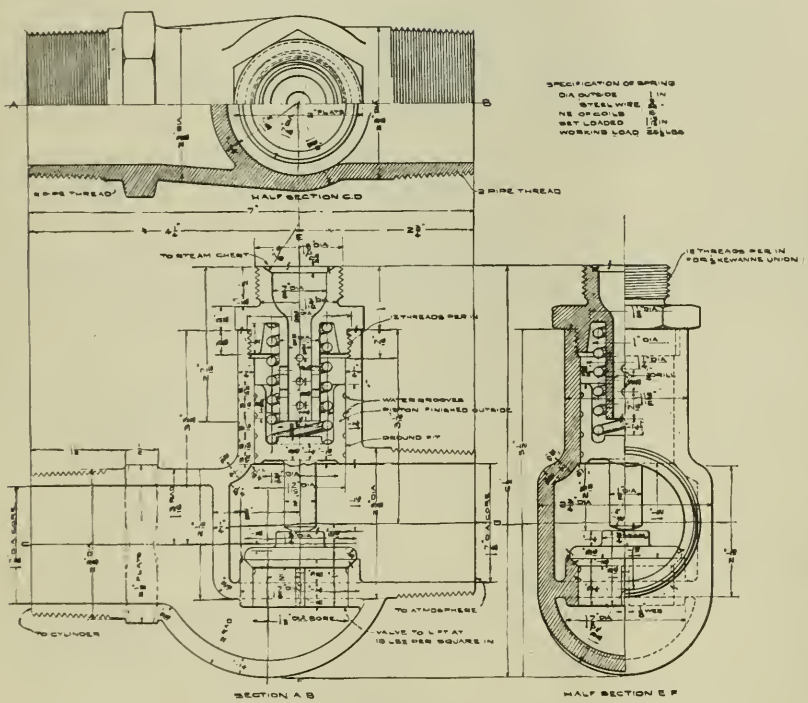

Fig. 3.

and the reverse lever set so that the other valve, the one to be tsted, was on center. A movement of the valves of about 1 in. was given during the test, by moving the reverse lever. The exhaust pipes were plugged so that no steam could pass to the other cylinder or out of the stack. Hose connections were screwed in the cylinder cock openings and steam condensed in barrels of ice water. The valve was well oiled and the lubricator kept running during the test.

Tests for leakage of side valves were made in the following manner on the Norfolk & Western: The valve tested had rectangular balance strips. The exhaust cavity was blocked and leakage was obtained around the balance strips, as well as the face of the valves.

On the Norfolk & Western, a piston valve in good condition loses from 250 to 400 lbs. of steam per hr. The worst valve tested on this road showed a loss of 544.31 lbs. per hr., with a mileage of 13,000 miles. The best slide valve on the Lake Shore & Michigan Southern showed a leakage of 348 lbs. per hr. This valve was in good condition, and had made a mileage of 17,500 miles.

The conclusions derived from these tests do not seem to favor either type of valve. The best piston valve shows a leakage of 268.56 lbs. per hr., and the best slide valve 348 lbs. per hr. If both kinds of valves were given equal attention the piston valve would

being central admission valves, the steam could be readily admitted to the central portion, and whatever escaped passed down through each end of the cylinder. Pipes were connected up with the cylinder cock openings and the pipes passed through barrels of water, which condensed all of the escaping steam. In most cases gages of mercury columns were placed on the cylinders and readings taken during the test. Three positions were taken of the valve: First, both valves on center; second, with the right valve 5/8 in. forward and left valve 5/8 in. back, and third, the right valve 5/8 in. back and the left 5/8 in. forward. In the positions 5/8 in. out of center, two of the rings are against the steam at one end. The results, however, do not seem to be affected by this.

The tests made for leakage of piston valves on the Lake Shore & Michigan Southern were conducted in the following manner:

The valve (Fig. 2) on one side of the engine was disconnected and set on center,

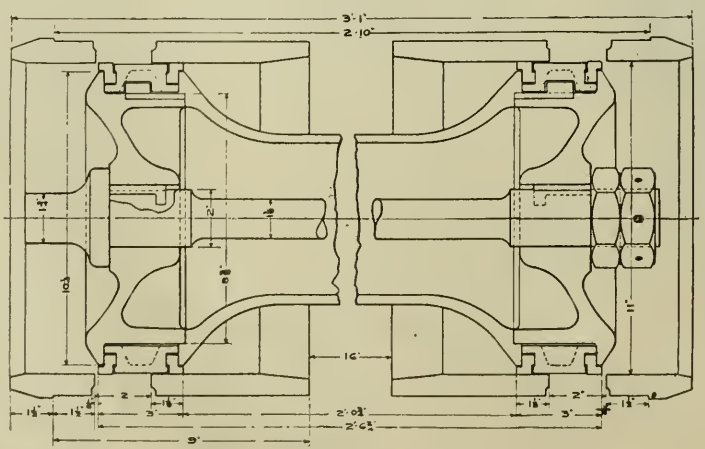

Fig. 2.

be the better as regards leakage around the packing rings.

The need of some kind of relief for the water of condensation in the cylinders or caused by foaming in the boiler, was recognized from the beginning of the application of piston valves to locomotives. The old time slide or "D" valves were perfectly free to lift from the seat and thus relieve the cylinders of water or undue compression; in this respect the valves were automatic. When the balance valve was introduced the lift of the valve became limited by the proximity of the balance plate; however, the reduction of pressure upon the top of the valve allowed an earlier relief than with the unbalanced valve, and the decreased lift was compensated by an earlier opening. Piston valves operating in cylindrical bushings, scarcely larger than the valve itself, can not lift, and if no provision was made, any excess of water in the cylinders would probably damage the cylinder, its head or the piston. This is particularly likely to happen with foaming waters. In the western portion of the United States waters containing large quantities of alkali (soda salts) in solution are comman, and if the amount of such matter exceeds 40 or 50 grains per gallon, priming is almost sure to occur. Other waters may not inherently possess foaming qualities, but when treated, in order to prevent incrustation (as with waters containing sulphate of lime or magnesia) the soluble salts remaining in solution constitute a distinctly foaming characteristic. In such cases it is of great importance that some relief be provided.

The desired characteristics of a by-pass valve are: (1) It must be positive in action. (2) It should be large enough to permit satisfactory operation at high speeds. (3) It should be simple in construction and automatic in action. (4) It should reduce the vacuum to a minimum, thus preventing the suction of cinders into the steam-chest. (5) It should relieve water and excessive compression in the cylinders, thus preventing breakage and overheating, with its consequential difficulty of lubrication when desirable to drift "hooked up" in order to equalize the wear on eccentrics. (6) It should exclude cold air from the valve chest and cylinder. (7) It should reduce the draft on the fire when drifting. (8) It should be low in cost.

There are several arrangements which fulfil all or most of these requirements. The apparatus used by the Southern Pacific and illustrated in last year's report, is in successful operation on that system, and show a reduction of 50 per cent. in the braking power of the pistons, due to the lower vacuum and compression. The device is automatic, being thrown out of action by steam pressure in the dry pipe when the throttle is open, and allowed to operate when the throttle is closed. The water is released by a separate safety valve.

The Central Railroad of New Jersey has experimented with the valve illustrated in Fig. 3, and which is intended to relieve excessive compression. When the throttle is open steam pressure seats the valve in addition to the spring, and when the throttle is closed the spring only is operative. This spring was originally intended to allow the valve to open with 15 lbs. excess pressure in the cylinder, but the continual blow was so objectionable that the pressure as regulated by the spring was increased to 38 lbs. The relief from the valve was allowed to blow into the atmosphere, but it could be piped into the stack.

The report is signed by Wm. McIntosh, Chairman; J. A. Pilcher, H. F. Ball, G. R. Henderson, C. B. Young.

## LOCOMOTIVE FRAMES.

The circular of inquiry brought out from the members a generous response, giving, in considerable detail, opinions and experience, accompanied by drawings locating fractures, with statements as to the probable causes. The study of this material is interesting, but unfortunately the information is so varied and the location of the fractures so distributed, it is very difficult to analyze or reduce them to any common law or base. The committee endeavored to construct a composite drawing, but had to abandon the idea. The breakages reported show cracks in and about all pedestal jaws. The fractures occur as frequently in the solid parts as through the bolt holes.

The preference of the members as to whether wrought iron or cast steel should be used is given as follows:

| | |
|---|---|
| Total number of replies | 41 |
| Roads favoring steel frames | 18 |
| Roads favoring hammered iron | 15 |
| Roads expressing no preference | 8 |

Based on the Number of Locomotives.

| | |
|---|---|
| In favor of steel, representing | 11,512 |
| In favor of iron, representing | 5,613 |
| Non-committal, representing | 4,015 |
| Total locomotives | 21,140 |

The causes of fracture may be classified as follows: (a) Design. (b) Imperfect welds and faulty material. (c) Inertia of the boiler with reference to the frames, augmented by high cylinder saddles and accompanying high center of gravity of the boiler; the fractures showing mainly between the cylinders and front driver. (d) Presence of water in cylinders, when accompanied by arrangement of valves that prevents the water getting away quickly and freely. A discussion, bearing mainly on point (c), furnished by one of the members, is as follows:

"There seems to be no question but that the fractures are usually between the cylinder saddle and the rear of the first pedestal, but it should be further determined whether or not the cracks start from the bottom of the rail. If they do, then the bending moment due to the inertia of the boiler when the motion of the frame is suddenly arrested cannot be a cause of failure, because the bending moment induced by such force would put the top of the rail in tension and the bottom in compression, and the crack would, therefore, start from the top, as previously explained, except when coupling. If they start from the corner of the pedestal it is reasonably certain that the failure is caused by a loose bolt or light design of pedestal binder. It is very probable that the binder bolt will show a very much larger percentage of failures extending in the corner of the pedestal to the top of the rail than the clip pedestal brace, because of the difficulty of securing a bolt sufficiently large to prevent it stretching in service. Those failures which occur in the front of the pedestal cannot be assigned to this cause (unless the pound would strain the frame in a place of weaker section), and in failures of this nature the design of cylinder fastening and keys should be thoroughly examined. It might be well to point out that the bending moment induced by the pull of the drawbar would be at a maximum at a point between the front pedestal and the front cylinder. A stress from such a cause would start a crack from the bottom of the rail. If the frames break from a definite load or fiber stress, then a good grade of cast steel should give equal if not better results than wrought iron, and the steel should be of a moderately stiff grade. If, on the other hand, the frames break by a definite amount of distortion or bending, then wrought iron or soft steel would give better results, inasmuch as it would take a smaller force to bend this material a certain amount and the fiber stress induced would therefore be considerably less in the case in which the stiff steel is used."

*Fiber Stress Analysis by H. V. Wille.*

The inertia of the boiler in accelerating or retarding the train has also been given as a possible cause of breakage. Since frames never start to break from the top but always from the bottom of the rail, it is evident that the inertia of the boiler while the train is being retarded cannot be a cause of fracture, but the bottom of the rail is put in tension in overcoming the inertia of the boiler while the train is being accelerated. The stress produced by this force is as follows:

Weight of boiler = 57,000 lbs. = W

Acceleration = 5.655 ft. per second. = a

$$\text{Force} \quad \frac{57{,}000 \times 5{,}655}{32.2} = 10{,}010. \quad = F$$

Center of gravity of boiler above center of frame 56 inches. = d

Bending moment = 56 × 10,010 = 560,560 inch lbs. = M

Moment of resistance. = 103.5

$$\text{Fiber stress} = \frac{560{,}560}{103.5} = 5{,}416 \text{ lbs. per square inch.} = f$$

This is well within safe limits and is not sufficient to cause the frame to break. When the train is being retarded by application of brakes the top of the rail is being strained in tension by this amount, but when the train is being accelerated the bottom of the rail is being strained, and other forces also tend to increase the stress due to the force necessary to accelerate the boiler.

Assume that the frame is deflected by force of blow. Deflection = a = .1 in. Length = e = 41 in. from center of cylinder to fillet in front of front pedestal.

$$f = \frac{3d\,Ea}{e^2} = \frac{3 \times .10 \times 30000000 \times 3.625}{41^2} = 19{,}600 \text{ lbs. per sq. inch.}$$

Side bending. Compression increased by steam pressure on other side: 350 lbs. per sq. in. compression; 200 lbs. per sq. in. steam on other side; 550 lbs. per sq. in. equals 308,000 lbs. total pressure; 23.5 lbs. = moment arm; 308,000 × 23.5 = 7,238,000 in. lbs. = bending moment; 1,650 = moment of rupture through section of smoke-box and frames; 4,390 lbs. per sq. in. = fiber stress.

Effect of rounding curves. The centrifugal force of the weight carried by the front drivers: 16 degree curve = 358 ft. radius; speed 30 M. P. H. = 44 ft. per sec.; weight on journals = 41,000 lbs.

$$F = \frac{W\,V^2}{g\,v} = \frac{41{,}000 \times 44^2}{32.2 \times 358} = 6{,}888 \text{ lbs.}$$

Moment arm = center of pedestal to first bolt in cylinder connection = 37.75; bending moment = 6888 × 37.75 = 260,000 in. lbs.; moment of rupture = 37,675; fiber stress = 7,960 lbs. per sq. in.

From the above calculations the following conclusions may be drawn:

(1) The inertia of the boiler following the sudden application of brakes cannot produce a sufficient force to break the frame. (2) The inertia of the boiler due to the acceleration of the train by acting with other forces, such as those produced by water in the cylinders, may bring about fracture. (3) The dynamic effect of the compression of water in the cylinders is the only force which, unaided, can cause failure of the frames by fatigue.

When the right side leads, the right side always pounds harder than the left. This is due to the fact that when the right crank passes the forward dead center the left cylinder is pulling forward so that it aids the right cylinder in throwing the right box

against the back jaw of the pedestal. The same is true on passing the back dead center, but when the left crank passes the forward center the right cylinder is pushing on the pin, thus subtracting from the left cylinder in pushing the left box against the back jaws of the pedestal. This should result in breaking more right than left frames when the right side leads and vice versa when the leff side leads.

The committee took the liberty of inviting manufacturers to take part in the deliberations. The steel casting representatives examined and approved the frame designs accompanying the report (not shown herewith) and also held independent meetings, agreeing on the following specifications:

Acid open-hearth steel, .28 carbon, .05 phosphorus, .05 sulphur, .60 manganese; tensile strength per sq. in. not less than 55,000 lbs.; elongation in 2 in. not less than 15 per cent.; all frames to be annealed.

Relating to the method of manufacture, a member contributes as follows:

"The method of casting, location of gates and headers, all have a very important part upon the life of the frame. It is the usual practice to cast the frame on an incline, the front end of the frame being at the top, the metal being poured into a riser at the back end of the frame, which is at the lowest point. This method results in washing the dirt and gases to the front end of the frame, and we have defective metal at the point at which the frames are most prone to break. It would therefore seem desirable to reverse this method and mold the frame so that the front end is at the lowest point and pour them through a gate leading into the two front rails. It would also seem inadvisable to place the riser at the point of the juncture of the pedestal leg to the top rail, so as to avoid any impurities separating at this point and prevent shrinkage cracks due to the different rates of cooling of the risers and of the frame section proper. It would no doubt be an improvement to locate the riser on the pedestal at a point between the top and bottom rail."

The following points should be observed: (1) Sensible design. (2) Material, cast steel, made to a rational specification, careful foundry manipulation, adequate and suitable annealing. (3) Provide such form of bracing as will prevent "weaving." By weaving is meant a movement of one side independently of the other, or of the separate parts or joints, with reference to each other locally. (4) The clip form of pedestal binder is preferred to the thimble and bolt type. (5) Provision for quickly and adequately draining cylinders. This point is just as important with slide as with piston valves. (6) Frames with single front rails should be made stronger and means provided to stiffen same back of cylinders or between cylinders and front driver.

From a study of the replies for the present at least, there is an intimation that the double front rail type is stronger, and stiffer in a vertical direction, and yet as flexible longitudinally as the single front rail form. The success foreign roads are having with plate or girder frames gives us a hint that may be valuable when scheming on future improvements.

The report is signed by T. S. Lloyd, Chairman; S. M. Vauclain, J. E. Sague, R. Wells, S. Higgins, A. Lovell.

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DRIVING AND TRUCK AXLES AND FORGINGS.

The committee last year reported a specification for locomotive axles and forgings, but was continued for the purpose of co-operating with the American Society of Mechanical Engineers, American Institute of Mining Engineers and the American Society for Testing Materials with a view of bringing about a common standard for specifications for locomotive axles and forgings. In accordance with this purpose a meeting was held which was attended by Prof. H. W. Spangler, chairman of Committee on Specifications, American Society of Mechanical Engineers; Wm. R. Webster, chairman of Committee on Specifications of the American Society for Testing Materials, and by members of the committee. It was agreed at this meeting to modify the specifications proposed last year by reducing the reduction of area to 25 per cent. and introducing a bending test. This modified specification is now before the American Society of Mechanical Engineers and will be proposed to the American Society for Testing Materials at their next meeting with the expectation that they adopt it as their standard specification for annealed high carbon steel forgings.

It has been proposed to omit the tension tests on the specifications for steel blooms. The committee feels that this test is essential in order to insure that the mills put sufficient work upon the blooms, for nothing tends to increase the failures or breakages of driving axles more than the use of steel which has not received proper manipulation.

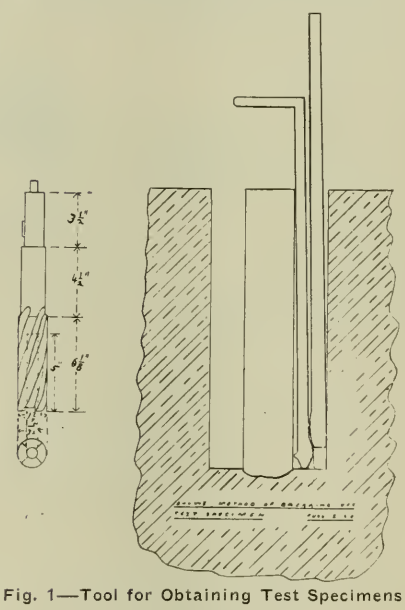

Fig. 1—Tool for Obtaining Test Specimens from End of Driving Axles.

The reduction in strength with holes drilled half way between the center and outside and also with a hole in the center is shown in the following table:

| Diam. of Axle. | Hole in Center. Per Cent. | Hole Half Way Between Center and Outside. Per Cent. |
|---|---|---|
| 6 inches | 1.35 | 15.3 |
| 7 inches | .71 | 10.9 |
| 8 inches | .41 | 8.2 |
| 9 inches | .25 | 6.1 |
| 10 inches | .16 | 5.0 |
| 11 inches | .11 | 4.1 |

If the hole is drilled to within 1½ ins. of the inner side of the hub it will have no effect upon the strength of the axle.

The specifications proposed last year would stand as follows with the modifications now proposed.

*Material.*
Open Hearth Steel.
*Chemical Requirements.*

| | Per Cent. |
|---|---|
| Phosphorus, not to exceed | .05 |
| Sulphur, not to exceed | .05 |
| Manganese, not to exceed | .60 |

*Physical Requirements.*

Tensile strength—not less than 80,000 lbs. per sq. in.

Elongation in two inches, not less than 20 per cent.

Reduction in area, not less than 25 per cent.

Bending test—1 in. x ½ in. test piece 180 degrees over 1 in. diameter.

One test per melt will be required, the test specimen to be taken from either end of any axle with a hollow drill, half way between the center and the outside, the hole made by the drill to be not more than 2 ins. in diameter, nor more than 4½ ins. deep. The standard turned test specimen, ½ in. in diameter and 2 ins. gage length, shall be used to determine the physical properties. Drillings or turnings from the tensile specimens shall be used to determine the chemical properties.

A method of breaking off test specimen and the tool for obtaining it from the end of the driving axle are shown in Fig. 1.

Proposed specifications for locomotive forgings are as follows:

*Material.*
Open Hearth Steel.
*Chemical Requirements.*

| | Per Cent |
|---|---|
| Phosphorus, not to exceed | .05 |
| Sulphur, not to exceed | .05 |
| Manganese, not to exceed | .60 |

*Physical Requirements.*

Tensile strength, not less than 80,000 lbs. per sq. in.

Elongation, not less than 20 per cent. in two in

Reduction in area, not less than 25 per cent.

Bending test—1 in. x ½ in. test piece 180 degrees over 1 in. diameter.

Proposed specifications for steel blooms and billets for locomotive forgings are as follows:

*Material.*
Open Hearth Steel.
*Physical Requirements.*

Grade "A":
Tensile strength, 70,000 lbs. per sq. in.
Elongation in two inches, 20 per cent.

Grade "B":
Tensile strength, 80,000 lbs. per sq. in.
Elongation in two inches, 17 per cent.

*Chemical Analysis.*

| Grade "A": | Per Cent. |
|---|---|
| Carbon | .25 to .40 |
| Phosphorus, not to exceed | .06 |
| Sulphur, not to exceed | .06 |
| Manganese, not to exceed | .60 |
| **Grade "B":** | **Per Cent.** |
| Carbon | .35 to .50 |
| Phosphorus, not to exceed | .05 |
| Sulphur, not to exceed | .05 |
| Manganese, not to exceed | .60 |

Grade "A" is blooms or billets for rod straps and miscellaneous forgings. Grade "B" is blooms or billets for driving and truck axles, connecting rods, crank pins and guides.

The report is signed by F. H. Clark, Chairman; J. E. Sague, S. M. Vauclain, L. R. Pomeroy, F. W. Lane, E. B. Thompson.

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GRATES FOR BITUMINOUS COAL.

*(From a paper by J. A. Carney.)*

It has been demonstrated that the cheapest fuel for locomotive use is that which can be bought for the lowest prices per ton, and it rests with the railroad mechanical engineer to so design his engine to burn this cheap fuel with the least inconvenience. The ash pan is so closely related to the grate that it is discussed in this paper in connection with grates. In designing a grate the first object is to properly support the fire; the second, to admit air enough to the fire to properly burn it; the third, to easily and effectually stir the coals and shake down the ashes, and the fourth, to be able to quickly remove the fire at the end of a run; a fifth and most important feature is to be able to

quickly and easily clean the fire on the road.

The ash-pan must be tight to prevent loss of hot ashes, and yet have enough openings to admit air freely to the under side of the grates. It must have sufficient volume to carry ashes made during a trip of many hours, and should dump and clean itself with a minimum amount of labor. There should be no flat places where ash can collect and fill up to the grates. While the air openings, according to theory, need be very small, they should in practice be as large as possible and allow the passage of sufficient air to not only burn the fire but cool the grates and accumulations of ash on them as much as possible.

Estimating the temperature of the products of combustion in the fire-box at 3,500 degrees F., the volume of the gases passing out of the fire-box will be about seven times as great as the air passing through the grates, due to the expansion caused by the high temperature. As all of the gases have to pass through the flues, the openings in the grates and ash pan need be one-seventh of the combined area of the flue openings. According to the above figures, an engine having 44 sq. ft. of grate area and 792 sq. ins. of flue openings, the total area of grate opening should be 114 sq. ins., with 114 sq. ins. opening in the ash-pan. In per cent., with grate area 100 per cent., this equals:

| | |
|---|---|
| Grate area | 100 |
| Flue area | 12.5 |
| Grate opening | 1.8 |
| Ash-pan opening | 1.8 |

*Grates (Finger and Box).*—The use of the finger grate is somewhat more common than the box construction. The box construction is used in good-coal districts, and while roads report some trouble where the coal is fairly good, others who are using poor coal report an endless amount of trouble. The fingered grate has the advantage of breaking up as well as stirring the fire, while the box grate can only lift and lower the fire, without breaking it up. The only objection to the finger grate is the possibility of burning the ends of the fingers if they are not kept level. This can be entirely overcome by care on the part of the fireman and the shaking mechanism kept in repair. The long-fingered grate is better adapted for poor coal than the short finger. It has a more violent action on the fire, breaks it up better, shakes down ashes faster and gives a larger opening through which the fire can be dumped in the least possible time. Grate fingers less than 5 ins. long do not give as good results with coal which clinkers or which fills up the box as those longer than 5 ins., although the general practice is to run under 4⅞ ins.

*Dead Grates.*—Dead grates are used by seven of the roads making replies. These roads use a better grade of coal than that found in the Middle West. As a general proposition, a dead grate is not advisable, especially in the front end of the fire-box, where there is most need of a good fire, especially with wide, shallow fire-boxes. It is easy to accumulate ashes in the front, and if the fire dies and cold air gets next to the flue sheet, it is difficult to make an engine steam.

*Dump Grates.*—Most roads have special dumping grates, both in front and in the back end of the fire-box, and the idea has a great deal of merit, especially when it is necessary to clean a fire on the road. These grates should be shaking as well as dumping grates.

*Shaking Grates, Area.*—Grates should be designed so that the entire grate surface may be shaken. If it is desirable to stir up the fire in the middle of the box, why not on the sides and especially the ends? The area shaken by one lever may vary with the quality of the coal, and if the ash melts and cements the grates tight, the shaking feature is out of the question and all designs are equally bad. The grate area shaken by one lever ranges from 7.2 sq. ft. to 29.8 sq. ft. The grates with the last-named area are used with West Virginia coal and practically no shaking is required. Generally speaking, the grate area to be shaken by one lever should not exceed 12 sq. ft. Some recently built engines have the grate lever fulcrum attached to the back of the boiler head with studs. These studs are liable to pull out and it is safer to attach the fulcrum to the deck or tailboard.

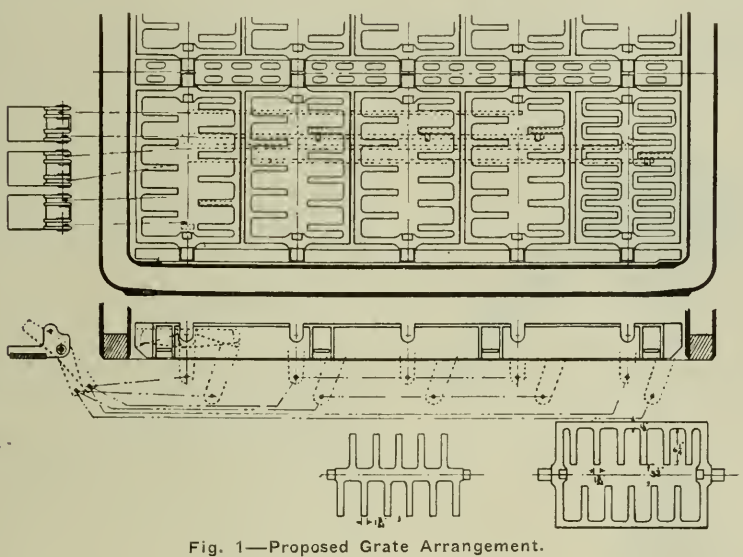

Fig. 1—Proposed Grate Arrangement.

*Grate Supports in Wide Fire-Boxes.*—It is impracticable to make grate bars wide enough to extend from one side of a fire-box to the other without a central support. This support prevents air from circulating under the fire in the middle line of the box, and there is a dead space a few inches wide from the front to the back of the fire which will clinker badly if great care is not taken in firing.

*Material.*—Grates should be made of as cheap a grade of cast iron as can be bought and have the required strength. Hard iron is not an objection, if the cotter and pin holes are carefully cored. Patterns should be accurately made and the foundry required to furnish castings that do not require any machine work. Many roads are following the practice of coring all cotter and pin holes, with excellent results, and a great deal of labor and many small drills are saved thereby.

*Proposed Grate.*—A grate should be capable of dumping the front section and the back section independently of each other and the balance of the grate sections, and in addition all sections of the grates should be capable of dumping. Dead grates are not desirable, although they are the practice on many roads. All sections of the grate should be capable of being shaken, and the sections so divided up that not more than 12 sq. ft. of grate surface is shaken by one lever. Grates should be supported by bars on the sides of the fire-box only, and these bars should be blocked away from the side sheets at least ½ in., to prevent corrosion of the side sheets. The fingers should be from 6 ins. to 7 ins. long, depending on the length of the fire-box and the number of sections into which the grates are divided. The air openings in the grates should be at least 40 per cent. of the grate area and 50 per cent., if possible. A drawing of a grate arrangement as outlined is shown in Fig. 1.

*Proposed Ash-Pan.*—The ash-pan should be self-cleaning and have a free air opening of at least 25 per cent. of the grate area, divided equally on the four sides of the pan. No design of pan is suggested, because its form is so dependent upon the frame construction and location of back driving-wheel axle or trailer axle that a satisfactory pan on one engine would be impossible on one of different design. The use of netting over air openings in the pan is objectionable, and so far as possible should be avoided and inclined slats used.

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TERMINALS FOR LOCOMOTIVES.

*(From a paper by Robert Quayle.)*

*Weak Spots in Roundhouse Operation.*—The following would come under the heading of the title:

Insufficient tracks for storing engines; poor coaling facilities or coalhouse too far from roundhouse; sandhouse badly located or inefficient; water supply improperly located or inadequate; cinder pits not long enough or so located that engines have to run a long distance after fire is dumped; cinder car track not depressed enough, causing unnecessary shoveling; lack of a wide-awake man outside, who should, while working as a hostler or in some other capacity, have supervision over clinker pit, sandhouse, coal shed and other men working in the vicinity; turntable too small or weak and not power driven, causing more time to be spent spotting engines and turning them than is absolutely necessary; a roundhouse too small to get engines inside and close the doors, or one that is improperly lighted and ventilated; a poor roundhouse foreman; a poor engine inspector; washout facilities not arranged to wash out with hot water, or to have at least a pressure of 100 lbs. per sq. in.; drop jacks that won't drop; cinder floors; poor method of giving out work and checking it up; poor discipline among shopmen; a machine shop stocked with obsolete tools, or so located that men waste time running back and forth; a storehouse minus necessary material; a heating system that won't heat properly.

*Organization.*—There should be a good, live foreman in charge, who is responsible to the master mechanic. All of the men

working inside and out should be amenable to his orders; such a man, if a firm disciplinarian, and one who has the good will of the men and is quick to think and act, is invaluable. Under him should be an assistant who is familiar with the engines, enginemen and workmen; it should be his duty to give out the work and see that it is properly done, keeping check of the men who have done the work, so that in case it becomes necessary at some future time to locate them there would be no difficulty in doing so.

A good staff of machinists, boilermakers, truckmen, helpers, boiler washers, wipers, engine inspectors, etc., is indispensable, all having their duties outlined so that there will be no friction in promptly doing the work. Fair and straightforward treatment of the men will in return get, in most cases, cheerful service. Proper records must be kept of the numerous peridoical inspections that are called for. The engine-house in and out register should be entered up daily, and a check of engineers and firemen who are laying off or sick is useful to locate and round up men in case of a shortage.

*(Other reports are held until the next issue.)*

## Train Despatchers' Convention.

The convention of the Train Despatchers' Association of America was held at St. Louis on Tuesday, June 21, in the old Exposition building. Thirty-three new members were elected. The report of the Executive Committee showed a net gain of 71 members during the past year and a total membership of 850; a balance of receipts over disbursements of $510, and $1,651 in the treasury.

The report of the Train Rules Committee was read. It took up several matters referred to it from the committee report of the preceding year and embodied suggestions for submission to the American Railway Association amending the definitions in the Standard Code of "Regular Train," "Superior Train" and "Schedule," Rule 4 (A), Rule 4 (B), Rules 20, 218 and 220; Form E, Form F, and Form K, with the view of making clearer the distinction between a regular train and a schedule, and of defining the action of sections affected by a Form F order in the matter of taking down signals, which it was the judgment of the committee were not sufficiently well defined in the Standard Code as it exists.

Papers were read from J. R. Cavanaugh, Superintendent of Car Service of the C., C., C. & St. L., on the subject of "Pooling Freight Cars"; on "Train Despatching," by S. H. Brown, of the Chicago & Alton, and on a "Schedule and a Train," by H. A. Dalby, of the Northern Pacific, all of which were followed by considerable animated discussion. The report of the Train Rules Committee was adopted with some slight changes and was ordered submitted, as revised, to the American Railway Association.

Informal discussion was had on a number of subjects relating to train rules and forms, telegraph block signaling and manual controlled signaling. The publication of the official organ of the Association, "The Train Despatchers' Bulletin," was ordered continued at its present size, 40 pages per issue. A resolution was passed authorizing the Executive Committee to draw on the treasurer for a sum not exceeding $100, in aid of the widow or orphans of a deceased member who are in need. Members were urged to be more prompt in notifying the secretary of actual or impending vacancies, so that members out of employment might be more effectually aided.

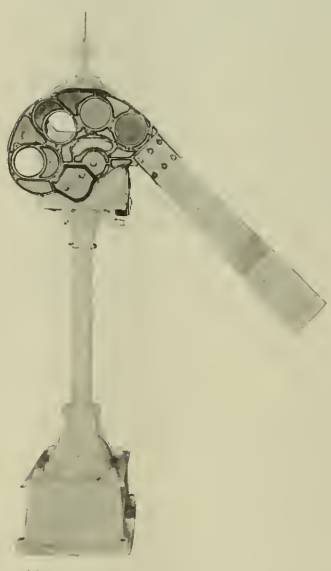
The election of officers resulted as follows: President, John W. Cuineen (L. V.), Auburn, N. Y.; Vice-President, F. X. Meyers (T. & P.), Marshall, Tex.; secretary-treasurer and editor, J. F. Mackie (C. R. I. & P.), Chicago. Denver was selected as the place of next annual meeting, which comes on June 20, 1905. The sum of $100 was appropriated toward the expense of entertainment at the next annual meeting.

Thursday afternoon was devoted to a trip over the lines of the St. Louis Terminal Railroad, for the purpose of examining its interlocking and signaling plant. The trip was very interesting; many of the members had never before seen a plant so extensive.

There were 66 members in attendance at the various sessions of the convention, and great interest was taken in all the proceedings.

## Herman's Direct Driven Semaphore Signal.

The engraving given herewith shows the latest electric motor for semaphore signals brought out by Mr. R. Herman, of Crafton, Pa. This motor is fixed to the top of the signal post and is so designed that it can be attached to any post. Where a motor signal is to be put in place of a mechanical



Herman's Electric Semaphore.

signal, which is supported on a wooden post, the old signal can be removed, the post sawed off square just below the top, and the new signal put on, without any other changes. Where necessary, the socket can be made any size or shape desired.

This is the signal of which a test was reported in the *Railroad Gazette* of June 10, page 447. The motor is connected directly to the spindle which turns the blade, and as there is only one moving part the blade moves as soon as the motor is energized. Doing away with the heavy connections between the motor and the signal, which are necessary when the mechanism is at the bottom of the post, and with unnecessary friction, reduces the demand on the power about two-thirds. The disuse of the large mechanism box at the foot reduces the size of the foundation, and where signals are placed on bridges the unsightliness of the mechanism box is done away with.

The power used to make the movements in the test referred to was 20 cells of Gordon battery, Type A, 300 ampere-hour. The motor was controlled by a signal magnet of 1,000 ohms, which was closed 25 seconds each minute and consumed 12 miliamperes each period, making the consumption of energy 300 miliampere-seconds per movement. The track relay, of 4 ohms resistance, was energized by two gravity cells connected in multiple, and the shunting was done by a Seth Thomas clock.

The signal made a movement of 90 deg. each time the circuit was closed (every minute). The arm is held at stop by a locking device; this in the test consumed 32 miliamperes for 35 seconds, or 1,120 miliampere-seconds per movement. The motor consumed 2.4 amperes per movement and the movements averaged five seconds. The batteries were put into service at 6.45 p. m. on March 15, and moved the signal every minute until May 4, when the automatic recorder had registered 73,100 movements. The battery then dropped to 7 volts on closed circuit, that is, connected through the signal. Then the batteries were given a rest of 12 hours when they showed 15 volts on open circuit. They were subsequently connected again twice, making the total number of movements 74,100; and they still showed 15 volts when the test was closed. The efficiency of the battery proved to be about 94 per cent. The cost of renewing the battery is $20, so that the average cost of each of the 74,100 movements would be .0257 cents. The weight of the semaphore casting and blade used was 115 lbs.

This motor is not geared direct to the signal but moves it by means of an electric clutch. Thus the mechanism is never turned backward, and the signal, in moving to the stop position, is entirely independent of the motor apparatus. The average speed of the motor in the test was about 2,600 revolutions per minute.

## Foreign Railroad Notes.

New signal and train rules have been prepared for the Austrian and Hungarian railroads, to go into effect May 1, 1905. The innovations are a general adoption of space instead of time intervals between trains and the requirement of continuous brakes for all trains running as fast as 60 kilometers (37 miles) per hour. Trains will be permitted to have two pulling and two pushing engines, and a "safety car" (interposed between the locomotive and the first passenger car) will no longer be required on trains which do not exceed a speed of 28 miles an hour. The telephone may be used to report the passage of trains; distant signals are to be used before main signals; red lights must always mean stop, and not be used on trains standing at stations which are to be passed or met by other trains, etc.

The Hungarian Minister of Commerce has addressed to the employes late on strike a circular which says that the great material damage caused by the strike and the blow to the good reputation of the nation and the State railroads cannot soon be made good; and only by the strictest attention to duty can the former reputation be acquired again. He has no intention of adopting repressive measures toward those who have returned to their duty: but those who directed the movement of the employes into criminal courses must be left to take the consequences which the courts may find them to have incurred. Faithful service hereafter will cause the government to do all it reasonably can to improve the condition of the employes.

Besides the four long tunnels, with an aggregate length of nearly 17 miles, which are being excavated for the new Austrian Alpine railroads, there will be a great number of smaller ones, whose aggregate length is nearly as great. Hand drills are used on these smaller tunnels.

RAILROAD GAZETTE

## LAKE BAIKAL WAR TRAFFIC.

The conduct of traffic across Lake Baikal last winter must count among the most remarkable of military operations. The ice-breaker ferry boats, something of the pattern of those which ply across the Straits of Mackinaw, have been able to cross the lake but a few weeks of each winter. The length of the ferry until a few months ago was 42 miles. On the average the two boats, one large and one small, have been able to make but three passages in 48 hours, with capacity altogether insufficient for the forwarding of men and supplies of a large army, and this year they made their last winter passage January 27. Meanwhile, by building on the east side of the lake, where the ground is not difficult, a section of the line around the south end of the lake, a harbor (Tanchoi) was reached, which is only about 25 miles from the terminus on the west side of the lake, and to this troops were marched over, and supplies carried in sleighs; while the light railroad laid on the ice, and worked by horses, was opened March 2, when 20 cars were hauled across; later on, some days as many as 220 cars crossed, and by March 14 no less than 1,300 cars had been transferred to the east side. But the railroad was not like one on dry land, or even that over the smooth surface of the Mississippi, on which Milwaukee & St. Paul trains used to cross. Great longitudinal cracks in the ice appeared from time to time, sometimes nearly 6 ft. wide, and the track would be shifted as these were closed. Where they were most frequent a grating of rails and timbers was placed under the track, which had to be watched constantly. When the cars had been mostly transferred and it was thought that the track had been got into pretty firm condition, it was ventured to haul locomotives over it. An old 30-ton engine sank with its fore wheels, but was raised again. The heavier engines (some 50 tons) were taken apart, the boiler, etc., loaded on two cars, and the frame and running gear hauled on its own wheels. In the course of four days 65 engines were transferred to the east coast. March 26 a wide fissure parallel with the track appeared, the weather moderated, and on the 27th the track was taken up, after 2,313 freight cars, 25 passenger cars and 65 locomotives had been hauled across, together with some 25,000 tons of freight; while 16,000 men had crossed on sleighs.

In April the navigation was open. The two regular ferry boats cannot transfer more than about 1,200 men per day; but the government has impresed nearly all the private steamboats on the lake, which are quite numerous, and with these it should be possible to transfer men and supplies faster than the railroad can bring them. Meanwhile, work is progressing with great energy on the unfinished part of the connecting line around the south end of the lake, over precipitous crystalline rocks, cleft in the most irregular manner by earthquakes. Notwithstanding the difficulties, it is expected to have the line in operation before the end of summer.

## RESPECT FOR THE LAW.

The Century dictionary defines the expression *reductio ad absurdum* as the proof of a proposition in geometry obtained by proving the falsity of its contradictory opposite. This form of argument, often used by the old-time rhetorician as a graphic means of enlarging a fallacy in his opponent's argument, is a good test to apply to an economic problem, for the reason that the end, when logically carried through, is apt to look quite different from the beginning. Perhaps the recent anarchy in Colorado, bordering almost on civil war in its intensity, may not have been wholly bad, since it has served to demonstrate with wonderful clearness what is bound to happen when either side, or both sides, in such a controversy, disregard all laws and all principles except those of immediate expediency, and hold their cause as of greater importance than the very sinews of the state.

There is probably not much to choose between the methods employed respectively by the mine workers and by the mine owners in Colorado, although in the matter of provocation, which the law takes into account, the mine owners seem to stand on the firmer ground. With the quarrel under way, the picturesque but astonishing war cry, "To hell with the Constitution!" was the rule of action for both parties in the controversy. We say this with the fullest belief that under circumstances as they existed, some form of military government was necessary, and with the fullest understanding that the laws are silent in the presence of troops. But when the Governor first called out the guard to protect the mines, actual rioting had not commenced, and in spite of the fact that it required no special gift of prophecy to see breakers ahead, it is perfectly evident that, in the interest of the mine owners, he flagrantly exceeded his authority.

The lesson of the Colorado strike, where the attitude of the strikers toward the law varied from that of all mobs everywhere in this country only in degree, seems to be that as soon as the conflict becomes hot, the contestant strips off the encumbrances of law as an athlete throws aside his blanket before entering a race. The Colorado strike has answered the outcry of the labor leaders in Pennsylvania and Chicago against government by injunction, which is at least a legal form. At Cripple Creek the government is by strength, and the strength, however misapplied, is at present directed against riot. This, then, must be the final outcome of a conflict where both parties look on the law with undisguised contempt. It has been carried out to the uttermost dregs in Colorado, with the result that the state is governed by its troops, who are at the call of one man. It chances that the present incumbent upholds the mine owners; therefore the state is controlled by the mine owners. The next governor may favor the Western Federation of Miners, in which case the state will be controlled by the strikers. And meantime, the state laws and the national Constitution are laid aside, like the Greek poets, as documents interesting but not timely.

What further absurdity is needed to complete the proof that government without regard to the law is no government at all? If the present state of affairs is the logical outcome of every strike where there is picketing; of every riot, and of every cry against the use of the injunction, it is no less the logical outcome of similarly high-handed acts by great corporations that have rightly given grounds for the suspicion and distrust which surround them. Individual law-breakers like the poor, are always with us, and occasion no special alarm, but the great need, for employer and employee alike, is a far deeper respect for the law; an understanding, on the one hand, that corporate dishonesty is the same as personal dishonesty, and, on the other, that it is quite as culpable to kill a man because he wants to work as it is to kill a man for his pocket book. That is an extremely simple principle, yet it is the root of the whole matter, and the Colorado strike of 1904 will, it is to be hoped, stand as an extreme example of what happens when an entire community tacitly accepts the assumption that the right of a mob, whether of strikers or of non-strikers, to ignore the law, is superior to the right of the individual.

## STREET RAILWAYS AND THE MUNICIPALITY.

There are three prominent grades of corporations which, in their relation to our municipalities, fall into the general class of "public service" corporations. They are (1) corporations that supply water; (2) corporations that supply light and (3) the street railways. To these should, perhaps, be added in the primary class the telephone and telegraph companies and, in a secondary class, steam heating supply corporations and corporations that operate vehicles other than street railroad cars. In the order of public necessity, saying nothing of convenience, the supply of water and light undoubtedly come first. The supply of municipal water dates far back to the ancients and, of light, at least to the time when Macaulay tells us that new street lamps were more effective than the whole corps of city watchmen in diminishing crime o'nights in London. And it is due to this antiquity of water supply and of street lighting, as well as to the magnitude of the service required—in times when corporations were limited in their resources and aims—that we find, so often as we do, those branches of public service under municipal ownership. If water supply companies had been active in the days of Cicero or lighting corporations in the seventeenth century, there might be now a different tale to tell. As it is the principle of inheritance applies to both those kinds of public service.

Not so with the street railway. Like the steam railroad its active history goes back but a few decades. Its beginnings were small. It required at first but a trifling capital. A corporation capitalized at a few thousand or, indeed, a few individuals, could supply the funds for a short horse railway of the old-fashioned type, perhaps operated for but a mile or two through a single city street. The single track represented no "servitude" on the through fare either in a technical and legal or in a practical sense. The "public service" idea was in the remote background; indeed, the phrase "public service corporation" did not until a comparatively recent date come into use. Naturally enough, therefore, as a localized concern in

the municipality the street railway began with a chartered corporation, and in this country the precedent has been followed as distinguished from a different policy in some foreign cities. And this notwithstanding the growth of the public service which the street railway supplies to a magnitude almost equal to that of water and light supply; notwithstanding greater servitude on streets by multiplied tracks and larger and more frequent cars; and notwithstanding the consolidation of many companies into one, the vast increase of receipts and profits and the greatly enhanced value of the street railway franchise.

It is perfectly natural that under these new conditions there should be movements in the direction of municipal ownership of street railways especially marked just now in some of the cities of the Middle West. And, since the application of electricity to the street railway, the movement as a more general fact has been somewhat strengthened by the double function of the street railway company of supplying light and power as well as transportation. As a lighting concern the street railway company has often invaded the province which a municipality has hitherto occupied, and in the future is likely to do so more and more. Hence a clashing of interests of which the tendency is to thrust municipal ownership to the front. Partly, perhaps for that reason but probably more from the broader theory of restricting the street railways to their "regular" business. The railroad commission of Massachusetts has been stoutly opposing a bill—which, however, has passed the State senate—which practically opens the field of electric lighting to the street railway corporations of that commonwealth. As further illustration of a tendency may be noted the merger of practically all its controlled trolley companies in Connecticut by the New York, New Haven & Hartford, under a "liberal" charter of one of the corporations which specifically grants the right to sell electric power and light.

But there are opposing forces and exceedingly powerful ones, both of an economic and a civic character, which resist the tendency to municipal control or ownership of the street railway. The danger of such an expansion of the sphere of municipal politics and spoils, as tested both by American experience and theory, is a trite argument but not for that reason less strong; and to be added to it is the fact that the rapid increase of street railways every year complicates the problem and makes the civic experiment more perilous. The city of say 100,000 inhabitants which 20 years ago might have taken over experimentally ten miles of horse railway with comparatively little risk to its tax rate or to its political morals faces a different proposition when the purchase of 100 miles of trolley track, with its equipment capitalized at several millions, is involved. Again, there may be cited a tendency especially in New England, to recognize and amplify the regulation power of the municipality over the street railway. It does not often extend to fares but it does reach such matters as layout, costs of paving and physical condition of roadbed and track. More important, in many States, is the element of local taxes in which the right of the municipality is apt to be expressly, and often liberally conceded. When a municipality can "regulate" with considerable freedom—and can acquire greater power by legislative grant—and when also it has big trolley tax receipts, its taxpayers are hardly apt to aspire to municipal ownership. Finally, in a more hypothetical and long look ahead, the drift toward acquisition of street railways by the steam companies seems certain to antedate ownership by cities. Such a consolidation may raise for future generations in new shape the question of federal control of the blended properties, but would, for the same reason, extinguish the municipal claim.

To summarize a situation, while the street railways have, from growth and other natural causes, come to assume a more close and intense relation of public service and in this way raised in certain cities the issue of municipal control much more potential obstacles have been created against it. Posterity may see the experiment tried in a few communities but never on an extensive scale—and with resulting failure, when tested, unless the economic conditions of American municipalities undergo a change radical, not to say impossible.

## The Railroads of the World.

The annual statistics of the *Archiv fur Eisenbahnwesen*, giving as near as may be the figures for the end of the year 1902, show the mileage of railroad at that time in each grand division of the world to have been as follows:

| | | | |
|---|---|---|---|
| Europe ..... | 183,997 | North America. | 233,186 |
| Asia ..... | 44,358 | South America. | 28,822 |
| Africa ..... | 14,554 | Australia ..... | 16,038 |
| Old World.. | 242,909 | New World.. | 278,046 |

This makes a grand total of 520,955 miles for the whole world, of which 53⅓ per cent. is in the New World and 44¾ per cent. in North America.

The additions to the railroads of the world for seven successive years have been, in miles:

| 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. |
|---|---|---|---|---|---|---|
| 9,796 | 10,747 | 10,864 | 13,533 | 10,800 | 16,551 | 13,338 |

This gives a total of 85,629 miles for the seven years, being an average of 12,233 miles per year. The average mileage built was greatest from 1880 to 1890, when it was 15,218 per year.

The considerable decrease in construction from 1901 to 1902 was due chiefly to the reduced construction in Asia (4,345 miles in 1901 and 2,535 in 1902) and Africa (1,690 miles in 1901 and 364 in 1902). More was built in America in the latter year than for several years previous; and more than appears from the *Archiv's* statistics, which takes its figures for the fiscal year ending with June for both Canada and the United States, which together have more than two-fifths of the world's mileage, and where more than two-thirds of the railroad completed in any calendar year is opened in the last half of such year.

The countries of Europe which added most to their railroad mileage in 1902 were:

| France. | Germany. | Russia. | Sweden | Austria Hungary. |
|---|---|---|---|---|
| 619 | 615 | 581 | 366 | 340 |

All the rest of Europe built but 664 miles. Russia is credited with no addition to its mileage in Asia in 1902, but 629 miles were opened in India and Ceylon, 165 in Japan, 174 in China, 95 in Siam and 12 in Corea. The table also includes 1,490 miles in French Cochin China, the larger part of which certainly is not built yet.

The English-speaking peoples maintain their position as the railroad-building race. Of the 520,955 miles of railroad in the world, 270.881 miles are in the United States and in Great Britain and its colonies. The railroad mileage of the British colonies in America though not one-tenth as much as that of this country, is nearly twice as great as that of any other American country, and Great Britain still has more than three-fifths of the Asiatic railroads, and since 1898 has built a fourth more than Russia in Asia.

The South American countries (with which we have included the West Indies) make haste slowly. They added but 234 miles to their lines in 1902, and but 1,804 miles in the four years then ending. Brazil, that great country, is credited with no addition since 1899, and Argentina, the United States of the Southern continent, with none in 1902, and but 406 miles since 1899.

The *Archiv fur Eisenbahnwesen* continues its tables of the capital invested in the railroads of the different countries, which it began a few years ago. Naturally, they are less complete than the statements of mileage; but the mileage for which the figures are not attainable cannot be very important. According to these data, the investments in the railroads of the world amounted at the end of 1902 to the stately sum of $34,964,342,000, of which more than $18,800,000,000 have been spent on the 184,000 miles in Europe and $16,160,000,000 on the 337,000 miles in the rest of the world. This gives an average of $114,760 per mile for the European, and of $57,009 for the Barbarian railroads. The country with the highest capital cost per mile is, of course, Great Britain ($256,839); the nearest approach to it is Belgium ($150,239). The cheapest in Europe are the Finnish State railroads ($32,104); but the private railroads of Sweden are put down at $22,558 per mile. Elsewhere the colony of West Australia has spent but $27,597 per mile for its lines (light, narrow-gage railroads); Japan, $38,320 (also mostly narrow-gage).

The summing up of the acquisitions of the world, all made within the last eighty years, in these instruments of production, results in something like awe. The capital which they represent could not possibly have been obtained in any previous age, and it is safe to say that the improved means of transportation themselves have made possible its accumulation and vastly more. The imagination is lost in efforts to foresee what may be the result in the next eighty years of these and of the other appliances which have so greatly multiplied the productive powers of man.

## The Pennsylvania Company.

The report of the Pennsylvania Lines West of Pittsburg for the year ending December 31, 1903, shows a decrease of $230,968 in net earnings, accompanying an increase of 4,967,890 in the aggregate number of tons moved. This decrease is due in large part to the unusually high charges in the maintenance and conducting transportation accounts, which increased operating expenses $3,808,255 and more than offset a gain of $3,577,286 in gross earnings. Owing to the increased tonnage, freight earnings showed a gain of $2,730,121. The number of passengers carried increased 1,847,380, leaving a gain of $457,165, gross, in the earnings of that department. The average ton-mile rate on all lines of the system was 6.7 mills, an increase of .2 mills over 1902.

The increases in the expenses of all the roads in the system for the year are due largely to the advance in the rate of wages made in November, 1902, to increased prices

of fuel and materials of all kinds and to the congestion in train movement resulting from overtaxed facilities. On account of these expenditures, there was an increase of $867,806 in the maintenance of equipment account and an increase of $2,713,666 in the conducting transportation account. The improvement work on the main line of the Pittsburg, Cincinnati, Chicago & St. Louis was finished during the year with the exception of the track elevation plan in Chicago, which still remains to be done.

In order to reimburse the Pennsylvania Railroad Company for sums advanced by it for betterments and for the purchase of additions to rolling stock, the Pennsylvania Company has issued its collateral notes to the amount of $50,000,000, bearing interest at 4½ per cent. per annum and running for a period of 18 months from April 1, 1904. The payment of these notes is guaranteed by the Pennsylvania Railroad Company.

After deducting $3,000,000 from net income for extraordinary expenses, $1,600,000 for 4 per cent. dividends and $1,583,137 for sinking-fund purposes, a balance of $276,590 was carried to the profit and loss account, making the latter $6,398,949, as compared with $6,122,360 in 1902. The summary of the year's operation follows:

| | 1903. | 1902. | Increase. |
|---|---|---|---|
| Gross earnings.. | $36,602,935 | $33,025,648 | $3,577,286 |
| Freight earn'gs.. | 27,696,777 | 24,966,656 | 2,730,121 |
| Pass. earnings.. | 6,117,930 | 5,660,764 | 457,165 |
| Total operat. expenses ..... | 27,116,684 | 23,308,429 | 3,808,255 |
| Maint. of Way.. | 4,341,853 | 4,371,003 | *29,150 |
| Maint. of equip.. | 6,066,670 | 5,198,863 | 867,806 |
| Conduc. of transportation .... | 14,836,711 | 12,123,044 | 2,713,666 |
| Net earnings.... | 9,486,251 | 9,717,219 | *230,968 |
| Interest, rentals, etc. ..... | 8,734,076 | 7,890,440 | 843,637 |
| Net income..... | 5,119,641 | 5,783,985 | *664,344 |
| Extraordin'y appropriation ... | 3,000,000 | 2,000,000 | 1,000,000 |
| Surplus to profit and loss..... | 6,398,949 | 6,122,360 | 276,590 |

*Decrease.

Local newspapers report that the locomotive enginemen of the Delaware, Lackawanna & Western have a serious grievance against their officers, and "it is rumored that the matter will be brought before the State Railroad Commissioners." It appears that, in order to test the faithfulness and accuracy with which the runners comply with the rules, false torpedo signals have been given, and, if the signal was disregarded, the engineman was "called down." The enginemen, says the reporter, dislike to be delayed; and "to have the stop simply to satisfy the officials that they are observing signals goes against the grain." In other words, the enginemen want to be their own bosses, instead of being bossed by the superintendent. Truly, a serious grievance! It is to be hoped that these enginemen are not so silly as they paint themselves when talking to the reporters. It would be a good thing if such a grievance were to be brought before the Railroad Commission (though it cannot be that the enginemen are so foolish as to think of taking such a means of promoting their claims) for then the Commissioners could, from their records, bring out the other side of the story: how collisions are occurring every month by reason of the lack of discipline among enginemen. The truly level-headed engineman would ask for more surprise-checking, rather than less. Only the other day the newspapers told of a collision (in New York State) in which an engineman, 65 years old, and with an excellent record, ran into the caboose ahead and was himself killed, the explanation being that he failed to properly reduce his speed on approaching the yard-limit post. In other affairs, where accurate care is essential, men have to be disciplined, or to discipline themselves, constantly, even to old age; but in locomotive running it seems to be deemed sufficient to trust to habit and to past success—which may be partly due to good luck. Those superintendents who are not satisfied to trust blindly to records have a duty to publish their principles; and that small minority of enginemen who believe it is wise to be strict with themselves as well as to be sharp in dealing with the company have a duty to support such superintendents.

Notwithstanding a large decrease in gross earnings, the recent report of the Pennsylvania Railroad Company for the month of May shows a tendency the right way in the effect on operating expenses of the retrenchment policy. Heavy decreases in gross were to be expected owing to general stagnation and the specific depression in the iron and steel industries, from which the Pennsylvania Railroad derives much traffic. The losses in gross for the month of May were $518,400 on the lines east of Pittsburg, and $539,100 on the lines west. Operating expenses, on the other hand, decreased $128,800 on the lines east, and $310,200 on the lines west. This shows that the conservative expenditure policy has in part, at least, tended to offset losses in earnings. As these losses have been due in large part to adverse weather conditions and to general industrial depression, they should prove merely temporary. As soon as a fair harvest is assured—and the prospects of a bumper crop seem good—the railroads will begin to pick up their traffic again and earnings should quickly improve. The numerous appropriations made by the Pennsylvania during the last two years for betterments have placed that company physically in such a position that even if earnings continue as bad as they are now, no new appropriations should be necessary for several years to come, and operating expenses can probably be so kept down as to offset adverse traffic conditions.

## NEW PUBLICATIONS.

*Report of Proceedings of the International Fire Prevention Congress*, convened in London, July 6 to 11, 1903. Prepared at the request of Jacob A. Cantor, President of the Borough of Manhattan, by Ira H. Woolson, E. M., Adjunct Professor Mechanical Engineering, Columbia University, and Official Representative for the City of New York. Printed by Martin B. Brown Company, 49 Park Place, New York, 1904.

The city authorities, through the office of the borough president, have just issued this report of the New York delegate, Professor Ira. H. Woolson. The report at hand is the only one issued in this country, and contains a complete digest of the whole proceedings of the congress so far as construction and protection are concerned. As it is composed of papers presented at the congress by eminent authorities from all parts of the world, it is a valuable document on the subject of fire prevention, and should be useful to city architects, building bureaus and engineers having charge and care of large public and commercial buildings. The chairman of the congress, in his opening address, called attention to the fact that while fire brigade gatherings, etc., have frequently been organized to exchange experiences relative to fighting fire, the world had never before seen a fire prevention congress or a conference of all those who were interested in precautionary measures for the prevention of outbreak and spread of fire. There are chapters on municipal fire protection as influenced by street planning and building regulations in Germany; on building construction from a fire brigade officer's point of view; fire preventive sections of the London Buildings Act; the planning and arrangement of large retail commercial establishments; safety and control arrangements for fire alarms; fireproof wood as a building material; fire patrol service for dock property, etc.

*Moody's Manual of Corporation Securities*, 1904 edition. 2,464 pages. Price, cloth, $10, prepaid. The Moody Publication Company, 35 Nassau street, New York.

The 1904 edition of Moody's Manual is much larger than previous issues, and is in every way more complete. The field which this standard reference book of corporations covers is well known. It may be said briefly that it fully treats of the entire field of American corporation investments, describing each corporation fully with regard to statistics and property owned and controlled, capitalization and bonded debt, dividends paid, financial conditions and earnings, officers, managers and directors, addresses of plants, offices, etc. Particular effort has been made this year to elaborate those sections devoted to steam railroads and other public service corporations, and in the railroad bond descriptions a much wider scope is followed than has been the case heretofore. The corporations are clearly indexed in the front, and there are also special indexes, such as the one in which the classification is by cities, and the list of industrial and other companies which have been absorbed or are controlled by larger corporations. The book is divided into eight sections for purposes of convenience and of centralization, and is illustrated with a number of specially prepared maps. It represents an enormous and cumulative amount of work, each edition in the past having helped to further the completeness of this present one. It is a necessary part of a contemporaneous financial library of reference books.

## TRADE CATALOGUES.

*The American Brake Shoe and Foundry Company*, Mahwah, N. J., has published a booklet describing its exhibit at St. Louis. This exhibit, which is designed to show the development of the brake shoe, is divided into two sections. The first section, which deals with unflanged shoes, illustrates the development of the wearing face of the brake shoe to secure durability and efficiency and the means employed to reinforce the shoe against failure by reason of the body metal cracking. The second section treats of flanged shoes and illustrates the development of the wearing face to prolong the life of the shoe and the means of reinforcing the body metal to continue the shoe in service in event of the body metal cracking.

*The Consolidated Railway Electric Lighting & Equipment Company*, Hanover Bank Building, New York, issues a pamphlet describing its axle light system of electric lights and fans for use on railroad trains. The principal parts of this system consist of a dynamo, storage battery and regulator, and the power is transmitted from the car axle by means of a rubber belt. The axle light system is now being exhibited in St. Louis on the Missouri Pacific train built by the American Car & Foundry Co.

*The Midland Railway Supply Co.*, Chicago, has issued a catalogue of Perry roller side-

bearings for all classes of railroad equipment, interurban and street railroads, wrecking cranes, steam shovels, etc. The Perry bearing is made up of 10 rollers, mounted on a carriage, which is normally held in a central position on the bottom bearing plate by means of light spiral springs. The catalogue also contains 30 pages of drawings showing the application of these side-bearings in different styles and sizes to all classes of car bolsters. It is made in a number of standard styles, and also in special sizes and designs for special service.

*The Joseph Dixon Crucible Company*, Jersey City, N. J., has sent out three small catalogues describing graphite cup greases, Ticonderoga graphite grease and Dixon's dressing for traction belts. Each of these catalogues contains an interesting description of the various machines on which graphite grease may be used as a lubricant, and also in cases of leather belting, where it may serve as a preventive of slipping and as a leather preservative.

*The New Jersey Tube Company*, Newark, N. J., has published a catalogue containing a complete description of its spirally corrugated boiler tubes with reduced fire-box ends. It is claimed that the chief advantage of these tubes is the freedom they give from live sparks, owing to the fact that the hot gases are retained for a longer time in the tube because of the rotating motion which is induced by the spiral form.

*The Damascus Brake-Beam Co.*, St. Louis, Mo., has prepared a new catalogue for distribution, showing the latest designs of Waycott, Damascus, "Loupurex," and Harriman brake-beams for freight and passenger cars and tenders. The catalogue also contains the results of tests made on Waycott brake-beams at Purdue University, which show that these beams far exceed the M. C. B. requirements for deflection.

*The Brown Hoisting Machinery Company*, Cleveland, Ohio, is sending out a number of colored cards illustrating the different cranes manufactured by the company. Each card has a photograph of some special variety of crane on the front, with a short description of the machine on the back. These cards can be obtained on application at the company's exhibit at St. Louis.

# CONTRIBUTIONS

## The Diamond Jubilee of the Midland Railway.

London, June 13, 1904.

To the Editor of The Railroad Gazette:

Perhaps you will allow me to point out a couple of printer's errors in your article of June 3, upon this subject. In line 10 from bottom of page 415, "7 ft. quays" should read "7 ft. gage," and in line 5 from bottom of first column on page 416, "Of these, three were passenger engines," should read "Of these 77 were passenger engines."

W. B. PALEY.

## A Persistent Fashion in Car Windows.

To the Editor of the Railroad Gazette:

"It would be a great convenience to the large army of commuters if the railroads running into New York had windows in their cars which could be opened. Unless a man has been in training for some months and accumulated muscles to rival Sandow he can tug and tug, and swear and swear, but he will not be able to budge these windows an inch. The only thing to do is to let them alone and perspire. It would be a popular thing if pocket derricks could be invented for commuters, by means of which they could force open the windows and get fresh air. As for women—well, they simply can do nothing at all, and unless they get the assistance of half a dozen strong men, with an occasional porter and brakeman, with a lifting capacity of about 10,000 lbs. to the sq. in., all they can do is to admire the scenery from behind the panes.

"Will this ever be remedied by the railroad companies?"

The foregoing is copied from the *New York Herald* in June, 1904. It sets forth substantially the same state of things that have been described in the *Railroad Gazette* repeatedly in the last 25 years and which have been made the subject of items in the newspapers probably every year for forty years—or more. From present indications the facts may call for similar notice for forty years to come. The car window painter appears to be always the same, whether the year be 1904 or 1894, or 1854, or—1954. I suggest that the *Herald* have the foregoing letter stereotyped. Why do you not more vigorously push your scheme for the modification of the severe laws which forbid a man to have burglars' tools in his possession, and thus open the way for each passenger to carry a jimmy? If a few dozen passengers would each carry and use one of these useful little bars and would take pains, in opening the windows, to mar the sash sufficiently to attract the attention of the Master Car Builder we should have a reform; for the M. C. B.'s expense account would be touched, after a while. R. M. K.

## The Damage Suit Industry in Texas.

To the Editor of the Railroad Gazette:

In your issue of June 10 you printed an article calling attention to the enormous growth of the damage suit industry in Texas, showing that about $2,000,000 was paid out in interest in a single year, a growth of about $1,800,000 in 12 years. No other industry in Texas compares with this, and how can it be otherwise when the state lends encouragement by offering a premium to the parties engaged in it? It is a law in Texas that an attorney can contract with an adventurer in advance, to bring suit against a railroad company. Such a contract gives an attorney 40 or 50 per cent. of any amount that he can secure from the railroad in the interest of his client. It is not necessary for his client to have a just claim. Causes are manufactured out of claims that would not be recognized by claim agents or railroad attorneys in any other state than Texas. I recall a case where a firm of attorneys conspired with a fakir to bring a suit against a certain railroad. The fakir was a brakeman, who let himself fall off a car. He immediately placed himself in the hands of these attorneys and their physicians. He was supported by them two or three years pending trial. During the trial the fakir, taking offense at being refused money for drinks by his attorneys, conspired with the claim agent of the railroad that was being sued, and agreed to take $700, and give the railroad company a release, in which he acknowledged that he was not injured and that he had been supported by these lawyers ever since his alleged accident. The trial went on just the same, notwithstanding this release was filed with the court, and a judgment rendered against the company for $1,600 and costs. The fakir had already secured $700 and absconded. His lawyers were allowed $600 by the court on the strength of their contract with the fakir, and the railroad company paid the bill.

Of course, this industry is going to grow as long as it is encouraged and protected by the state laws, administered by courts prejudiced against corporations, and it is growing rapidly. Railroad companies, whose legal affairs were attended to a few years ago by one attorney, are now compelled to employ attorneys in every county seat in the State through which the railroad passes, and they are always kept busy.

TEXAN.

## For Quicker Work in the Claim Department.

To the Editor of The Railroad Gazette:

One question which was disposed of without adequate discussion at the recent meeting of the Freight Claim Association, at Savannah, Ga., can be so easily settled, if only claim agents will take an interest in its settlement, that I feel warranted in bringing it to the attention of your readers. Not having been present at the Savannah meeting, I do not know why it was postponed or laid on the table; but whether it is or is not settled in association, there is nothing to hinder any two roads, or all of the roads in any territory, from taking action on their own responsibility. At any rate, they can agitate the subject, and agitation will do good. I refer to the letter of Mr. Edgeworth, of the Indiana, Illinois & Iowa, who recommends that claims be sent to the next road in interest instead of invariably to the next connection.

Much good paper and ink, and many hours' time of clerks who might otherwise be better employed, are used up in reading tedious piles of letters and then simply referring them to some one else for the desired information. Mr. Edgeworth, in his letter to the committee, said: "Some time ago, upon investigation, I found that about twenty-five per cent. of claims received in this office each day, in which this road was intermediate, were of the nature described, and that we in turn simply referred them on for information or to note information or remarks. I took the subject up with immediate connections and arranged with most of them to refer such claims direct. I also instructed my clerks not to handle such claims, but to return them to the road received from, pointing out why the claim was one which could be handled direct. The result is that we are receiving very few such claims at the present time." Mr. Edgeworth is satisfied from his experience that there would be very little trouble or friction from the adoption of a rule to send claims direct.

I need not tell your readers that the question of curing this widespread evil of delays in settling claims is one of long standing. Conventions have wrest'ed with it, off and on, for years. The grievances of shippers and consignees are so numerous that, in spite of the fact that little good has been accomplished by the complainants which have been made in the past, the complaining is still kept up. You cannot convince business men that the intolerably slow process which prevails in claim departments throughout the railroad world is necessary or reasonable. Consequently, every discussion between a shipper or a shippers' organization and railroad officers leaves the impression that the railroad men are not up to their business: and oftentimes, if we knew the inner feeling of the shippers it would be necessary to use stronger language than this. To speak plainly, they sometimes think that we are blockheads. The fact that Mr. Edgeworth has made an actual experiment with his connections should silence

critics. If anyone has an argument to offer against this proposition, I should like to hear it; but action, it seems to me, would be much more profitable than criticism.

G. F. H.

## Locomotives for the Central South African Railroads.

The accompanying illustrations (Figs. 1 and 2), show a new locomotive recently built by the Vulcan Foundry, Ltd., of Newton-le-Willows, Lancashire, England, for the central South African railroads. The central South African system now includes all the railroads in the Orange River Colony and the Transvaal, as also the Pretoria and Pietersburg line. The gradients, for the most part, are exceptionally severe, the rise from the Orange River to the central plateau being 1 in 80, while the corresponding descent into Vereeniging is 1 in 100. Toward Johannesburg the gradients average about 1 in 80, while on some stretches of line, notably the descent into the Crocodile River valley, they are as steep as 1 in 60. With a view to hauling heavier loads than previously, the orders have recently been placed for the new locomotives, which, for power, size and weight, are exceptional for the 3 ft. 6 in. gage. The truck wheels are 2 ft. 6 in. in diameter, and the "drivers" are 4 ft. 9 in. in diameter. The cylinders are 18 in. x 26 in. The boiler has a total heating surface of 1,481 sq. ft., with 131 sq. ft. in the fire-box. The grate area is 21.75 sq. ft. The tractive force (taking 90 per cent. of the boiler pressure, which is 200 lbs. per sq. in.), is 26,602 lbs. The frames are the bar type, and the fire-box rests on them, in order to secure a wide grate. The engine, in running order, weighs 135,175 lbs. The tender is the 8-wheel type. The tender holds 4,000 gal. of water and 10 tons of coal, and weighs 109,395 lbs.

In addition to the "Pacific" type engines, there is to be used a number of six-coupled double-end tank locomotives, several of which are also being built by the Vulcan Foundry Company, and one of which is illustrated in Figs. 3 and 4. The truck and driving wheels are 2 ft. 6 in. and 4 ft. 6 in. in diameter respectively. The cylinders are 18 in. x 26 in. The boiler is the same as that of the "Pacific" engines, above described. The tractive force is 28,080 lbs. The frames are the bar pattern, machined out of rolled steel slabs. The engine weighs 176,760 lbs. The two side tanks have a capacity of 1,800 gal. of water, and the bunker holds 3 tons of coal.

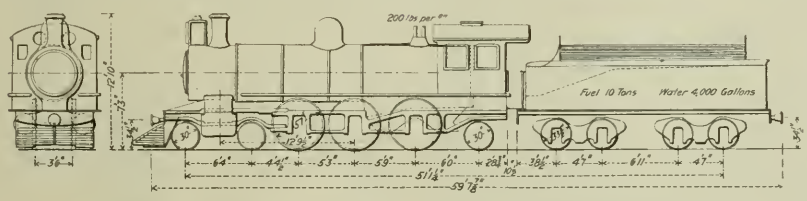



Fig. 2—Central South African "Pacific" Type Locomotive.

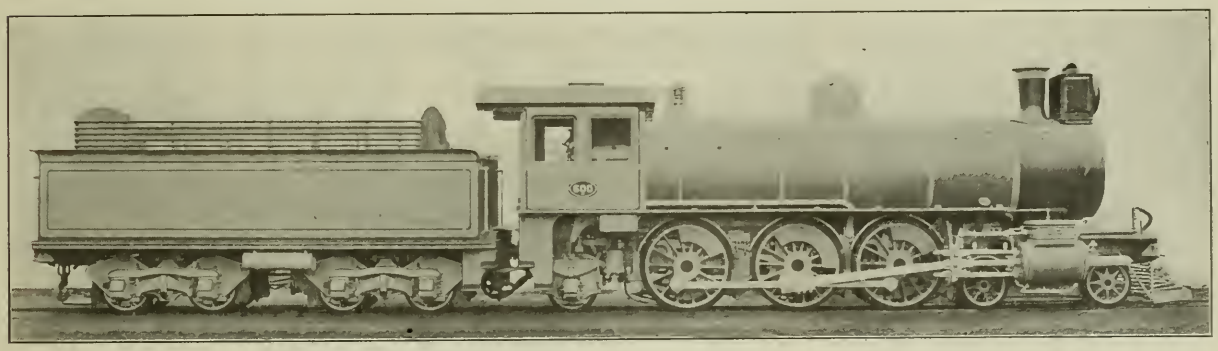


Fig. 1—"Pacific" Type Locomotive for the Central South African Railroads.

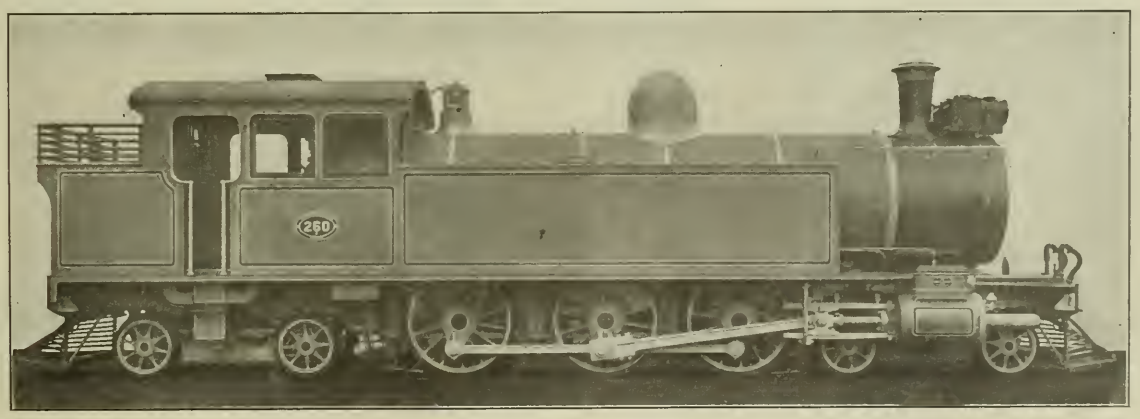



Fig. 3—Double-End Locomotive for the Central South African Railroads.

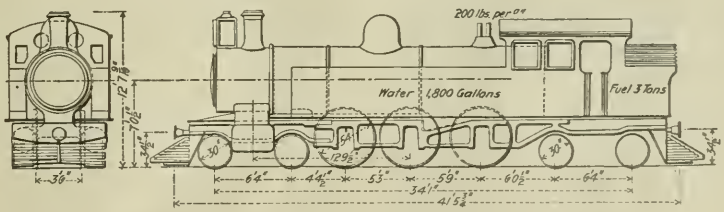



Fig. 4—Double-End Locomotive—Central South African Railroads.

## The Roundhouse Foreman.*

Mr. Thompson's main points were that the roundhouse foreman should have authority equal to that of the master mechanic; should have clear judgment and know how to handle men; and he must be able to conclude quickly, after listening to the engineer's tale of woe, whether to accept it as a straight story or tell him that the engine must be made to run another trip without repairs. He must be a good all-around organizer and capable of promptly taking care of his business during rush hours. He must

*Abstract of paper by N. O. Thompson, read before the New York Railroad Club, May 20, with discussion by Messrs. McIntosh, Hayward, West and others.

be a man who can make brief and intelligent statements; he should be an engineer of known ability; he must have mechanical ability enough to decide what work can be slighted or not done at all and the engine be safe to make one or more trips; he must be broadminded enough to recognize that there is a commercial side to the transportation of freight and passengers on a railroad. The runner who has been earning $150 to $175 a month cannot be expected to do well as a foreman at $125 a month, working ten or twelve hours a day. Notice your foreman when things are going smoothly as well as when things go wrong. Do not reduce his force, but in dull times give him some engines to overhaul. Do not burden him with office work; it is more profitable to hire a $50 clerk. The successful shop foreman is not necessarily the best roundhouse foreman.

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*Mr. McIntosh*—Most roundhouses are sadly deficient in modern conveniences. More repairing ought to be done in the roundhouse. With the varied new appliances now in use on engines, many more conveniences are needed in the roundhouse; the stitch in time that saves nine should be attended to in the roundhouse.

The ideal roundhouse foreman should have the following qualifications: He must not be either too old nor too young; must have a good education and a thorough knowledge of handling and repairing locomotives; must know how to handle men successfully; be diplomatic enough to keep on good terms with yardmaster, trainmasters, train despatchers and others; must be of a cheerful disposition—optimist preferred; will not object to being on duty 52 Sundays and 300 nights each year; is not affected by climatic changes and willing to transact business out of doors in the absence of shelter; he must not murmur when obliged to pull one engine apart to repair another while awaiting the convenience of the storekeeper and purchasing agent to bring up supplies; he should always have a few engines up his sleeve to meet emergencies.

*Mr. Hayward*—This position has been much changed during the past ten years. We can no longer depend upon finding good roundhouse foremen among superannuated runners; we must educate men by putting them through the shops, then in the roundhouse, then on the road and then back in the roundhouse. There is great economy in roundhouse repairs; $10 properly spent here will save $100 in the shop. Therefore, we must have well-equipped roundhouses, a foreman equal to a master mechanic, and he must have all the cardinal virtues.

*Mr. West*—The foreman must hear complaints cheerfully, and, if he cannot repair the engine, must give the runner the necessary encouragement to keep him agoing until the next day. Engines fail not alone by reason of mechanical conditions, but because the men on them are disgruntled.

*Mr. McIntosh*—Mr. Forney's mention of discovering a crack in a truck wheel carried me back to some early railroading, more years ago than I care to admit, where a party we will call Billy was operating a locomotive in the capacity of engineer and Mike was firing for him. Mike was ambitious and often looked the locomotive over to find out if anything was wrong with it. Just about Christmas one year Mike crawled down around the engine and came out, very officious, and said, "You have got a crack in your truck wheel," and the engine was taken out of service and Billy missed the run out; but he got Mike in a corner and said, "You blanked idiot! What did you go poking around that wheel for? I was saving that for Christmas for a lay-off."

*Mr. West*—For the past four months we have had at one division terminal a separate man to attend to the despatching, and it works very satisfactorily. He keeps in touch with the train dispatcher and the man who attends to repairs can devote his mind to his own work.

*Mr. Hayward*—We have lately put this into effect at Waldo avenue, Jersey City, and find it a great advantage. Much time is taken up in answering inquiries from the train despatchers and road foremen, and this change greatly relieves the roundhouse foreman. We have also put a competent man in charge of the ash pit; also, in repair work, we have organized gangs of men under a leader, thus arousing competition between rival gangs to get their engines out quickly.

*Mr. Gaines*—When a large number of engines come in about the same time, a good man at the ash pit can save time if, in conjunction with the runners, he will take out the engines in the lot that are ready to make another trip, and get these out ahead.

*Mr. Maxfield*—At Jersey City last winter roundhouse foremen had very severe experiences. With the thermometer 16 below zero, engines were frozen solid to the track and could not move with their own steam (the engines are so large that the roundhouse doors cannot be shut). . . . The whole secret of roundhouse work is efficient organization and an ample number of men. In winter it will pay to have twice as many men as in summer. During that cold weather from 15 to 20 per cent. of the men were absent, sick.

*Mr. Bourne*—I lately heard an attractive scheme outlined for covering the center of the roundhouse. It has been figured that it could be done for $500 per pit. Then the house could be warmed in winter and the men could get across from one side to the other much quicker.

*Mr. Frost*—At Jersey City we have a man who looks after stay-bolts alone; a boiler maker should have nothing to do with renewing stay-bolts. The man who hunts for defective stay-bolts should not have the work of renewing them.

President Vreeland, in closing the discussion, told of the troubles of the electric railroad "roundhouse foreman," the man who has to see to the running repairs of electric street cars.

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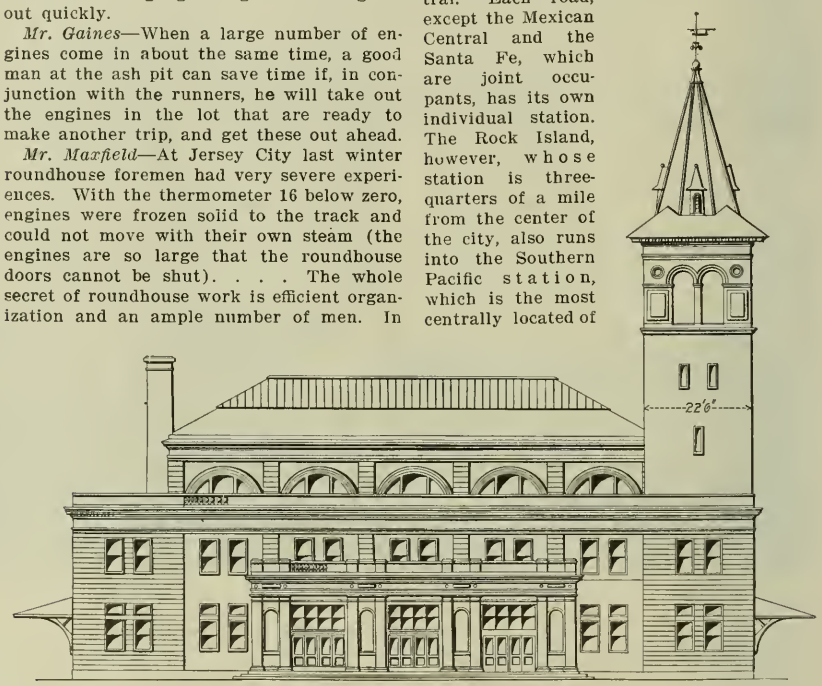
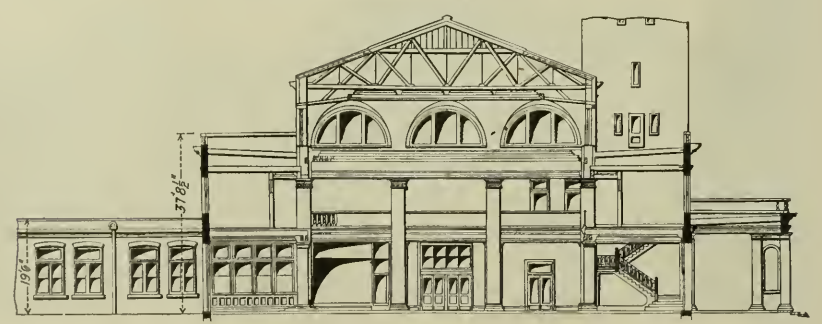
### The El Paso Union Station.

El Paso, Texas, with a population of about 20,000, is the most important gateway between the United States and Mexico. Five lines of railroad enter the city, viz., the Southern Pacific, Texas & Pacific, Santa Fe, El Paso & Northeastern (Rock Island), El Paso & Southwestern and the Mexican Central. Each road, except the Mexican Central and the Santa Fe, which are joint occupants, has its own individual station. The Rock Island, however, whose station is three-quarters of a mile from the center of the city, also runs into the Southern Pacific station, which is the most centrally located of all of the stations. Plans have recently been completed for a union station, which will be located at the corner of Crosby and San Francisco streets, in the western part of the city. The site is about three-quarters of a mile from the business center and is near the river. When completed this station will be one of the finest in the Southwest.




East Elevation, El Paso Station.



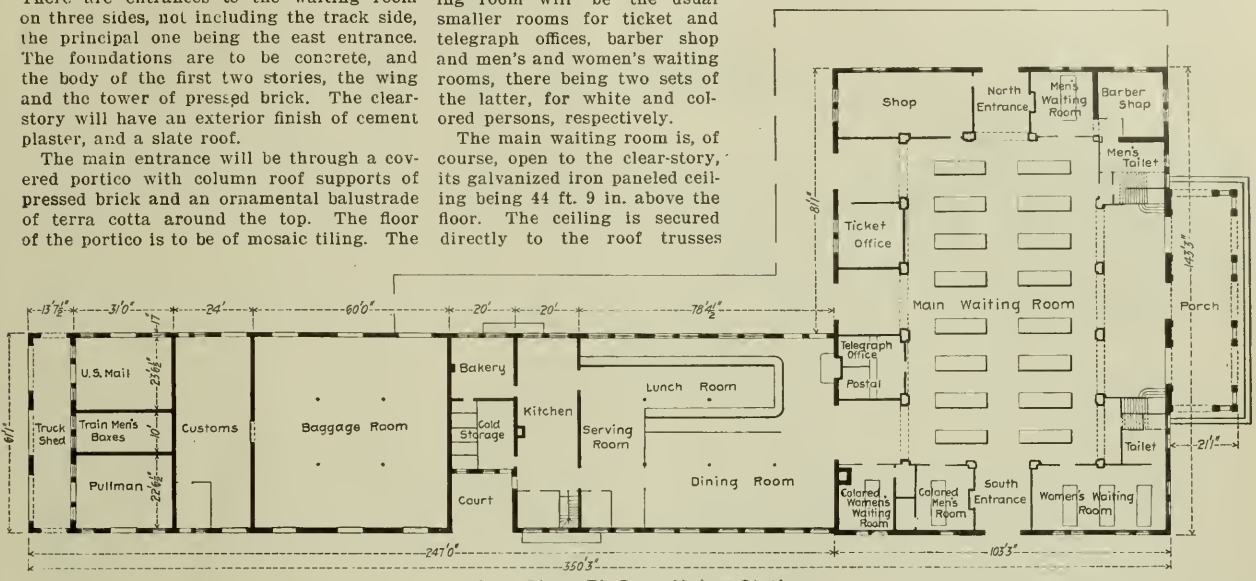

Cross Section Through Waiting Room.

Engravings from the architects' drawings are presented herewith, from which it will be seen that the main building is a two-story structure with a clear-story, and a

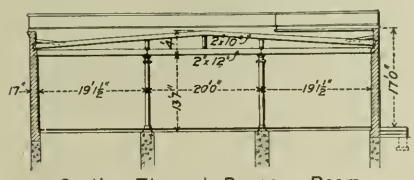
tower, 130 ft. high, at the street intersection. It is 143 ft. 3 in. x 103 ft. 3 in. and has a one-story wing 61 ft. 1 in. wide extending back 247 ft. parallel to the tracks. There are entrances to the waiting room on three sides, not including the track side, the principal one being the east entrance. The foundations are to be concrete, and the body of the first two stories, the wing and the tower of pressed brick. The clear-story will have an exterior finish of cement plaster, and a slate roof.

The main entrance will be through a covered portico with column roof supports of pressed brick and an ornamental balustrade of terra cotta around the top. The floor of the portico is to be of mosaic tiling. The main waiting room will be approximately 60 ft. x 100 ft. Two stairways leading to the second floor flank the main entrance, and grouped around three sides of the main waiting room will be the usual smaller rooms for ticket and telegraph offices, barber shop and men's and women's waiting rooms, there being two sets of the latter, for white and colored persons, respectively.

The main waiting room is, of course, open to the clear-story, its galvanized iron paneled ceiling being 44 ft. 9 in. above the floor. The ceiling is secured directly to the roof trusses and contains ground glass ceiling lights for transmitting the light from the galvanized iron skylights, with ribbed glass, in the roof. The clear-story has semi-circular windows in the side and end walls—five on each side and three on each end. Below these windows is an ornamental expanded metal and plaster cornice resting on columns of similar material, which are 3 ft. in diameter, 28 ft. high, spaced 20 ft. apart on centers and surmounted by ornamental plaster caps. On the second floor, back of these columns, is a balcony, with an ornamental iron railing between the columns. The second-floor offices open onto this balcony. The main waiting room will have a mosaic tile floor and plaster walls and ceiling. The first floor offices and waiting rooms will be similarly finished. The second floor balcony will have a wood floor, ornamental base and trimmings, iron balustrade with wood hand rail, plaster walls and the ornamental plaster cornice above.




Floor Plan, El Paso Union Station.

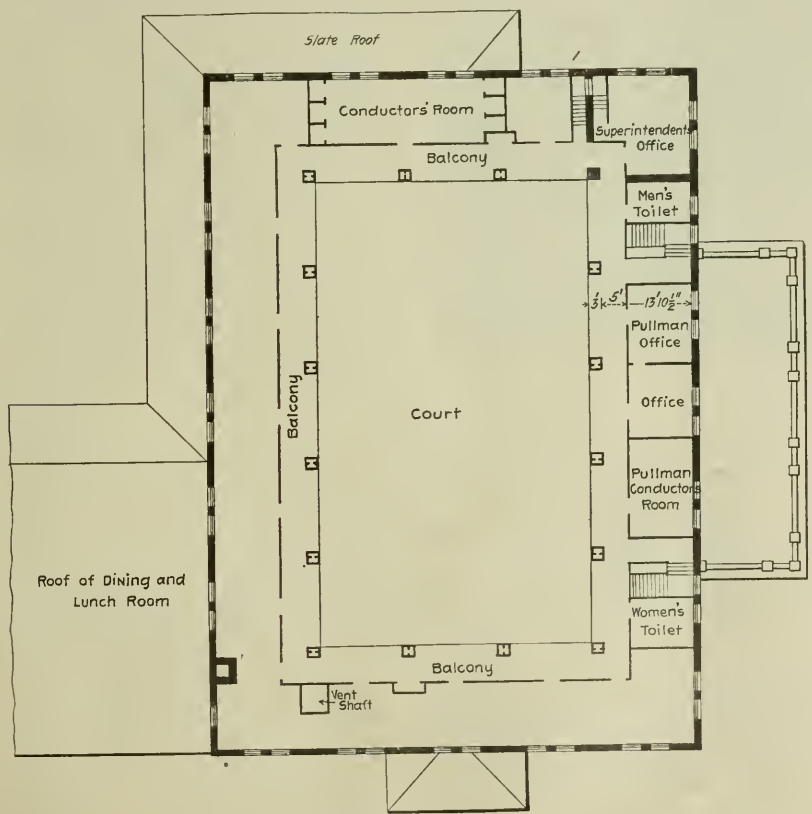



Section Through Baggage Room.

The wing will contain the dining and lunch room and kitchen, baggage room and several smaller compartments for customs, mail, trainmen's boxes, Pullman quarters, and at the west end a shed for baggage trucks. The dining and lunch room will be finished similar to the waiting rooms and offices. The remaining rooms will have cement floors, brick walls and plastered ceilings and will have rolling steel doors.

Starting from the east side of the north entrance, a stationary awning having a slate roof and supported on brackets secured to the building walls, extends around the track side of the station to just beyond the entrance to the checking counter in the baggage room. The usual iron fence will separate station and trucks, and cement walks will be laid on all sides of the building. All entrances will have stone steps. The building will be heated by steam and lighted by electricity, the light fixtures being combination electric and gas. At the outset the station will have eight tracks, six of which will be stub and the other two through. There will be no sheds, it being considered unnecessary to provide such protection in this dry, mild climate. The station complete will cost about $280,000; the amount for the building alone, however, will be something less than half of this. It is expected to have it completed the first of next year.

The Board of Directors of the union depot company consists of Messrs. H. U. Mudge of the Atchison, Topeka & Santa Fe, who is President; H. R. Nickerson of the Mexican Central; H. J. Simmons of the El Paso & Southwestern; C. B. Eddy of the El Paso & Northeastern; A. S. Johnson of the South-




Second Floor Plan.

ern Pacific; J. W. Everman of the Texas & Pacific, and W. W. Turney, representing the citizens of El Paso. The architects are D. H. Burnham & Company, Chicago.

## Steel Car Design.

BY A. STUCKI.

III.

(Copyright, 1904, by the Author.)

*Distortion of Trucks on Curves.*—When rounding curves the inside wheels of a truck tend to run ahead and pull the truck out of square, owing to the difference in length of the two rails. (See Fig. 10.) The magnitude of the force $f_1$, tending to cause this distortion, is the weight on the two wheels

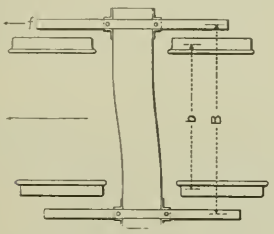



Fig. 10.

on one side of the truck multiplied by the coefficient of friction between wheels and rail. It is a minimum at high speeds and a maximum at low speeds when the load may be as high as $\frac{Q}{2}$. The stress in the arch bars due to this force is, $f = \frac{Q}{2} \times \frac{c \times b}{B}$ where c is the coefficient of friction and b and B are the dimensions shown in Fig. 10. Q is the load on the center plate.

The moment to be resisted by the connection between the arch bars and the transoms is $M = f \times \frac{B}{2}$, taking moments about the center pin. Since $f = \frac{Q}{2} \times \frac{c \times b}{B}$ then $M = \frac{Q}{2} \times \frac{c \times b}{B} \times \frac{B}{2}$ or $M = \frac{Q \times c \times b}{4}$

Assuming c as 0.3, the moments M, for the three capacity trucks are as follows:

M = 184,800 inch pounds for 60,000-lb. trucks.

M = 237,300 inch pounds for 80,000-lb. trucks.

M = 289,800 inch pounds for 100,000-lb. trucks.

If the connection is strong enough, the wheels will slip; but if the connection yields or is purposely given some play, the inside wheels will run ahead, causing the outside wheels to creep up on the conical tread and run on the portion with a slightly larger circumference. The inside wheels will work out until they run on the small circumference of the tread and the difference in the respective lengths of the path of travel for the two wheels is thus equalized so that the wheels will run without slipping.

Example: The maximum unit shearing stress in the column bolts of a 100,000-lb. truck due to distortion of the truck on a curve, with 1¾-in. bolts spaced 15 in. apart is found as follows:

$$\text{Shear} = \frac{\text{Moment}}{\text{Area of Bolt} \times \text{Dis. bet. Bolts}} = \frac{289,800}{2.4 \times 15} = 8,050 \text{ lbs. per sq. in.}$$

*Lateral Motion Trucks.*—Box and other cars having a center of gravity, when loaded, about 6 ft. above the rail and when mounted on the usual form of rigid bolster truck have a certain amount of lateral motion at the height of the center of gravity. It is made up approximately as follows:

| | Resulting lateral motion. |
|---|---|
| 5/16 in. Clearance between rail and flange. | 5/16 in. |
| ⅛ in. Clearance between body and truck center-plates | ⅛ in. |
| 3/16 in. Clearance between axle and bearing, each way | 3/16 in. |
| ⅜ in. Clearance between body and truck side bearings | ⅜ in. |
| ½ in. Additional compression of springs. | 1¾ in. |
| Total | 3 in. |

The effect of this lateral motion is to allow the car to run a certain distance beyond the point of tangency after striking a curve before all of the slack and lost motion is taken up and the pressure of the wheel flanges against the rails forces the center of gravity of the car out of its original straight path. This distance is:

85 in. on a curve of 100 ft. radius.
120 in. on a curve of 200 ft. radius.
147 in. on a curve of 300 ft. radius.
170 in. on a curve of 400 ft. radius.

Several forms of swing bolster and lateral motion devices have been applied to trucks, all of which accomplish the same end. Usually about 1⅛ in. additional lateral motion is given to the bolster in each direction. This permits the car to run a somewhat longer distance after striking a curve before the center of gravity is displaced, namely:

99 in. on a curve of 100 ft. radius.
140 in. on a curve of 200 ft. radius.
172 in. on a curve of 300 ft. radius.
199 in. on a curve of 400 ft. radius.

After the wheel flanges once touch the rails, the lateral motion and rigid trucks act alike and the flange wear on curves is the same for both. On a straight track, lateral motion trucks allow the cars to rock and sway more than with rigid trucks, causing them to ride somewhat easier. They also relieve in a small degree the binding of cars equipped with M. C. B. couplers when rounding sharp curves.

*Helical Springs.*—The following notation has been used: (See Fig. 11.)

| | Large Coil. | Small Coil. |
|---|---|---|
| Diameter of wire | D | d |
| Radius of coil | R | r |
| Solid height | H | h |
| Load carried by one coil | P | p |
| Fiber stress per square inch | S | s |
| Modulus of torsion, usually taken as 12,600,000 | g | g |
| Length of wire | L | l |
| Deflection of coil under load | F | f |

The load per coil is $P = \frac{S \times \pi \times D^3}{16\,R}$.

The maximum fiber stress is usually taken as 80,000 lbs. per sq. in. and this value substituted in the above equation will give the maximum load to which the spring should be subjected. This is called the *capacity*. To prevent overloading, the spring should be designed so that it becomes solid when the load equals the capacity. Bars over 1⅝ in. in diameter are seldom used for spiral

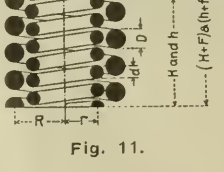



Fig. 11.

springs because of the difficulty of obtaining a uniform temper in the steel. The minimum radius of the coil should not be less than 1¾ × diameter of the wire. In order that the two coils of a double-coil spring shall work together in unison under a given load the proportion R : r = D : d should be strictly adhered to and the lengths of the two coils, L and l, should be made equal. For car springs, the working load is usually taken at 50 per cent. of the capacity.

The deflection of the coil under a given load is proportionl to the length of wire in the coil, all other conditions being equal. It is $F = \frac{2\,\pi\,RH}{D} \times \frac{32}{\pi} \times \frac{PR^2}{g\,D^4}$ or simplified, $F = \frac{64PR^3H}{gD^5}$. If the deflection F, corresponding to the capacity, plus the solid height H, equals the free height of the spring, the coil cannot be subjected to a fiber stress greater than the safe maximum of 80,000 lbs. per sq. in.

The length of the bar is $L = \frac{\pi\,RH}{D}$ and this length is used in calculating the weight of the spring, assuming .2833 lbs. per cu. in. as the weight of the steel. In practice, the bar is usually tapered at the ends without changing its mass so that

$$L_1 = \pi\,RH\left(\frac{2}{D}+1\right).$$

The minimum weight usually allowed is 97 per cent. of the normal weight.

*Brakes.*—The braking pressure exerted against the wheels of a freight car equipped with air brakes is usually adjusted to be equal to 80 per cent. of the light weight of the car, trucks included. The braking pressure exerted by hand brakes is usually taken at 90 per cent. of the light weight of the car and the system of levers is so designed that this may be obtained with a pull of 1,500 lbs. on the hand-brake chain. If the chain is wrapped around a 1¾-in. brake-shaft, an 18-in. hand wheel is sufficiently large to enable a man to exert this force. In applying the hand-brake rod to the cylinder lever, the connection should be in line with the cylinder push rod.

The cylinder pressure in the air brake system is normally a maximum at 60 lbs. per sq. in., which will exert against the piston a force of approximately:

1,700 lbs. in a 6-in. cylinder.
3,000 lbs. in an 8-in. cylinder.
4,700 lbs. in a 10-in. cylinder.
6,800 lbs. in a 12-in. cylinder.

Cars weighing over 40,000 lbs. should be equipped with a 10-in. cylinder so as to reduce the piston travel for a given movement of the shoes.

*Curves over which a Car Should Pass.*—All freight cars should be designed to pass around a curve of 150 ft. radius unless other special conditions are imposed. Although main line tracks seldom have curves of less than 300 ft. radius, shop tracks, spurs and sidings are often laid out with curves of as small a radius as 100 ft. The following table gives the radius of curves from 10 deg. to 40 deg. measured on a 100-ft. chord:

| Deg. | Rad. | Deg. | Rad. | Deg. | Rad. |
|---|---|---|---|---|---|
| 10 | 559.7 | 20 | 287.9 | 30 | 193.2 |
| 11 | 521.7 | 21 | 274.4 | 31 | 187.1 |
| 12 | 478.3 | 22 | 262.0 | 32 | 181.4 |
| 13 | 441.7 | 23 | 250.8 | 33 | 176.0 |
| 14 | 410.3 | 24 | 240.5 | 34 | 171.0 |
| 15 | 383.1 | 25 | 231.0 | 35 | 166.3 |
| 16 | 359.3 | 26 | 222.3 | 36 | 161.8 |
| 17 | 338.3 | 27 | 214.2 | 37 | 157.6 |
| 18 | 319.6 | 28 | 206.7 | 38 | 153.6 |
| 19 | 302.9 | 29 | 199.7 | 39 | 149.8 |

*The Wheel Base of a Car.*—On a curve, the lateral projection of a car is reduced to a minimum by making the distance between truck centers, c, Fig. 12, according to the table given below, the projection f, being

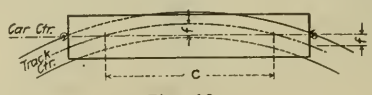



Fig. 12.

the same at the ends and center of the car. The table covers different curves and different lengths of cars. For different radii of

curves, the projection f changes, but the value of c does not. The column showing the value of c, gives exact and approximate values; the latter should be used in designing:

| Length over end sills in ft. | C. to C. of Trucks. Ft. Approx. | Exact. | Projection f, Fig. 12, in Feet on 75-ft. Curve. | 100-ft. Curve. | 125-ft. Curve. | 150-ft. Curve. | 200-ft. Curve. | 300-ft. Curve. | 500-ft. Curve. |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 20.0 | 21.10 | .749 | .56 | .449 | .374 | .281 | .187 | .112 |
| 32 | 22.0 | 22.62 | .835 | .64 | .512 | .426 | .32 | .213 | .128 |
| 34 | 24.0 | 24.00 | .963 | .72 | .577 | .482 | .375 | .241 | .144 |
| 36 | 26.0 | 25.46 | 1.080 | .81 | .628 | .540 | .425 | .270 | .162 |
| 38 | 28.0 | 26.80 | 1.203 | .90 | .722 | .602 | .451 | .301 | .180 |
| 40 | 28.0 | 28.28 | 1.333 | 1.00 | .800 | .666 | .50 | .333 | .200 |
| 42 | 30.0 | 29.70 | 1.469 | 1.10 | .881 | .734 | .55 | .367 | .220 |
| 44 | 32.0 | 31.10 | 1.61 | 1.21 | .968 | .806 | .60 | .403 | .242 |
| 46 | 34.0 | 32.53 | 1.057 | 1.32 | ... | .882 | .66 | .441 | .264 |
| 48 | 36.0 | 33.94 | 1.15 | 1.44 | 1.15 | .960 | .72 | .480 | .288 |
| 50 | 38.0 | 35.35 | 1.25 | 1.56 | 1.25 | 1.04 | .78 | .520 | .312 |

*The Body Bolster.*—The load on the body bolster may be concentrated at the center if all the load is carried by the center sills, it may be distributed nearly uniformly over the entire length of the bolster or it may be concentrated at the ends if the entire load is carried by the side sills or side framing. The bending moment at the center is a minimum in the first case and a maximum in the last case. It is well to design the bolster for the maximum bending moment so that failures may not occur when the car is jacked up under the ends of the bolsters and the entire load concentrated at those points. The center plate tends to distribute the reaction at the center over a short distance on each side so that the section required 4 in. from the center can be safely used at the center and the bolster made of uniform depth for at least 8 in. of its length at that point.

The maximum stress in the bolster exists when the car is on a straight track. On a curve, with the side bearings touching, the bolster is given additional support and will stand a much greater load.

On wooden cars with separate steel bolsters, the load in the car is nearly uniformly distributed and three-fourths of the weight of the car body is carried at the ends of the bolsters. The following may be considered as fair average values of the moments, 4 in. from the center, for the three capacity cars built in this way:

897,000 in. lbs. for 100,000-lb. cars.
715,000 in. lbs. for 80,000-lb. cars.
546,000 in. lbs. for 60,000-lb. cars.

It is not necessary to increase the section obtained by these moment values, if the car is to be jacked up at the ends of the bolsters.

For cars in which all of the load is carried by the sides and for cars having the load resting near the center, which are likely to be jacked up at the ends of the bolsters, the following may be considered as fair average values of the moments, 4 in. from the center:

1,670,000 in. lbs. for 100,000-lb. cars.
1,370,000 in. lbs. for 80,000-lb. cars.
957,000 in lbs. for 60,000-lb. cars.

These average values should only be used in preliminary calculations. The actual moments should be carefully figured after the form of construction has been decided upon and the location of the point of application of dead and live loads accurately determined. The stress usually allowed for body bolsters is 12,500 lbs. per sq. in for open hearth steel, carbon from 0.15 to 0.2.

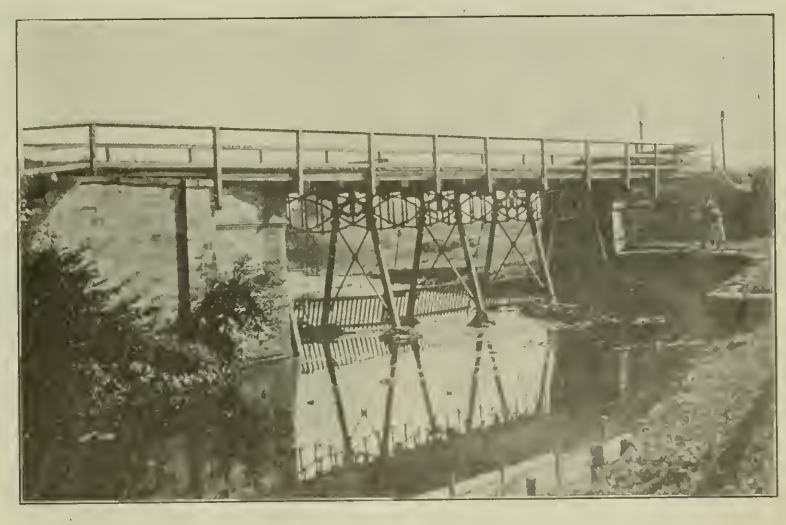
The rivet holes should be subtracted from the effective cross-sectional area in the tension members only. In the compression members, the rivets can be considered as filling up the holes. The king pin hole is compensated for if eight or more rivets are used in fastening on the center plate, and in such a case it should not be considered in estimating the cross-sectional area. The end sill and the diagonal braces will usually give ample support to the body bolster to resist horizontal stresses. If the diagonal braces are omitted, the bolster should be given ample stiffness in this direction to resist excessive end shocks.

*(To be continued.)*

## The First Iron Railroad Bridge.

BY F. C. COLEMAN.

In the issue of June 17 was described and illustrated the first iron truss railroad bridge built in the United States—the Manayunk bridge on what is now the Catawissa branch of the Philadelphia & Reading, built in 1845. The accompanying photographs illustrate what is believed to be the first iron railroad bridge ever built, which was some time ago removed from the position it had occupied for nearly 80 years, constituting an interesting link with the day of the early railroad systems in Great Britain.



The First Iron Railroad Bridge.

This bridge was built in 1823 for the Stockton & Darlington Railway, the first public railroad system, and placed at the western extremity of the original main line, at a place named West Auckland, some eight miles northwest of Darlington. The bridge spanned the Gaundless, a tributary of the River Wear, and was in use when the line was opened in September, 1825, between Witton Park and Stockton. The bridge was composed of cast and wrought iron in combination, and is said to have been not only the first metal railroad bridge ever erected, but the only one of its kind. The piers were cast iron columns braced together, the bracing bars being connected at their point of intersection. The spans measured 12 ft. 8 in. The frames constituting the girder each consisted of a pair of wrought iron arched members united by cast iron verticals cast round them. Each frame had thus to act as a couple of arches—one arch being inverted, since there was no bracing between the verticals. All the shearing forces were therefore resisted by the curved members. The cast iron vertical pillars extended upward to form a support for the roadway. The ends of the top and bottom members had bosses cast round them and spigots were made to fit into the top of the column forming the piers. Each pair of columns was connected by a casting which fitted into the grooves in the bosses at the ends of the main girders; in fact, the entire general design was such that the structure should fit together like a puzzle. The bridge is believed to have been built to the designs of George Stephenson, who was at this time engaged as the Engineer-in-Chief of the Stockton & Darlington, although a Mr. Storey is generally credited with its erection.

Civil engineering at this period was scarcely recognized as a distinct profession. From the early correspondence of the Stockton & Darlington it is gleaned that the first bridge at Darlington, built for the company, was the work of an architect, Benomi of Durham, while the first railroad skew bridge ever built, spanning the River Tees at Croft Spa, was the work of a millwright. It was close to the spot occupied by the old bridge, shown in the illustration, that on the day of the opening of the "first public railroad" the proprietors assembled and were drawn up the Brusselton Incline, a distance of 1,960 yards, in 7½ minutes, which was not a bad performance for those early days of the locomotive. It was, however, with the view of obviating the disadvantages attendant upon this difficult climb that the construction of the Shildon Tunnel was undertaken in 1839, the work being completed in 1842, from which time the bridge was chiefly used for mineral and goods traffic. In consequence, however, of the increasing weight of the locomotives and train loads during quite recent years, it was deemed advisable to replace the old relic by a more massive and substantial structure, which is composed of plate girders placed directly under the rails. By way of comparison, it is of interest to note that "Stephenson's No. 1 Engine," to carry which this bridge was erected, had a total weight when in working

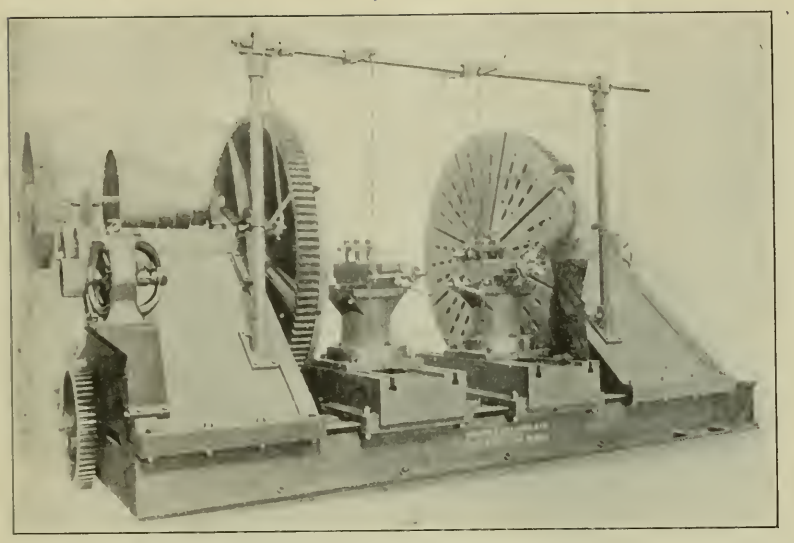


Fig. 1—The Sellers 100-in. Wheel Lathe.

order of 6½ tons and a nominal horse-power of 16.

It may be of interest to here make reference to the first railroad suspension bridge ever erected. By an Act of Parliament dated May 23, 1828, sanction was obtained to a Bill authorizing the building of a line between Stockton and Middlesbrough, including the building of a bridge across the Tees at the former town. The building of this, the first railroad suspension bridge, was intrusted to a Captain Brown, R. N. Before, however, bringing the bridge into traffic, the proprietors wisely decided to have it exhaustively examined. In the first experiment a weight of 18 tons was placed on the center of the bridge, which showed a deflection of 9.3 in. Further experiments were made, when 28 empty wagons were placed on the bridge with engine and tender, weighing altogether 37 tons and extending from one end of the bridge to the other. The result was a deflection of 2.3 in. Subsequent trials were carried out, with equally unsatisfactory results, and the engineers reported that trade might be carried on with the bridge as it was by passing loaded wagons over, one by one, the engine passing over first. It was added that the engine might return with the whole train of empty wagons connected closely together and that twenty wagons might be passed over this way in about six minutes, after the man got into the method. This mode of procedure was, for a time adopted, but it is not surprising to learn that before long a more solid structure had to be erected.

## Railroad Shop Tools

(*Continued.*)

### WHEEL LATHES.

The 100-in. wheel lathe shown in Fig. 1 is made by William Sellers & Company. This lathe is arranged so that the bearings of the axles can be turned up by shifting the saddles on the bed, without taking the axles off the lathe. The saddles are made narrow enough so that in most cases they can be moved under the wheel flanges. The centers are set close to the back edge of the bed, so that the pressure on the tool falls within the bed surface. The feed is obtained from a rock shaft placed overhead and supported on columns, as shown. All the gears are cut from the solid. The two compound rests are operated by an electric motor attached to the machine. This lathe can be arranged for driving by electric motor. When operated by a countershaft the fast and loose pulleys are 36 in. in diameter x 7½ in. face, and should be run at 120 r.p.m.

### AXLE LATHES.

The Putnam No. 3 double axle lathe shown in Fig. 2 will swing 22 in. over bed and 14¼ in. over carriage, and will take 8½ ft. between centers. The bed is 12½ ft. long. The carriages are independent and have three positive feeds for roughing and finishing. The driving head has six changes of speed, ranging from 10 to 40 r. p. m., and is

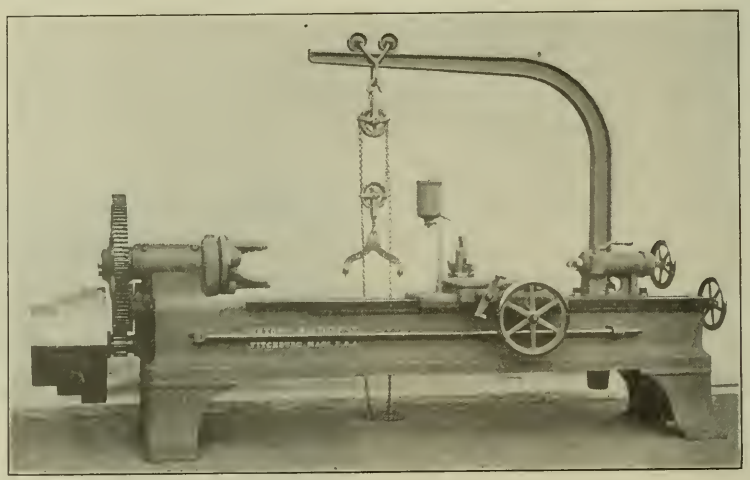


Fig. 3—The Putnam Single-Axle Lathe.

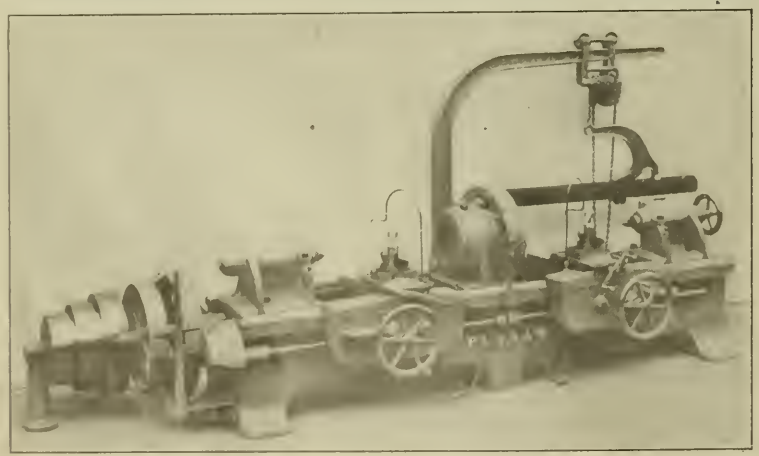


Fig. 2—The Putnam No. 3 Double-Axle Lathe.

equipped with a quick-change device which enables the speed changes to be made while the machine is in motion. The driving head has a 13-in. opening and is operated by a 30:1 spur gearing, which is driven by a 26-in. cone having three changes for a 6-in. belt. The head has an equalizing self-centering dog ring, which prevents bending strains in the axle. The bearing has a compressed babbitt lining and an adjustable take-up. The main driving shaft is 3½ in. in diameter. The carriages have quick hand movement and are fitted with automatic safety stops which make it impossible for the carriages to collide or run against the driving head. The feed mechanisms have phosphor bronze pinions and the feeds obtainable are ⅛ in., 3/16 in. and ¼ in. per revolution of the axle. The tail-stocks are secured to the bed by four anchor bolts and are longitudinally adjustable on the bed. The right-hand tailstock spindle is operated by a screw and hand wheel and has a split collar. The weight

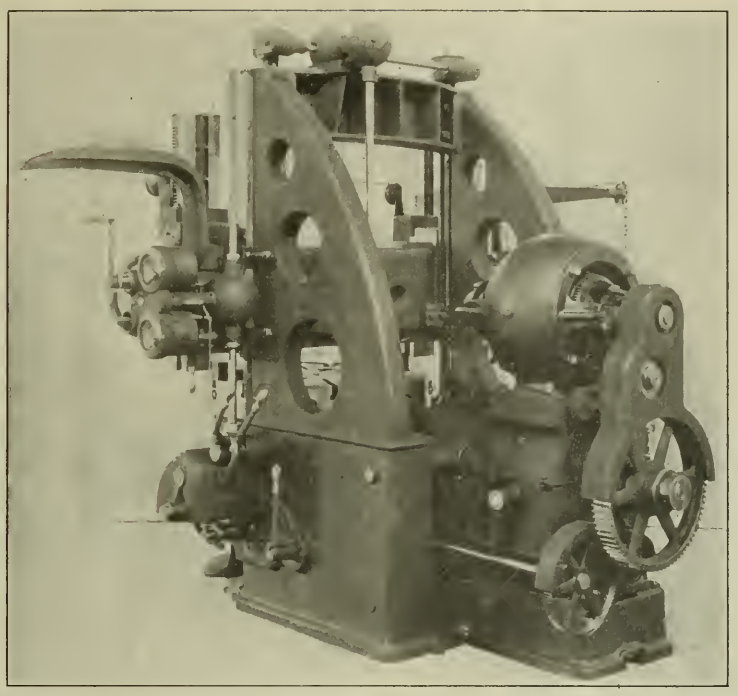


Fig. 5—Gisholt Boring Mill, Showing Motor.

of the machine is 12,200 lbs. without crane.

The Putnam single axle lathe shown in Fig. 3 is for turning both car and locomotive axles. This machine will swing 13 in. over the carriage and will take 7 ft. 6 in. between centers. A double set of driving pulleys are provided on the countershaft. This enables the use of different speeds without shifting the belt in the driving cone. The driving cone has six speeds and has an anti-friction bushing, which permits high speed service. The driving cone has steps 18 in., 22 in. and 26 in. in diameter and is driven by a 5-in. belt. The head and tail spindles are cast steel. The head is self-oiling and receives the lateral pressure on an anti-friction collar. Two feeds are obtainable for roughing and finishing. These can be thrown off or on while the machine is in motion by the lateral adjustment of the shipper rod shown on the front of the lathe. The carriage screw has a hand wheel for squaring up the ends and shoulders of the axles. The tailstock can be set to turn straight or taper and is secured to the lathe bed by three anchor bolts. It has a split binder and an oil cup and spoon for oiling the centers. The weight of this machine is 8,100 lbs.

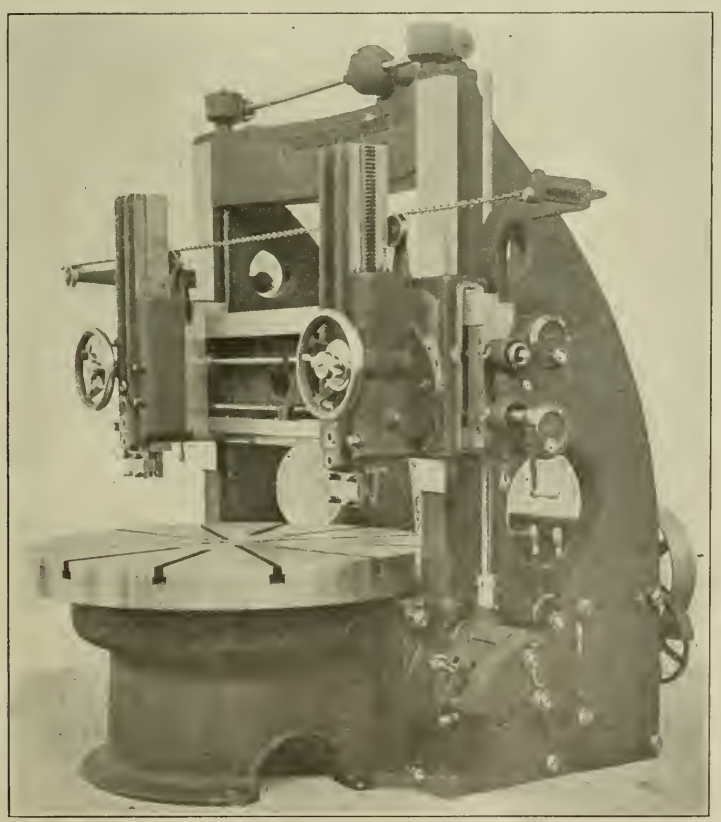


Fig. 4—Gisholt Boring Mill.

BORING MILLS.

The increasing use of the boring mill is one of the important features of modern railroad shop practice. A number of machining operations that were formerly done in lathes are now performed on the boring mill. This fact is largely due to the great improvements made in this tool in the last few years, and also to the rapidity and ease with which the work can be placed on the machine and chucked.

The accompanying illustrations (Figs. 4 and 5) show the Gisholt boring mill. The general design of the headstock is closely identified with the headstock of the turret lathe which this company makes. It is the friction type and back-geared. Six mechanical changes of speed are allowed by the headstock, and the table has 12 changes of speed. A lever within reach of the operator gives absolute control, and by reason of the friction device enables the operator to start or stop the machine without touching the motor or shifting belt. When the motor drive is used the motor is mounted directly on the headstock. This gives a close connection and one that does not necessitate any additional floor space. The cross rail is raised or lowered by power and is controlled by the lever just behind the feed-gear boxes, as shown in the illustration. The heads are independent, having separate feeds both vertical and horizontal, and each is controlled from its own side of the mill. The heads may be swivelled to any angle. Positive stops are provided so that the down slides may be brought to coincide with the table center. By a friction device in the feed mechanism any injury to the heads or gears resulting from their collision is averted. The down slides of this mill are provided with taper gibs to take up the wear. The feed screws and feed rods are fitted with micrometer index dials. These dials read to .0010 in. and reduce the amount of measuring and calipering to a minimum. By means of the feed tripping dials, which are shown at the end of the cross-rail, the feeds may be set to trip automatically at any point. A range of ten feeds is given on both vertical and cross feeds, any of which is instantly obtainable. The right-hand head may be removed and replaced by a turret head. Either the regular head or the turret head may be fitted for screw cutting, if desired. The spindle is self-oiling and rests on a beveled, babbitted surface. A spur pinion drive is used. The table may be a universal chuck fitted with movable jaws, or a face plate with independent jaws may be substituted. These mills are made in six sizes, ranging from 34 in. to 74 in.

*(To be continued.)*

## Accounting Officers.

The sixteenth annual meeting of the Association of American Railway Accounting Officers was held at Saratoga, N. Y., June 29 and 30. It was the largest meeting, with one exception, ever held by the Association. In this organization questions arising during the year are exhaustively considered by committees of members experienced in

their respective departments before being presented to the whole body for action at the yearly meeting.

Mr. J. W. Renner, of the Pennsylvania Company, the President of the Association, opened the convention with an interesting and instructive address, speaking of the great advance in the science of railroad accounting. From what was in the beginning only the check of the receipts and the expenses of a railroad the business has developed to a well-balanced piece of machinery, showing clearly and concisely the relations of the various departments to the final results.

A committee on statistics was appointed to improve work in that field and to secure, so far as practicable, uniformity on different roads.

Four departments of the Government of the United States sent representatives to the meeting to confer with a committee of the Association on the settlement of bills for transportation of Government troops and supplies; and it is expected that improvement in and simplification of Government accounts will result.

Freight and passenger accounting methods were the subject of much interesting discussion, and the thorough reports of the respective committees were adopted and approved without much change.

The Association's plan of freight claim settlements adopted at the Denver meeting was the subject of papers by Messrs. Whitehead of the Atchison, and Dudley, of the Chicago, Milwaukee & St. Paul.

The committee on disbursing accounts has considered and reported on many questions of detail during the year.

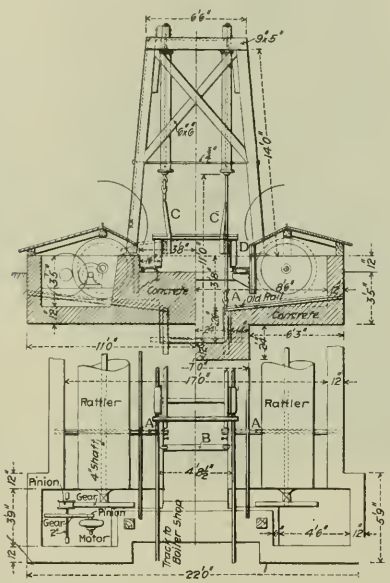
Mr. A. D. Parker, of the Colorado & Southern, was elected President of the Association for the ensuing year.

The untiring efforts of Mr. A. I. Culver, Vice-President of the D. & H. Co., in promoting the pleasure and comfort of the members and their families and in placing the services of the D. & H. Co. at their disposal for a trip to Lake George on Friday were heartily appreciated.

## Flue-Rattlers at the Aguas Calientes Shops of the Mexican Central.

At the new Aguas Calientes shops of the Mexican Central the climate is such that the flue-rattlers can be out of doors all year. Noise and dust did not need to be considered, hence it was not necessary to place the rattlers under cover. They are at the end of a short track leading into the boiler shop. The rattlers are the ordinary cast-iron slat type and are placed one on each side of the track in a pit having concrete walls and bottom. The bottoms of these pits slope towards the track, with two rails, "A," to form a slide or runway for the flues. Under the track is a secondary pit, also provided with rails on the sides and bottom. Two 8-in. I-beams, the concrete at each end, span the pit lengthwise and support the rails of the track. Above the track is a framework of wood carrying four pneumatic hoists, the piston rods of which have hooks. The stroke is long enough to reach the lifting frames, "B," which are made of 4-in. channels, which rest in the center pit. Both rattlers are completely housed, with the part of the roof next to the center track hinged for putting flues into the rattler. Each rattler is driven by a 10-h.p., 500-volt, direct-current Crocker-Wheeler motor connected to the rattler by double reduction gearing. The motors and gearing are housed separately from the rattlers in a dustproof housing.

When the flues are cut out of a boiler they are loaded on a special push car having two arms, "C," on each side, held vertical by a locking device. The car is then run between the rattlers and, after the hinged roof has been raised and two slats of the rattler removed, the arms on one side are released and drop on the 4 in. x 4 in. timber, "D," forming a slide for the flues. Two cast-iron brackets, "E," inside of the housing form a




continuation of these arms and permit the flues to be loaded directly into the rattler. After they are rattled, two of the slats are again removed and the rattler revolved until the opening is below and the tubes fall out. They are then dragged into the small center pit and rest in the lifting frames, "B." The push car is run out of the way, the flues lifted, the car run under them and the flues loaded on to the car by simply lowering the frames, "B." They are then run over to the racks ready for safe-ends.

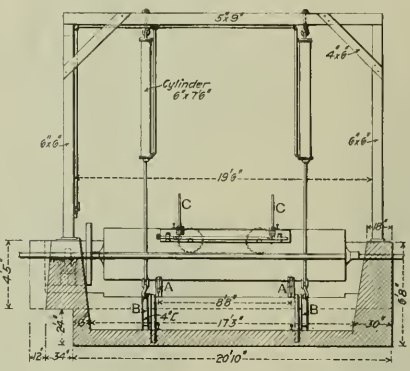
The rattler was designed by Mr. C. T. Bayless, Mechanical Engineer, to whom we are indebted for the data.

## The Master Mechanics' Convention.

The 37th annual convention of the American Railway Master Mechanics' Association was held in the ballroom of the Grand Union Hotel, Saratoga Springs, N. Y., June 27 to 29, inclusive. The meeting was called to order by President W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western. The following officers were elected for the ensuing year: President, P. H. Peck (C. & W. I.); First Vice-President, H. F. Ball (L. S. & M. S.); Second Vice-President, J. F. Deems (N. Y. C. & H. R.); Third Vice-President, Wm. McIntosh (C. R. R. of N. J.); Treasurer, Angus Sinclair (*Railway and Locomotive Engineering*). The following amendment to the constitution was adopted:

"One representative member may be appointed by any railroad company to represent its interests in the association; such appointment shall be in writing and shall emanate from the president, general manager, or general superintendent. Such member shall have all the privileges of an active member, including one vote on all questions, and in addition thereto shall, on all measures pertaining to the determination of what tests shall be conducted by the association or the expenditure of money for conducting the same, have one additional vote for each full 100 engines which are in actual operation or in process of purchase by the road or system which he represents. Such membership shall continue until notice is given the association of his withdrawal or the appointment of his successor.

"A representative member shall pay, in addition to his personal dues as above, an




Flue Rattlers at the Aguas Calientes Shops of the Mexican Central.

amount for each additional vote to which he is entitled, as shall be determined each year by the executive committee, pro-rated upon the cost of conducting such tests as may be determined upon at each convention, provided that no such assessment shall exceed $5 per vote per year.

"Any proposition recommending the adoption of standard constructions or practice shall be in writing and be accompanied by drawings if the latter are necessary for a clear understanding of the subject. Such proposition shall then be submitted to the association for discussion, after which a vote shall be taken to decide whether the proposition shall be submitted for decision by letter ballot to all the members entitled to vote. If decided in the affirmative, the secretary, within three months from the time the vote of the association is taken on such measure, shall send by mail to each member a blank ballot, and a copy of the proposed recommendation, with a report—to be approved by the executive committee—of the discussion thereon. Such ballot to be filled up, signed and remailed to the secretary, who will count all the ballots received within 30 days from the date that they were sent to members, and he shall then announce the vote in such manner as the executive committee may prescribe. Any recommendation securing two-thirds of the votes cast shall be adopted by the association.

"All reports, resolutions and recommendations involving the use, or proposed use, by railroad companies, of any device or process which forms the subject matter of any existing patent, shall first be submitted to the executive committee, and shall be submitted to the association only by the executive committee."

The secretary's report showed that the total membership is 791 and that the balance on hand is $2,874.80.

### First Day's Proceedings.

EXTRACTS FROM THE PRESIDENT'S ADDRESS.

Comparing the engines of 1868 with standard modern freight engines, we find that the boiler pressure has increased 120 per cent., tractive power has increased 296 per cent., boiler diameter 52 per cent., grate area 260 per cent., weight on drivers 272 per cent., and total weight 259 per cent. The increase

in the number of locomotives during the past seven years on the Norfolk & Western has been 37 per cent., and total increase in tractive power 79 per cent. The increase in tractive power per engine is 30.7 per cent. During this time freight ton mileage has increased 86.7 per cent. and freight ton miles per engine has increased 35.2 per cent. The freight ton miles per pound of tractive force has increased 4.23 per cent., and freight engine mileage has increased 55 per cent., the increase in average miles per engine being 13.18 per cent. The total tons of coal per 1,000 on miles is 4.09 per cent. The average cost of repairs, expressed in terms of "freight engine miles," has increased but 2.03 per cent., and repairs, in terms of "ton miles of freight," has decreased 14.96 per cent. Freight train mileage has increased 23.6 per cent., the average weight per train has increased 50.9 per cent., and average number of tons hauled per engine has increased 21 per cent. While the average tons per train has increased 50.9 per cent., the cost of repairs to locomotives, expressed in terms of "ton miles of freight hauled," has decreased 14.96 per cent.

The statement has been made by many managers that the motive power department has not kept pace with the advance in transportation, and that while we have developed a locomotive of the tractive power demanded by our managers, we are unable to utilize this power because the power of the engine is limited to the capacity of the boiler, and that the boiler is far from ample to furnish steam to utilize the tractive power. This has led to the oft-repeated inquiry, "Is the big engine a failure?" It is an admitted fact that the heavy locomotives have given very satisfactory service, particularly during the past years, and that the unprecedented increase in the traffic and commerce of the country during the past year, and particularly during the past winter, has presented problems heretofore unknown, and notwithstanding the enormous increases that have been made in the number and capacity of locomotives, and, in many cases, equally large increases in the facilities for handling traffic in terminal yards, intermediate sidings, and double tracking, the frequent congested condition at the important terminal centers has baffled the best efforts of experienced transportation officers, and much of this trouble was attributed to the failure of locomotives.

In the anxiety of traffic officials to relieve the situation, engines were loaded to their fullest capacity, and tonnage rating of trains was increased to such a point that it required the full tractive power of the engine, when worked to its full capacity, to move them, and the question of the economical point of rating for a locomotive was not considered. In place, however, of relieving the situation, this simply resulted in a further congestion by the slow movement of the train and long hours between terminals, resulting in increased engine failures, or, what should be properly called "boiler failures."

Many of our managers seem to lose sight of the important element of time and consider only the question of tons per train hauled and cost per ton mile, forgetting that the element of time was one of the most important factors in the problem of transportation. As an illustration, we will take a locomotive, the tonnage rating of which has been determined by previous tests as capable of handling 1,000 tons over the division, at a speed of 10 miles per hour, or, to express it differently, would make 10,000 ton miles per hour. If now it is desired to move a train at double the speed, or make the division in five hours instead of 10, assuming that the resistance of the train remains constant, it would require just double the power to make a speed of 20 miles that it did with a speed of 10 miles, or, in other words, it would require two locomotives of the same capacity to move the train at this increased speed. This you will recognize is an impossibility, and it is the efforts which are made to accelerate the speed of engines that are largely responsible for engine failures.

There are two committees of the American Railway Association acting in conjunction with a joint committee of the Master Mechanics' Association: First—On the subject of ton mile statistics. Second—On the subject of statistical inquiry.

The capacity of the engine to move traffic is not governed by the tractive power of the engine, but the capacity of the boiler to develop the highest tractive power possible. In the design of the boilers we are restricted within the lines of clearance of the width and length of the locomotive, so that it is not possible to design a boiler within the limit of space allowed that will develop and utilize the full tractive power as determined by the adhesion of the engine.

It was demonstrated in a test made by Professor Goss on the locomotive testing plant at Purdue University that a locomotive running at a uniform rate of 35 miles per hour with a wide-open throttle and steam pressure of 150 lbs., the coal burned was as follows:

| Cut-off. | Horse Power. | Total pounds coal per hour. | Coal per sq. ft. of grate per hour. |
|---|---|---|---|
| 6- inch | 300 | 1,262 | 72 |
| 8- inch | 434 | 1,978 | 113 |
| 10.5-inch | 495 | 3,133 | 179 |

Let us consider what this means with one of our modern locomotives having a grate area of 50 sq. ft. If it were possible to maintain a rate of combustion of 150 lbs. of coal per sq. ft. of grate per hour, it would represent a consumption of fuel of 7,500 lbs. of coal per hour, assuming that the engine was burning the best quality of bituminous coal, containing 14,000 B. T. U., which would mean a generation of 105,000,000 heat units per hour in the fire-box. In comparison with this we will take the grate areas of locomotives with the ordinary narrow fire-box, having a grate area of 30 sq. ft., which would represent 63,000,000 heat units per hour in the fire-box. Is it to be wondered that we have frequent failures with the wide fire-box and large grate area locomotives?

It has frequently been demonstrated that in times of extraordinary freight congestion a given tonnage can be moved in less time and at less expense, and the blockade of freight has been relieved simply by a slight reduction in the tonnage rating of the train, which permitted moderately higher speeds, thereby increasing the total volume of business moved, not only without increasing the cost per ton mile, but actually resulting in a very marked decrease in cost. This cost point was admirably brought out in the excellent paper presented by Mr. C. H. Quereau at the last convention, in which reference is made to a paper by Mr. Wm. Bennett on the subject of economical trade load, based on an experiment showing the effect of change in tonnage rating. It was shown that a reduction of five cars from a 45-car train reduced the average time of trains on the road five hours per train, which in 30 days resulted in an increased movement of freight from 26,160 tons to 31,104 tons, and an increase in revenue from $23,544 to $27,993.60, which represented total increase of $4,449.60 in favor of the 40-car train. While we must admit that such questions will have to be considered by each road individually, yet I think that the association should inaugurate a general investigation which will direct attention to the vital character of the problem and indicate in a general way the principles involved, and I recommend that it be one of the subjects for investigation and report at the next convention.

The past year has brought remarkable progress in machinery, tools, and shop equipment. This has found its greatest development in commercial establishments, but we have been busy in applying the improved practices in our locomotive and car shops. We are, however, only beginning to develop in this direction, and there is much to be gained by applying methods for increasing production and improving shop methods.

Much is being said and written concerning the conflict between electricity and steam. Electricity is said to be about to drive steam out of the field. I see no conflict whatever. I recognize that electricity can do certain things better than steam, and that it will gradually extend its field to meet new requirements which steam cannot reach. There is no occasion, however, for any anxiety or any fear of conflict, but rather we should receive it with open arms. In shop practice it has worked wonders and bids fair to revolutionize some of our present methods and equipment. The days of long line shafting, isolated steam engines and boiler plants are fast disappearing, and their places are being taken by central power plants, central electrical plant and systems of power distribution. This has brought our power cranes within reach of all departments, serving as an ally to the labor-saving methods by the use of compressed air, and opening up an entire new field in machine tools. Machine tool builders are trying to meet the advanced methods of designing and bringing their products up to sufficient capacity of the variable speed motors. These tools in combination with high speed steel are rapidly changing shop conditions and practices. Years will pass, however, before the steam locomotive will give place to electricity, but that it may do so in the future is not beyond the range of possibility, as indicated by the rapid advance which has been made in New York city and other places. The extension of its use will be gradual, and many new problems will appear in connection with electricity, and they are being slowly worked out. They can best be met by men of experience. It behooves us, therefore, to look out that the development does not pass into other hands, or some one some day may write of the "passing of the master mechanic."

I wish to impress upon the younger men who are before me to-day these opportunities, which they must not lose. The members of this association must look deeply into electricity as we now have it, for there is surely more to come in the future. The development in electricity is not like that of the locomotive, an evolution, but the rapid development constitutes rather a revolution which finds the average mechanic of to-day totally unprepared to meet it. The demands of the future will require a knowledge other than that possessed by the locomotive and car builder of to-day; it will require a combination man, not only capable of meeting the demands upon him for construction and maintenance of cars and locomotives, but a full knowledge of electricity as a motive power. I see no reason for fear of a conflict between electricity and steam, but rather an inducement for the mechanical man to familiarize himself with the principles of electricity as a motive power, and thereby fit himself to become the combination man.

I desire to call attention to the apprenticeship question: There is no lack of good advice from this association as to the proper

methods for the advancement of the apprentice, with a view of recruiting from their ranks. Little, if anything, however, has been done in a practical way. It is all very well to provide facilities for intellectual and educational advancement, and a progressive system of instruction through the various branches of mechanical work, but we should also impress upon them the understanding that their employer is their friend, and that the surest road to advancement lies in the path of loyalty and industry, by drawing from the ranks of the worthy employes to fill positions of trust and responsibility. We can assure these young men that their opportunities for advancement from the ranks to official positions are greater to-day than ever before.

The president of the Master Car Builders' Association, in his annual address, proposed the consolidation of the two associations, and while this has for a number of years been a subject of discussion, it has never before been brought forward with the official support of the Master Car Builders' Association. There are many good reasons for a consolidation, and I can see no objection. I would recommend that the executive committee of this association be instructed to confer with the executive committee of the Master Car Builders' Association with a view of treating in a spirit of cordial co-operation the proposal of consolidation of the two associations.

On invitation of the President, Mr. W. J. Johnson, Mechanical Superintendent of the Bombay & Central India, made a few remarks. He said he had traveled 11,000 miles to attend the convention. He paid a tribute to the excellent work done by the association.

### TON-MILE CREDIT FOR SWITCH ENGINES.

*(Reported elsewhere in this issue.)*

Mr. William McIntosh (C. of N. J.): The committee has solved the problem nicely, and has adopted the only means of arriving at the value of a switching engine. I take exception, however, to the suggestion that the total weight be used. There are many road engines still switching, so that it is not wise to take the total weight, but rather the weight on drivers.

Mr. E. W. Pratt (C. & N. W.): A great many of the roads in the East have a larger proportion of switch engines proper in service than those in the West, and the weight on drivers is as readily obtained as the total weight of the engine. Switch engines in gravity yards will, however, be benefited. The same engine will probably switch more cars in a gravity yard than where the yard is level, but perhaps that will offset the amount of fuel burned and the wear and tear on the engine, as compared with a level yard.

L. R. Johnson (Canadian Pacific): There are switch engines in service which have a truck sometimes in front and sometimes in the rear, and it would not be wise to record the work of that engine by its weight on the drivers. The fairest way of reckoning this ton-hour system would be by taking the total weight of the engine, exclusive of the weight of the tender. In our accounting departments we are following the general line of ton-mile statistics. When the statistical departments take up our work it will, of course, have to be understood that the switch engines should be taken entirely apart from the performance sheet of our general road engines, because we put our road performance sheet on a different basis. One class follows the ton-mile basis, and in some cases the ton-mile-hour basis, and now we propose the ton-hour basis.

R. H. Soule: It is possible to find a factor by which the engine-ton-hour could be converted approximately into train ton-miles, and with such a factor you could bring statistics down to a uniform basis. The converting factor would probably be about 200; that is, for each ton-hour of engine service you are really doing about 200 ton-miles of train service.

George L. Fowler: The weight on drivers or the weight of the engine is a simple figure. To take the tractive power of the engine would have been the same thing, although to have taken the ton-mileage basis would have simply added another factor which the association would have been obliged to agree upon. The object in presenting this system was its simplicity. A ton-mile basis is simply adding another factor in the multiplication.

David Brown (D. L. & W.): If you decide on the ton-hour, it should be the average ton-hour of all the engines on the system, not the engines of the same weight.

George L. Fowler: The idea in giving the weight of the engine was in order to give a road that had heavy engines credit for more work than is done by a light engine.

G. R. Henderson: Mr. McIntosh made suggestions in regard to using the adhesive weight instead of the total weight, and the members of the committee who are here present think that suggestion was a fair one. On a road that has a gravity yard, the cars which can be handled depend on the amount which can be pushed uphill, and the engine can hardly take more cars down hill than can be pushed uphill. I offer a motion that the report be changed so as to mean the weight as represented by the *adhesive weight* of the engine. (The motion was carried.—Editor.)

### GRATES FOR BITUMINOUS COAL.

*(See Railroad Gazette, July 1, p. 114.)*

G. R. Henderson: I do not know what some of our Western roads would do without the use of netting over the air openings, especially in dry seasons and in countries where there is very little water. On these roads it is always customary in the summer time to use a netting over the damper openings to prevent the fire from spreading.

J. A. Carney (C. B. & Q.): Our reason for doing away with the netting is that it cuts down the opening area about 50 per cent. The practice on our road is to use netting where there is liability of fire falling out. Some recent designs have a deflector plate, which allows the ashes to fall on the plate and then drop down inside the box. Another objection to the use of netting is that it clogs up.

John Player (American Locomotive Company): It is proposed to make the openings in the ash-pan 25 per cent. of the grate area. The air opening of the ash-pan should be based on the flue area, instead of grate area. The proposed grate shows a conventional form of central bearing bar which is very wide, and which must be kept clean in order to work perfectly. A simple way of overcoming that can be done by making the trunnion pockets in the grate rockers instead of in the bearing bars. In that way the central grate frame can be narrowed to 1½ in., thus avoiding clinkering.

### COAL CONSUMPTION OF LOCOMOTIVES.

*(Report elsewhere in this issue.)*

G. R. Henderson: Some roads have a system of examining firemen every year, which has advantages over waiting for three or four years when they are ready to be enginemen. If you wait until they have served their full apprenticeship of three or four years, and then make an examination, you find they are poor material, and that you have therefore wasted time with them. On some roads when the fireman is employed he is given a small book of questions, and is told that at the end of the year he will be examined on those questions. If he is not able to pass that first year's examination he is not considered a satisfactory employee; but if he passes with a certain definite percentage (60 or 70 per cent.), he is given further time to perfect himself. If it is shown that he has given attention to the questions he is carried on a second year and given another book, and if upon the second examination he shows efficiency in his knowledge of the contents of the book, he is carried on a third year. The third year gives him the final examination on which his promotion depends. If he passes that examination he is eligible to promotion as soon as a vacancy occurs.

Prof. W. F. M. Goss (Purdue University): It is rather significant that the report does not make a very great argument in favor of the large grate. The results obtained, so far as the amount of coal burned for a given amount of work done is concerned, are substantially the same with the large grate engines as with the small grate engines. If we attempt an analysis of that fact we shall find the important saving which is made by the use of the large grate comes from the reduced loss of cinders and sparks through the stack, but that loss is in part offset by the greater skill which is required in firing the wide-grate engines. It is essential to good results that an even fire be kept and that the excess air be regulated or controlled. With a large-grate engine it is difficult at times to prevent the ingress of air which is beyond that required for combustion, which absorbs heat from the furnace and passes on through the tubes.

Prof. H. W. Hibbard (Cornell University): The large locomotive, with the big fire-box, has emphasized the shoveling of much coal, and a number have spoken about men of muscle and no brains. The man that does not have quite so much muscle but that has a whole lot of brains, so he knows how to use his muscles to the best advantage, is the man that succeeds when the big muscular man that has no brains fails. You have got to teach the men that simply shoveling in tons of coal is not making steam, but that coal has got to burn, and it is not only the carbon in the coal that has got to burn, but the hydro-carbon gases that come from that coal.

H. A. Gillis (American Locomotive Company): What we have lost for some years has been the instruction of the fireman by the engineer. On a big engine the fireman is away from the engineer, and there is no one to help him.

W. R. McKeen, Jr. (Union Pac.): The most important feature of coal economy is the statistics which we have. Most roads seem to be measuring the coal by coal pockets, some by individual coal chutes. But that gives us very little check on the individual performance of the engine, and very little check on the individual performance of the fireman. We should equip our coal chutes with a weighing device, and get the exact number of pounds of coal consumed over a division, and convert that into ton-mile statistics on some basis, as, for instance, an individual fireman's basis, which can be handed to the traveling engineer or the traveling fireman.

S. W. Miller (P. R. R.): The one subject of round-house attention has more to do with the successful operation of locomotives than any other one thing. It is difficult at some round-houses to properly care for large

engines. It is also harder to renew packing rings in a 22 in. x 28 in. cylinder, where the cylinder head weighs 300 lbs., than in the case of lighter engines. It takes three men, where formerly one man was used. The transportation department expects us to turn these large engines out of the round-house in the same time as it takes for the smaller engines.

LOCOMOTIVE FRONT-ENDS.

(*See Railroad Gazette, July 1, p. 107.*)

The executive committee was authorized to appropriate at their discretion such funds as are necessary to carry out experiments outlined in the report.

TOPICAL DISCUSSIONS.

*For lubricating main side rods and driving-box bearings, which is the better practice, grease or oil?*

F. F. Gaines (Lehigh Valley): This question should not be considered solely from the intrinsic value as a lubricant of the two articles in question, but rather from the relative economy that is to be obtained by their use. While theoretically to prevent friction, the thinnest possible lubricant that will run cool under all conditions should be used, there are other points to be considered. It is maintained that suitable grease can be made, which has little, if any, greater viscosity than oil when in use. Even granting that the grease has a greater viscosity, and that there is some initial heating due to its use, this is more than offset by the fact that the use of grease is cheaper, very much more reliable and cleaner.

Engines that are equipped for grease in all rod bearings will make 100 miles to ⅛ lb. of grease, against at least one pint of lubricating oil. With grease on all the heavy engines on my division, there has not been a single hot pin. The visible part of the machinery, instead of being spattered with oil and caked with dust, comes in nearly as clean as when it goes out, as the grease is only fed as required.

M. K. Barnum: I made some experiments on the Union Pacific with grease in rod cups, and an 8-wheel passenger engine ran 30 days on one filling of the rod cups. It would have been necessary to have filled the cups at each end of the road, if not in between the terminals, on each trip, if free oil had been used.

W. G. Wallace (D. M. & N.): At one time we fitted up an engine for grease on one side and the other side with oil. After making 45,000 miles we took the engine in for repairs, and we did not find that either the pins or the brasses showed excessive wear on the side where the grease was, but in fact it was less.

D. Meadows (M. C.): We have a class of engines in which the percentage of babbitt in the main rock brasses was very large, and we found that in using the grease the babbitt would not hold out. It was necessary to change the brasses and put in solid brasses, doing away with the babbitt entirely. The grease practically cuts out engine failures from hot brasses altogether.

*With the large modern engines equipped with power brakes, is not screw reverse mechanism preferable to present hand-lever arrangement, and is quick reversal a vital consideration?*

John Player: The American locomotive engineer is at present not able to accept a screw mechanism. A screw reverse gear would be troublesome and awkward. In case of emergency, it would probably cause confusion. Furthermore, the lever mechanism is simple, easy of application, and takes up little room in the cab, especially on large engines that have the lever alongside of the fire-box. The screw gear is cumbersome.

David Brown (D., L. & W.): The lever and the screw are both wrong. We ought to have an arrangement to work the mechanism by power, using either air or steam.

D. Meadows (M. C.): The reverse lever is one of the best indicators to the engineer if his valves are being lubricated properly. That would not apply to the screw gear. If the engineer is in doubt whether the valves are being fully lubricated, he simply unlatches the reversing lever.

*What is the best practice with reference to providing air spaces under locomotive grates, especially with wide fire-box locomotives?*

F. J. Cole (American Locomotive Company): The ashpan is merely a receptacle for containing the ashes and should not be constructed so as to interfere with the free admission of air. It is usually arranged with dampers so that the admission of air may be regulated, but the operation of these dampers is not generally observed by railroads, consequently the openings are very often left without dampers. Air openings cannot be too large. That is, no injurious effect follows so long as there is a fire and the grate is covered with coal. But on the other hand there may be insufficient openings for the admission of air for the proper combustion of fuel.

Because all the gases must pass through the stack it does not follow that ash pan openings equal in area to the stack will give the best results. The draft in the stack has a high velocity and the smoke-box vacuum varies from 2 to 6 in. of water. The vacuum in the fire-box should be much lower and as free air admission provided as possible. If there is any doubt as to the proper openings to provide, the total flue area is suggested as a convenient base. It seems unnecessary to exceed this in any case. In many cases very free steaming engines can be cited which have about 75 per cent. flue area for ashpan openings. Of course, care should be taken to arrange the openings so that they are not obstructed on the outside by braces, plates, etc., and on the inside by accumulations of ashes. It is often difficult to provide enough openings in front or back or on the sides which will not be partially choked as the pan fills up.

This is especially true of wide fire-boxes and for that reason the best results have been obtained by making the side openings directly under the fire-box frame, these openings to be 3 or 4 in. deep and extend along the length of the fire-box. The side openings underneath the fire-box ring not only afford free admission of air, but also good facilities for readily clearing off the slopes of the ashpan of ashes and cinders which may accumulate and bank up under the grates.

The air openings in deep ashpans can often be advantageously made in the sides about 20 in. or over from the bottom and covered with netting to prevent the escape of hot cinders. These can be further protected by using a sloped solid plate extending the full length of the opening at the top, about 3 in. wide at an angle of, say, 45 deg., to further prevent the hot ashes from passing through the netting.

Openings in front, when unobstructed, are desirable and it seems advantageous to provide all the openings in the front of the pan which are possible, supplementing them with side and back openings to provide the required area. With an engine moving rapidly the air will flow in through the front openings at a higher velocity than at the sides or back.

Prof. Goss: One view of the ashpan problem might well embrace the whole apparatus which controls the movement of air from the outside atmosphere through the mechanism of the engine and back into the air. There is first the front-end, then the flues, then the grate, and then the ashpan. Now, this movement is stimulated by the action of the exhaust jet, and evidently if any one of the elements is unduly constrained, then the exhaust jet will be called upon to do more work. If the opening in the ashpan is small, we must compensate for that small size of opening by doing a larger amount of work with the exhaust jet. Evidently the tube area we cannot change materially. That is a factor which is fixed by the general design and proportions of the engine, and we must make our draft act through the tubes at whatever cost, but we do have very great freedom in controlling the opening in the ashpan.

*What is the best method of caring for locomotive front-ends?*

W. O. Thompson (N. Y. C.): The following method is used by our road: The material used is Walker's smokestack black, thinned with Sipe's Japan oil, in proportion of one part Japan oil to two parts of stack black. It is very quick drying, has considerable elasticity, with a deep black color, has good wearing qualities, and when it does scale, the tendency is to all scale off instead of in spots. The cost of labor for applying on our large locomotives is 17½ cents each. Quite a saving can be made and the appearance of the engines generally can be improved if the painting of the front-ends be under the supervision of the engine inspector or the man who has charge of the work in the engine house.

W. McIntosh (C. of N. J.): I notice a disposition in using any kind of coating for a locomotive front end to spread it on too thickly. I find the best results can be obtained by coating the surfaces sparingly, usually with a brush, rubbing on just enough to moisten the surface.

J. F. Walsh (C. & O.): Graphite rubbed on thinly and frequently, and preferably with a little towel, dampened and then dipped in, or the graphite sprinkled on, gives us the very best and prettiest front-end that I have seen anywhere. It costs comparatively little and it doesn't scale.

F. A. Chase (C., B & Q.): About a year ago we commenced using a mixture of one pound of flake graphite, one pound of white lead and one pound of boiled oil, and with the pooled engines we have a man that takes care of the front ends and the smokestacks, and he puts a very thin coat on. Where a very thin coat is put on with the brush an engine will run from five to ten days without recoating, and it has cost on an average about nine cents to coat the front end of a large engine.

*Packing for air pumps for high speed brakes.*

A. J. Cota (C., B. & Q.): It is generally considered by air pump repair men that there are three essential points to be observed in order that good service may be gotten from any piston rod packing. (1) The air and steam cylinders must be in perfect line. (2) The packing in piston heads must make a perfect bearing on the walls of the cylinder during the entire length of the piston stroke. (3) That the piston rod must be true and well lubricated.

Very good results have been obtained by the use of a swab nicely fitted around the piston rod in conjunction with an oil cup fastened to the air pump by one of the center-piece bolts and fitted with a quarter-inch pipe, which would allow oil to drop directly on to the swab. In making the swab a piece of thin sheet brass was first formed so that it would encircle the rod at a loose fit. Lamp wicking was then wound around the brass ring and after being saturated in oil was forced in place on the piston rod. This brass

spring can be made of such depth that when properly wound with wicking and forced in place, it will effectually prevent the piston rod gland nuts from working loose.

I have made a number of tests with different makes of metallic packing and different kinds of soft packing, taking care that each kind should receive thorough attention and the best results were obtained from the metallic.

*The advisability of reducing the diameter of stay-bolts and shortening the space between the stay-bolts proportionately.*

G. R. Henderson: In order to find out just what would be gained by making reductions in size and spacing, I have prepared a tabulated statement showing the results of some simple calculations made upon the subject. This assumes a 1-in. bolt as a reference base, and the computations have been worked up for 1, ⅞, ¾ and ⅝ in. stay-bolts.

*Comparison of Stay-Bolts.*

| Nominal outside diameter, inches. | Approx. diam. at bottom of thread, ins. | Approx. area at bottom of thread, sq. in. | Pitch for 5,300 lbs. strain at 200 lbs. pressure, inches. | Per cent. metal left in sheet. | Proportion of bending strain to 1-in. diameter. | Reduct'n in bending strain to 1-in. diameter, per cent. | Length bet. sheets for same reduction with 1-in. bolt, inches. |
|---|---|---|---|---|---|---|---|
| 1 | ⅞ | .601 | 4 | 75. | 1.00 | 00 | 4 |
| ⅞ | ¾ | .442 | 3 7-16 | 74.5 | .86 | 14 | 4 5-16 |
| ¾ | ⅝ | .307 | 2⅞ | 74. | .71 | 29 | 4⅜ |
| ⅝ | ½ | .196 | 2¼ | 76.3 | .57 | 43 | 5¼ |

From this it appears that if we lengthen the stay-bolt by increasing the water space, we will reduce the bending strain even if we maintain the same diameter of bolt. Recent practice has caused this increase in length, though for another reason, namely, to provide more water next to the side sheets, in order to prevent their rapid destruction by the severe heat of the fuel. If we consider that the distortion of the stay-bolts by expansion increases with the distance from the mud ring, where the inside and outside sheets are securely tied together, we come to the conclusion that at the bottom of the water leg we can use standard bolts and spacing, but as we rise from the ring, the bolts should be smaller (and closer) or longer, in order to prevent an increase in bending strain. There is comparatively little trouble with stay-bolts within 2 ft. of the mud ring, so that if we admit that a 1-in. bolt can be safely used at that height, and the fire base be 5 ft. high, we can determine the length of the top bolts. We found in our analysis, that the strain was directly proportional to the deflection (or expansion of the inside sheet), so at 5 ft. from mud ring, it would be 2½ times as great as at 2 ft. This would call for a bolt considerably less than ⅝ in. diameter, which would not be considered. The increase in length is however, practicable. As the strain and length vary inversely as the first power of the former to the second power of the latter, we can figure, from a 4-in. length at 2 ft. above the mud ring, and find that if stay-bolts give no trouble when 4 in. long, 2 ft. above the mud ring, the same size bolt, 6½ in. long, 5 ft. above the ring, should also be free from breakage. Modern designs very nearly fulfil these conditions, as far as vertical deflection is concerned. The question of horizontal bending is not so easily adjusted, but we believe that most stay-bolts are broken by vertical deflection.

The spacing must be considered in connection with the proper cleaning of boilers. If the bolts are too close together it will be extremely difficult to get out the mud and deposits; this is worse at the bottom of the water spaces where, fortunately, the bolts need not be so closely assembled to make up for reduction in size, but this cleaning is important at every point and we believe the increase in length is better than the decrease in diameter and spacing. It is often necessary to insert studs in the outside sheet between stay-bolts, to secure pads, etc., and the close spacing would be detrimental; the additional cost of applying and inspecting a greater number of bolts must also be considered, so that taking cognizance of all these points, we are inclined to believe that the increase of length is better than decrease in size and pitch.

F. J. Cole (American Locomotive Company): In considering the relative diameter of stay-bolts and spacing, it is always necessary to analyze the question in all its bearings. It is usually arranged that the tensile strength on any bolt of given diameter is the same, but when you consider the strains on the outward bolts, the vertical rows, which are the bolts which nearly always break out first, you will find the smaller bolts are always very much overloaded, and so far as we are able to ascertain, it requires a bolt of a certain diameter to withstand that strain.

## Second Day's Proceedings.

On motion of Wm. Forsyth, the recommendations contained in the president's address were referred to the executive committee for proper action.

### TOPICAL DISCUSSIONS.

*Leaky flues in wide fire-boxes.*

M. K. Barnum: Leaky flues in wide fire-box locomotives are due more to improper firing and to bad water than to any peculiarities of design. Holes in the fire allow cold air to pass through the grates, and as this is most apt to occur at the front end of the fire-box, the cold air strikes the flue sheet and ends of the flues, causing them to contract unequally and leak.

In some wide fire-boxes the mud ring is made with an angle near the middle of the sides for the purpose of dropping it down at the front to clear the driving wheels and to obtain more space between the grates and bottom row of flues, but even with this arrangement the lowest flues are often not more than 10 to 15 in. above the grates. This leaves a ridge in the grates across the middle of the fire-box and forms a pocket at the front, which the fireman is very apt to overload with coal.

Brick arches afford protection to flue sheets from cold air, and this may cause an apparent difference as to leaky flues in favor of narrow fire-boxes. With equally good water and proper firing and the same length of flues, wide fire-boxes will not give much, if any, more trouble than narrow fire-boxes.

G. R. Henderson: It is generally thought that waters which contain much incrusting matter give the most trouble from leaky flues; but some of the Western roads have come to the conclusion that foamy waters are as bad as incrusting waters.

F. C. Cleaver (Rutland): It is better to get too much coal against the flue sheet than not enough, the idea being to check the air from coming close to the sheet.

J. H. Manning (D. & H.): We have about 225 engines with wide fire-boxes using anthracite coal, and we wash our boilers out about every 25 to 30 days. Our flues last from two to four years. The thing to do to prevent leaky flues is to take care of the feed water.

G. R. Henderson: Feed water, no doubt, is very largely responsible for leaky flues, but you do not get rid of all your troubles by treating your water. If the water contains carbonate salts, carbonate of lime, and magnesia, it is very easy to get rid of that, but if water contains sulphates of lime and magnesia, when you introduce soda ash it leaves a residue of sulphate of soda, which is a foaming material. It is possible to convert an incrusting water into a foaming water, and it is this foaming water that in a great many cases is as destructive to engines as the incrusting water.

H. H. Vaughan (Canadian Pacific): We have had lately success with arches against the sheet to keep cold air from passing across the flue sheet, but the arch became stopped up with cinders on the top. To overcome that we ran the face brick close against the sheet for about a foot, then left an opening 6 in., then continued the arch. That gave a chance for the cinders to fall out and yet didn't leave opening enough for much cold air.

J. F. Walsh (C. & O.): We are having two Pacific type engines built with flues 19 ft. 6 in. long, and bowed up an amount equal to their diameter to allow for expansion and contraction.

H. T. Herr (N. & W.): With engines of similar capacity, the wide fire-box engine has less fire-box heating surface than the narrow fire-box engine, which requires a higher duty of the flue heating surface in the wide fire-box than in the narrow. This results in a greater tendency to cause fluctuation of temperature in the wide fire-box than in the narrow.

*Limit of width of soft coal burning fire-boxes with reference to high evaporative efficiency.*

Lawford H. Fry (Baldwin Locomotive Works): The wide fire-box for soft coal is a necessary result of the modern demand for large locomotives. The reason, of course, for widening the fire-box is to obtain sufficient grate area without increasing the length beyond the point at which the grate can be easily fired. There are two extremes which have to be avoided in designing a fire-box. If the combustion is too rapid, the draft carries a large proportion of fuel through the flues and the engine gives a low economy. On the other hand, if the grate is made too wide, the fire will be too light and excess air is carried through. The evil of this excess air has been forcibly brought to our attention. We have found that some locomotives when taking a 13-car train would burn 85 lbs. of coal per sq. ft. of grate, and would evaporate 7 lbs. of water per lb. of coal. When they were working with a 10-car train, the combustion was cut down to 75 lbs. of coal per sq. ft. of grate and the evaporation was cut down to 6 lbs. of water per lb. of coal; the difference being due to the excess air which was carried through the fire.

If we take ordinary soft coal, burning at 120 lbs. per sq. ft. of grate per hour, and admit sufficient air to produce 20 lbs. of gas per lb. of coal, the fire-box temperature will be about 1,800 degs. and the loss in the smoke-box about 23 per cent. of the total heat produced at the grate. If, now, the rate of combustion be decreased to 100 lbs. of coal per hour, the air supply being increased to give 30 lbs. of gas for each lb. of coal, the fire temperature will drop to about 1,260 degs., and the loss in the smoke-box will be increased to 35 per cent. In the first case a pound of coal evaporates 7.4 lbs. of water, while in the second case it would only evaporate 6.3 lbs. of water. This reduction in efficiency is due to the greater volume of the gases from the fire, which carry away a greater amount of heat. There is also a loss by reason of the lower fire-box temperature, as the absorption of heat is less rapid from the low temperature gases than the high temperature gases.

Of course, it may be argued that the fire-box could be made wide and the draft adjusted so as to give the proper amount of air, but it must be borne in mind that the locomotive is not always working at its maximum efficiency. We may design the draft to give an economical rate of combustion at the maximum efficiency, and then when the locomotive is light-loaded the fire will be so light

that the draft will take through an excess of air. It is desirable to have the inside sheets of the fire-box vertical, so that the steam which is generated rises in a narrow sheet, up past the fire-box sheets, and does not mix in with the steam in the water space. If the sheets slope inward the steam rising vertically from these sheets mixes in with the water and interferes with the circulation.

DRIVING AND TRUCK AXLES AND FORGINGS.

(*See Railroad Gazette, July* 1, *p.* 114.)

This report was read by Mr. L. R. Pomeroy (General Electric Company). He called attention to a special drill used by J. F. Kincaid (American Locomotive Co.), for removing test specimens from axles. Mr. Kincaid showed the drill and a test specimen, and said that a specimen could be got in 20 to 40 minutes from hard steel and in 20 minutes from soft steel. Mr. H. A. Gillis (American Locomotive Company), thought some means should be provided for determining "piping." Annealing of axles should also be required.

The committee was continued and the subject held open until after the meeting of the International Railway Congress next spring.

BOILER DESIGN.

(*See Railroad Gazette, July* 1, *p.* 109.)

After some discussion of the report a resolution was passed authorizing the executive committee to raise a fund not exceeding $5,000 to be used under the direction of a special committee for conducting experiments concerning important features of boiler design.

TECHNICAL SCHOOL GRADUATES.

(*Paper elsewhere in this issue.*)

H. A. Gillis (American Locomotive Company): We have a tendency to forget that most young men who have gone to technical schools not only have the theoretical training, but they also have a considerable practical training, and that they are sometimes quite as expert as the older mechanics who have learned their trade in the shop. Every apprentice ought to be given credit for knowing something before he starts into the shop, and he ought not to be rated down at any such rate as 10 cents an hour. Every fellow that comes out of a technical school is not going to make a foreman. He may not have the slightest conception of how to handle men. Yet such a fellow may have splendid abilities along some other line. He may make a fine engineer of tests.

R. H. Soule: The technical graduate has been to the technical school perhaps four years, and he has done sufficient while there to ground himself in the fundamentals of engineering, and when he graduates and chooses railroading as his specialty, his education should continue for a while longer on that same general line. If he chooses the motive power department he should get an all-round knowledge in that department, and therefore the method which is usually in vogue is really preferable to the one suggested. It is surprising that the railroads have got as many technical graduates as they have, because as a general thing they put them down among the ordinary apprentices, and at the same wages.

W. McIntosh (C. of N. J.): We should give the technical graduate credit for the practical training acquired at college, some of them gathering what is equal to an ordinary apprenticeship during that time, coming out practically equipped to go into the shop and give as good a return as many mechanics. I take no stock in the systematic training of the technical graduate, that is, placing him in a shop and letting him go through a certain course. I do not believe that that amounts to nearly as much as to turn him loose in the shop and say, "Here, we will give you an opportunity to go in there, and if you develop ability we will pay you reasonable wages and give you a standing in the line of promotion."

TERMINALS FOR LOCOMOTIVES.

(*See Railroad Gazette, July* 1, *p.* 115.)

H. H. Vaughan (Can. Pac.): We are going to cover a 20-stall roundhouse this year to see if it will not improve the roundhouse conditions, and in doing that we are taking an old 20-stall roundhouse and taking the depth of the truss from the roundhouse roof, which will give us 6 ft. of light all round the curvature of the house, and put a high roof in the center, which costs about $700 a stall, so that the cost is not serious in comparison with the advantages. We can keep it fairly ventilated.

## Third Day's Proceedings.

IMPROVED TOOL STEELS.

(*Paper elsewhere in this issue.*)

F. F. Gaines (Lehigh Valley): In my experience few, if any, machines built previously to the last three or four years are capable of giving maximum output. If you attempt to drive the machines to the capacity of the steel, the gears break, the spindles break, the bearings run hot, etc. Up to capacity of the machine, high speed tool steel has made a radical change in all shop methods of machining.

W. O. Thompson (N. Y. C.): I have been using high speed steel for both finishing and roughing, and it is as good on the finishing cut as it is on the roughing cut.

M. K. Barnum: A good grade of steel of a lower value in price than the alloy steel will answer all the requirements for finishing.

C. A. Seley (C., R. I. & P.): It does not seem to pay to use expensive steel in cases where the cheaper steel would do the work. Undoubtedly, when tools are worn in size, but still retain the properties which will permit of their high speed use, there are a number of special holders on the market which will enable us to use a piece of steel down to a very small point.

Wm. McIntosh (C. of N. J.): We are not giving the necessary attention to tool holders. In other words, we are using full blocks of steel when with a special toolholder we could reduce the size very much. In that manner we could carry a liberal supply of finished tools on hand, and minimize the amount of time lost in traveling back and forth to the grindstone.

PAINTING LOCOMOTIVES.

(*Report elsewhere in this issue.*)

Mr. A. P. Dane (B. & M.) in opening the discussion called attention to an error in the report and asked that the phrase "the material-saving paint sprayer" be struck out.

The report was accepted by the association.

AUTOMATIC STOKERS.

(*See Railroad Gazette, July* 1, *p.* 109.)

F. Walsh (C. & O.): On account of the limited number of these devices on the market, we have had to confine ourselves to the one stoker. In our experience with the stoker, we find that it reduces repairs to flues. We have run a 22 in.x28 in. consolidation engine for three weeks without making any repairs to the flues. We have had the stoker on some large passenger engines, and the engine will go from one end of a long division to the other with practically no variation in the steam pressure. The service in which we find the stoker most valuable is on the long fire-box engine running over a long division, pulling from 2,500 to 3,500 tons of freight, where the fire-box door would be opened two-thirds of the time. We have given you the capacity of the stoker as it would ordinarily be fired; but it can be increased almost double by throwing the coal, instead of depending upon the screw.

P. H. Peck (C. & W. I.): Our engines are getting bigger every day, burning more coal, but the men are not any bigger than they were 20 years ago. We have got to come to some mechanical stoker in the near future.

Prof. W. F. M. Goss: We should not expect to get any large increase in efficiency from the application of a stoker to a locomotive, because history shows us that we have not obtained any large increase in efficiency by the application of stokers to stationary plants. There are certain conditions which have to be met in stationary service where stokers are used that are not found in locomotive service, and which will make difficult the application of those types of stokers or automatic furnaces which are used in stationary service. Thus, with a chain grate, or with other forms of stokers used in stationary boilers, it is essential that there be no very sudden changes of load upon the boiler. It takes a given time for the furnace to respond to a change in condition, and of course the locomotive stoker must respond promptly to changes in condition.

The stoker described is more an automatic shoveler than a stoker. Instead of putting the coal into the furnace a scoopful at a time, it puts the coal into the furnace a fraction of a pound at a time, and it spreads it perfectly, and because it goes in a small quantity at a time and is well distributed, we get freedom from smoke. The apparatus is the sort which we must look to for success in the automatic firing of locomotive boilers.

F. F. Gaines (Lehigh Valley): You cannot properly cover an anthracite fire automatically. It is all right for soft coal, or in a narrow fire-box, but, with a wide fire-box, combustion is constantly changing from one portion of the box to another.

J. F. Walsh (C. & O.): I have seen the stoker set in the door opening of a room 10 ft.x11 ft. and it would distribute the coal level over the entire surface of that floor. There is no question as to the stoker being capable of distributing the coal evenly.

H. T. Herr (N. & W.): A skilful fireman can fire just as well as a stoker, but he cannot endure the work as long as he could if he had the stoker. That is the important feature of the stoker.

Max Toltz (Canadian Pacific): I had an opportunity to probably make the first test with the stoker on the Great Northern in 1902. We did not find any coal economy. The apparatus was installed on a consolidation engine, about 165,000 lbs. on driver, narrow fire-box, 120 in. long. The economy was in boiler repairs. The engines were running on our bad water district, in North Dakota. We did not have as many leaky flues and the roundhouse work was reduced considerably. The main object of putting on the stoker at that time was to save the hard work the fireman had to do.

LOCOMOTIVE FRAMES.

(*See Railroad Gazette, July* 1, *p.* 113.)

Wm. McIntosh (C. of N. J.): The ordinary frame has too many bolts in it. We should eliminate these bolts, if possible, and make each frame as nearly as possible one homogeneous mass. In 1900 I had some frames designed for a Mogul engine, without any joints in it. They have run with entire satisfaction.

David Brown (D., L. & W.): We get more breaks on the bottom braces of a rod

frame than any other part of the frame, and we generally find the breaks within 5 to 7 in. of the bottom of the pedestal leg. You will probably find them spring open ⅛ in., which indicates that the bottom brace was too short.

H. H. Vaughan (Canadian Pacific): Considerable frame movement is due to twisting, especially on rough tracks. The bottom jaw of the pedestal moves in and out from ⅛ to 3/16 in. with reference to the top of the frames. That is due largely to the side thrust of the leading wheel. If you calculate the amount of opening at the bottom of the jaw necessary to strain the material above the elastic limit, you will find it is a little under 1/10 in. This is what happens largely—the men are careless in handling the engine, and with water in the cylinder it is an easy matter to stretch the binder, and the engine goes over the road with that amount of slack in the binder and causes stretching of the frame over the top bar. As a remedy the clip binder has been applied, and none of the engines with a clip binder has developed that trouble.

## E. E. Betts' Car Record System.

Mr. E. E. Betts, of the Chicago & North Western, Chicago, has devised a simple scheme for saving work in copying car numbers into books, and has issued a pamphlet describing his plan. This pamphlet is copyrighted and application has been made for a patent on the plan. The most novel feature of Mr. Betts' arrangement is the form of blank provided for the freight conductor's trip report and for the interchange report.

| | |
|---|---|
| Initial | |
| Number | |
| Contents | |
| Point of Shipment | |
| Final Destination | |
| Taken at | Conductor |
| Left at | |
| Car Mileage | Date |
| Weight of Car and Contents in Tons | |
| Ton Miles | |

Fig. 1—One Square of Conductor's Report.

| | |
|---|---|
| Initials | |
| Number | |
| Point of Shipment | |
| Final Destination | |
| Contents | |
| Delivered to | R. R. |
| At | |
| Date | Hour |
| | M. |

Fig. 2—One Square of Interchange Report.

The conductor's report is a sheet 9 in. wide x 15 in. long, made up of 28 squares, each 2⅛ in. wide x 1¾ in. high. This report serves for 28 cars, each square containing the data for the record of one car. The conductor makes two copies of this report, by the use of a carbon sheet, and the original, being perforated, is torn up into squares. One square of such a report is shown in Fig. 1. The blank has four columns, with seven squares in a column. The heading of the blank shows the usual data—date, hours, termini, mileage, overtime, etc.

The interchange report is in similar form, one square of this being shown in Fig. 2. Fig. 3 shows a complete sheet of the junction.

As every one interested in car accounting knows, there is troublesome and costly "lost motion" in the car-record office in consequence of the great amount of time occupied in flopping the leaves of a large book to find the proper page on which to enter a given car-number; and the separating of each record, by putting it on a card by itself, so as to enable the perfect sorting of the numbers in proper order, provides the rational remedy for this "lost motion." Mr. Betts sets forth the advantages of his plan as follows:

A car record is made from conductors' wheel reports, showing cars handled in their respective trains, agents' interchange reports, showing cars received from and delivered to connecting lines, and junction reports, received from railroads, showing the delivery of a car to any line, except the owner road. On a railroad owning 50,000 cars, and having 15,000 foreign cars on the line, there would be about 30,000 records to enter daily. Each clerk is assigned about 3,000 home cars and 1,200 foreign cars, and will make between 1,200 and 1,500 entries on a local or home record and about one-half as many on a foreign record. In order to make these entries each clerk must look over, say, 1,000 wheel reports, 300 interchange reports and 200 junction reports, 1,500 in all, taking therefrom an average of two cars per report. After locating his car on the report he must then turn to the proper place in his book and make the entry. It is no small problem to keep these 1,500 reports circulating properly so that each clerk will have work all the time. Each clerk must rest his eye on each car number on each report, or 30,000 car numbers daily, which consumes a great deal of time; and after locating his car additional time is consumed in turning to the proper place in the book where the entry is to be made, so that the time consumed in actually writing the record in the book is a small per cent. of the total time consumed in the entire transaction. To do away with this lost motion and permit the record clerk to devote his entire time to the actual writing of the record in the book, this system has been devised.

As soon as the squares are received in the car accounting office they are deposited in

| JUNCTION MOVEMENT | | JUNCTION MOVEMENT | | JUNCTION MOVEMENT | | JUNCTION MOVEMENT | |
|---|---|---|---|---|---|---|---|
| Initials | | Initials | | Initials | | Initials | |
| Number | | Number | | Number | | Number | |
| From | R. R. | From | R. R. | From | R. R. | From | R. R. |
| To | R. R. | To | R. R. | To | R. R. | To | R. R. |
| Date | | Date | | Date | | Date | |

Actual size of blank 9x15 inches. Actual size of squares 2⅛x1¾ inches.

Fig. 3—Junction Record.

a box 4x4x4. A boy then separates the home records from the foreign and private line records, for which two boxes, 3x3x3, are provided. These boxes to be lettered "Home Record" and "Foreign and Private Line Records." The home records will then be separated by the two ending numbers, 100 boxes being provided for this purpose, lettered, "00," "01," "02," "03," "04," and so on, up to and including "99." The foreign records will be separated in accordance with initials, boxes being provided for each road or private car line. After these separations are made the records are then ready for distribution to the clerks in accordance with work assigned. Duplicate boxes are provided for clerks lettered as above, in accordance with the assignment of work.

The leaves of the local record book are 23 in. long x 24 in. wide, 2 rows of car numbers and days of the month on each page, 75 car numbers in each row, 150 to the page, and 300 numbers in sight all the time, without turning a leaf. The book is arranged so that all of the cars with the same ending number are placed consecutively. Take, for instance, cars ending with "00." Car 100 comes first, followed by 200, 300, 400, 500, 600," and so on, to include all cars in the equipment ending with "00." Then follow with cars ending with "02," "04," etc., if the equipment is separated into odd and even numbers. On a road with 30,000 box cars, even numbers, there would be 300 cars with numbers ending with "00." There would be 300 car numbers in the record book visible at all times, so that, when the record clerk gets his work it can be entered without any turning of pages at all.

The foreign records are distributed to clerks in accordance with the accounts assigned them, each clerk having a separate box for each account. It is not necessary to separate these records according to any numbers, as very often the ending numbers appear on one or two pages.

Under this system a local record clerk can care for 10,000 cars, and a foreign record clerk for 5,000 as easily as 2,500 and 1,200, respectively, under the present system. There is, therefore, a saving of over 70 per cent. clerk hire over the present method.

There is no additional work entailed upon conductors in making up the wheel report with the exception of writing the date on each square, and for this a rubber dating stamp should be provided, with conductor's name on it.

The plan will save considerable office space, which often is valuable.

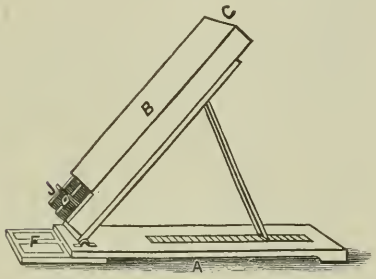
The only offset against the saving made is the cost of extra stationery used, and the wages of the boys to distribute the records. This will vary according to the size of a road; but on a basis of 65,000 cars, home and foreign, a net saving of at least $10,000 per annum can be effected.

On several large railroads the records after receipt in Car Accountant's office are now being transcribed, in order that the work may be distributed direct to the clerks. This is expensive, and productive of error. By using the original reports this expense and liability to error are avoided.

## The Tintometer.

The tintometer, devised by J. W. Lovibond, of Salisbury, England, is an instrument by means of which the color of any object, liquid or solid, opaque, translucent or transparent, can be measured and analyzed in such a way as to permit the keeping of a simple and easily understood record; and for facilitating the establishment of color standards and promoting adherence to them. The enumeration below of the uses to which this instrument is put, will suggest various departments of work in which it could profitably be used on a railroad; but it is described here more particularly because it is adapted to testing the colors of signal glasses. A signal engineer having called our attention to the frequency with which colored glasses offered are found to vary in tint from the glasses of the same color already in use or bought from other makers, it seemed proper to call attention to this simple means of establishing standards and of enforcing conformity to them after they are established.

The construction of the tintometer is shown in the illustration. The box B is a rectangular tube black on the inside for cutting off side lights. The tube is divided in the middle lengthwise. In the right-hand side at the lower end is placed the standard glass J, 2 in. x ¾ in., and in the left-hand side the object to be tested. The observer looks into the box at C and sees the standard glass and the glass to be tested side by side and readily notes any difference that may exist; and by successively using standards of different degrees he can measure such difference. The illustration shows in the left side a square glass cup for holding liquid, as, for example, impure water, or oil, or wine. When a very pale liquid is to be tested the instrument is provided with a glass receptacle made very long, so as




to enable the observer to see through a large mass of the liquid. Where necessary, a reflector is placed in front of the lower end of the box. The manufacturers of the tintometer make a series of standard glasses in which the colors are accurately graded from .006 to 20 units. These glasses are of three colors, red, yellow and blue. To make orange, red and yellow are used together: to make green, yellow and blue are used together, and to make violet, blue and red are used. The standard white is pure precipitated limed sulphate, pressed to an even surface. Each of the three colors of a given number has the same color value as either of the other colors of the same number. For example, five units of orange are made by taking five units of red and five of yellow, and looking through both together. By taking equal units of all three colors the light will be entirely absorbed and the result will be black. There are 155 gradations for each color, so that there are 465 different glasses; but for ordinary uses only a small portion of these are needed. A glass with .006 units is so pale that the color is barely recognizable. Experience with these glasses has shown results corresponding to those found by Aubert, who found that a normal eye would detect an admixture of one part of white light in 360 parts of color.

The tintometer is used by dyers of silk, wool and cotton; by painters; by makers of dyes, yarns, and cloth; paper makers and stainers; by steel makers for measuring the color of metals, both cold and when melted, and for estimating the percentage of carbon in steel: also for estimating the percentage of sulphur in steel and iron and in copper ores; by oil refiners and soap makers; by chemists for measuring the turbidity of waters; by bakers for ascertaining the color value of dough; and for many other uses. In testing color-blind persons it affords an accurate means of finding and recording the degree of color perception and of measuring the difference of color vision between two eyes.

The tintometer is sold in America by Eimer & Amend, of 207 Third avenue, New York City, and costs from $21 upward. Standard glasses cost 72 cents each.

## Performance of Automatic Signals Under Unfavorable Conditions.*

BY H. S. BALLIET.

V.—Batteries (Continued.)

The storage cells in most general use for signals belong to the class known as "lead accumulators." In these cells, strips or plates of lead separated by strips of rubber or suitable insulating material are placed in an electrolyte consisting of sulphuric acid diluted to about 1.17 specific gravity, which density corresponds to about 23 per cent. of acid in the liquid. When charging an accumulator, the passage of current through the cells causes the accumulation of sulphuric acid, which in turn produces a phenomenon known as gassing or boiling, which is an indication that the cells are about charged. In addition to noting this gassing point, it is well to observe the color of the plates, which should be a deep velvety brown for the positive and a slaty gray for the negative. This condition also is a sign that they are properly charged. Not infrequently there is present an insoluble sulphate which forms on the edges of the plates; it resembles a white coating or glaze. This condition should be avoided and if it occurs should be treated by prolonged overcharging and discharging to about 1.8 volts per cell.

It will be noticed as the charge continues that the density of the electrolyte increases; it should in all cases gradually rise from the normal (1.17 specific gravity) to about 1.21 specific gravity, indicating the presence of about 28 per cent. sulphuric acid when the charge is completed.

The e.m.f. of the various cells which have been mentioned is approximately as follows: Gravity, 1 volt; potassium hydrate cells, .7 volt, and sodium cells, .7 volt while that of the accummulator is approximately 2 volts. It is 2.05 when slightly discharged and gradually falls to 1.90 volts when nearly discharged.

The acid must be diluted with pure distilled water and the acid itself be made from sulphur; not from pyrites, as is frequently done. In the maintenance of these cells, great care should be exercised that the acid is properly diluted and that it is free from impurities such as copper, iron, arsenic and nitric and hydrochloric acids, otherwise the plates are apt to be injured.

The experience of the past winter has refuted many claims which have been advanced to discourage the general adoption of accumulators for signal purposes. It has been stated that these cells should be placed in 7-ft. wells, like the gravity battery, on account of their liability to congeal. Readings taken at various times and in widely different localities indicate that the drop in 55 cells was less than one volt for the 110 volts represented, *i. e.*, the rest measured 110 volts before the cold wave set in and during its progress; the decline due to the cold was about one volt, apparently. These records come from points where the discharge rate

*Previous articles on pages 137, 242, 287 and 382; also p. 102, Vol. XXXVII.

averages 5 amperes for 4 seconds. A number of these readings were taken with the thermometer registering 20 deg. F. below zero. A few cases are on record where accumulators are used to deliver approximately .5 ampere continually; these are protected with nothing but a 1-in. hemlock partition, and the temperature is known to have been 10 deg. F. below zero for four days, with no apparent reduction in e.m.f. From these records, it seems justifiable to use these cells within shelters like numbered 5 in my last article. If this conclusion is correct, it indicates the possibility of great improvement in the operation of electric signals during severe winter weather, owing to the higher voltage available.

It has been the general belief that accumulators should be kept in cool places, but experiments carried through two years show that no ill effect results from exposing them directly to the rays of the sun. A curious result of the change in capacity by the application of heat is that by this means we can apparently get more current out of a cell than is put in.

A well known storage battery authority reports as follows: "A cell was charged at 14 deg. C. with 61.9 ampere hours at a rate of .109 amperes per square inch. The cell delivered on discharge after being heated to 45 deg. C. 96 ampere hours. Charged at a rate of .0685 amperes per square inch and temperature of 14 deg. C., 76 ampere hours were put into the cell and it discharged 108.3 ampere hours on being heated to 45 deg. C."

To apply charging current to a number of sets of accumulators through line wires a central station is necessary; or the current can be purchased from some convenient power company. It is not always economical to establish a central station, especially when current can be bought at four cents or less per kilowatt hour and the service is available under all circumstances. When a system of signals extends through many towns and power of suitable potential is available, it is better to charge in small sections, as the use of a number of different sources reduces to a minimum the danger of interruption.

There are in service at this time three distinct methods for operating automatic block signals when accumulators are used: (1) Power-charged cells by line wire, (2) power-charged cells (portable), (3) by employing primary cells. When power lines are installed the wires used in transmitting the charging current to the various sets of batteries are placed on the poles carrying the telegraph and telephone wires, the cost of a separate pole line being thus avoided. These line wires are generally .165 inch in diameter, being hard drawn copper with either double or triple braid weatherproof insulation and each wire weighing between 520 and 600 lbs. per mile. In case of sleet or high wind storms, these wires are subjected to many chances of interruption and unless the system is designed to work in spite of occasional breakdowns of the pole line, there is likely to be unnecessary detention to trains owing to the accumulators becoming exhausted. Cases are on record where pole lines have been washed away by floods so that they could not be restored for a week. In cases like this, it may become necessary to put in primary cells temporarily. Such a condition has repeated itself in certain sections of the country for two seasons, and without the aid of primary cells the automatic block signals would have been out of order at least 12 hours after traffic was resumed; but by the use of primary cells trains were run by the signals (track-circuit) while there was still one or two feet of water covering the track.

According to the report of a committee of the Railway Signal Association, power lines are only applicable where three, four or more parallel tracks are signaled, the blocks being approximately one mile in length. Figures quoted by this committee and data supplied by those operating such a system show great economy as compared with a primary cell installation. As a rule, on a four track road six cells (approximately 12 volts) in series are installed, thus making it possible to operate four signals from one battery if necessary. Also at terminal stations or yards and in special outlying cases where many signals are required in order to move a large number of trains close together, the total number of cells to operate them can be reduced, thereby effecting a saving as compared with primary cells. Where conditions are favorable, accumulators are used for track circuits. Where conditions warrant the use of power line and accumulators the decrease in the labor charge is very perceptible.

When portable accumulators are used, it is customary to install four cells (approximately 8 volts) at each signal. These cells should be of sufficient capacity to furnish current for at least one month. At the expiration of this period, the cells are removed and taken to a designated central station where they are charged. If signals are 1½ miles apart and only one or two tracks are signaled, the portable accumulator system is preferable.

Under such a system all cells can have a regular inspection and the life of the plates can be much extended by having expert attention. The rapid increase of the "all-electric" power-operated interlocking plants has made portable batteries popular because there is no need of installing special central stations. These all-electric plants are being rapidly introduced at isolated places on many railroads, so that the question of distributing cells every 30 days becomes an easy problem. By supplying a full set of 55 or 56 cells of accumulators, they can be charged in multiple with the regular quota of cells used for the interlocking plant, with no additional expense for fuel or attendance. These cells are always available for renewal of those which are exhausted. The cost of transportation of the cells is practically nil, when a regular routine of renewals is established. Work trains on congested parts of the road and tricycle speeder cars on less busy sections can be used for this purpose. On a large road the maintenance force can often be reduced as much as 40 per cent; *i. e.*, a road employing a signal repairman and a batteryman for every 15 miles of double track can reduce the force in almost every case so as to require only one batteryman for every 30 miles. Such a system has advantages over the line wire system because there is no pole line to interrupt the regular charging; neither are crossed overhead circuits causing short circuits or grounds. In case of serious floods or other interruptions it is probably less annoying and there is less delay in getting signals in working orders.

When accumulators are charged by primary cells, it is customary to use the gravity cell, four being required for each accumulator. Such records as are available indicate that the cost of maintenance on such a system is less than with primary cells used direct and more than by either the portable or the line wire charging systems.

Objections to such a system are (1) the fact that the gravity battery needs frequent renewing, (2) liability of broken jars in the charging battery and (3) possibility of freezing of the charging battery, unless extraordinary measures are taken, as mentioned in the beginning of this article. There is one advantage gained by such a system as compared with a primary cell system, and that is the increased amount of current available at all times. In a system of electric semaphore signals, this is very necessary where weather conditions are variable.

The question is frequently asked as to the advantage of having the battery or power localized at each signal, as compared with the systems using a common source of current or power. The subject should be considered in two distinct parts: First, signals worked by battery; second, those worked by power. When battery is employed and the current for each block is localized (whether it be at the signal it operates or at the next signal in advance with the signal-operating current transmitted by line wire) the delay to trains is reduced to a minimum, because an exhausted battery, a broken cell or a broken line wire interrupts but one signal. When a common battery is used for several signals, all of them are interrupted.

When air is used a broken main pipe or a shut-down at the pumping station affects all the signals dependent on that pump or that pipe. When compressed air in reservoirs or liquid carbonic or dioxide gas is used, with a supply at each signal, the delay or interruption is limited to one signal.

High winds in summer and sleet or snow in winter are responsible for many broken line wires and not a few detentions to trains are charged to this cause under the battery system. Floods have caused the stoppage of many trains and under a common battery system would cause no end of complaint from the transportation department, whereas if each signal has its own battery, the failures are reduced to a minimum and in many cases the signals are in perfect working order long before the track is ready for service.

During the past winter many main air pipes were pulled apart on account of contraction; and not a few cases are recorded where many miles of signals were out of order for hours from this cause. What little damage is incurred by high water when air or gas is provided in cylinders at each signal is inconsiderable, and the detention to trains is even less than in the battery system.

## Master Mechanics' Reports.

Last week we printed a number of reports and papers presented to the Master Mechanics' Association. Others will be found below:

### COAL CONSUMPTION OF LOCOMOTIVES.

One of the most thorough and comprehensive reports presented was that of the committee appointed to consider the above subject. The report is subdivided under four general heads as follows:

1. Is the operation of large engines what it should be from a standpoint of engineers and firemen?

2. Are the present tendencies as to large grates and heating surfaces disadvantageous? Are the proportions correct?

3. Is the large locomotive giving results in operation which would be expected from the large increase in capacity?

4. Is the operating department of railroads deriving the amount of assistance and relief from large locomotives which may be justly expected? If not, how should the attention of the locomotive designers be directed?

*Operation of Locomotives from Standpoint of Engineers and Firemen.*

Theoretically, the pooling of locomotives is advantageous, but there are many conditions which detract from the theoretical benefit of such method of handling, when applied in practice. It may happen that en-

gines pooled at different terminals will run over not only one division, but a number of divisions and come in contact with various conditions affecting their economical operation, and the interest manifested by the men who operate the engines and those who care for them at terminals is diminished, resulting in a decreased efficiency in their performance. The pooling system has a demoralizing effect on the interest which is taken in the maintenance of the engines and their operation by the enginemen and firemen, resulting ultimately in less loyalty to the company which they serve. However, in numerous instances pooling is necessary, and where such is the case it cannot reasonably be expected that motive power can be maintained with as little expense as can be done with regularly assigned engines. The attention to detail of maintenance in keeping the motive power in serviceable condition without continual shop repairs is the keynote to good operation and economy, and is more likely to be obtained under a regular assignment where each man runs one engine. This is perhaps largely the cause of the numerous troubles due to leaking which are experienced with this type of engine. It is much easier to maintain an even fire on a small grate than a large one and the tendency with the large grate to allow different temperatures at different parts of the fire is considerably more than obtains with the small grate, hence the necessity of additional care on the part of the men operating an engine with a wide fire-box and relatively large grate area.

*The Relative Merits of Large Grates and Heating Surfaces and Their Proportions.*

The tendency in locomotive design recently has been to the broad fire-box, giving a relatively large great area and tube heating surface, while the fire-box heating surface has not been increased in proportion to these. For purposes of comparison the committee selected eight locomotives of different types of the dimensions shown in Table I. Data of tests from these engines was available and comparisons were based on these tests:

TABLE I.

| Letter. | No. | Type. | Cylinder. Diam. | Cylinder. Stroke. | Wheel. Diam. | Fire-Box. Lgth. | Fire-Box. Width. | Flues. Number. | Flues. Diam. | Flues. Length. | Weight in Working Order. Drivers. | Truck. | Total. | Boiler Press. Lbs. per Sq. In. | Heating Surface. Fire-Box. | Flues. | Total. | Grate Area. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 606 | Mogul Comp. | 15½ / 26 | 28 | 62 | 100¾ | 71¼ | 350 | 2 | 13- 4 | 135,000 | 29,000 | 164,000 | 200 | 183 | 2,443 | 2,626 | 48.5 |
| B | 1,051 | Prairie Comp. | 17 / 28 | 28 | 69 | 108 | 71¼ | 318 | 2¼ | 18-11 | 141,690 / 156,190 | 68,500 / 54,300 | 210,190 | 220 | 195 | 3,543 | 3,738 | 53.5 |
| C | 601 | Mogul Simple. | 20 | 28 | 62 | 100¾ | 71¼ | 350 | 2 | 13- 4 | 132,000 | 25,100 | 157,100 | 200 | 183 | 2,443 | 2,626 | 48.5 |
| D | 565 | Prairie Comp. | 16 / 28 | 28 | 63 | 102⅛ | 72¼ | 318 | 2¼ | 18- 4⅞ | 134,500 | 76,500 | 211,000 | 210 | 219 | 3,447 | 3,666 | 51.25 |
| E | 175 | 10-Wheel Simp. | 18 | 24 | 63 | 77⅛ | 33⅝ | 196 | 2 | 13- 9½ | 88,400 | 34,500 | 122,900 | 180 | 145 | 1,415 | 1,560 | 17.9 |
| F | 839 | Consol. Simp. | 21 | 30 | 56 | 112½ | 41¾ | 263 | 2¼ | 14- 6 | 147,300 | 18,200 | 165,500 | 200 | 182 | 2,233 | 2,415 | 32.6 |
| G | 923 | Consol. Simp. | 21 | 30 | 56 | 112½ | 64¼ | 273 | 2¼ | 14- 6 | 157,850 | 17,250 | 175,100 | 200 | 156 | 2,318 | 2,474 | 47.3 |
| H | 861 | Consol. Simp. | 21 | 30 | 56 | 112½ | 41¾ | 263 | 2¼ | 14- 6 | 147,300 | 18,200 | 165,500 | 200 | 182 | 2,233 | 2,415 | 32.6 |

particular engine than where one man runs forty engines. With a regular assignment each engineman becomes not only an inspector but an educator for the particular fireman who may be assigned to him and a certain pride attaches to both men to maintain and have maintained that part of the property of the company which is entrusted to their care.

Nearly every railroad follows the general rule of obtaining enginemen by promoting firemen who have passed through a reasonable course of training in road service prior to their promotion. This being so, the importance of employing proper material for firemen is apparent. The primary requisites in employing firemen are, a fair general education, the importance of fuel consumption, the best methods of firing to result in fuel economy and the operation of the locomotive to prevent fluctuations in temperature which are detrimental to the boiler and consequently efficient operation. Satisfactory evidence should be given by firemen applying for a position of their knowledge and ability to handle fuel, prior to the approval of their application. Railroads have had to employ men on short notice and have consequently taken the material which has offered. If, however, it were well established as a general rule that each railroad required certain qualifications to be fulfilled before employment would be given, vacancies could be filled with material of a higher order, as the inducements offered are superior to those of most trades consistent with the requirements from the applicant.

The result of pooling engines is further shown by the inability of firemen to cope with the differences in designs of engines as well as can be done when they are regularly assigned to one engine, especially where conditions warrant the use of both wide and narrow fire-box engines. The care with which wide fire-box engines should be fired is not generally appreciated by the

Engines A, B, C, D and G are examples of the tendency to increase the grate area by broadening the fire-box and may be considered modern engines of this type of construction. Of these engines A and B are Vauclain four-cylinder compounds, D a tandem compound and C and G simple engines.

The tests which were made were carried out under road conditions to determine the relative efficiencies of engines of the types A, B, C and D, as compared with the opposite extreme of type, E. Under similar conditions engines of type E have a high rate of combustion, as compared with types A, B, C and D. There is a high fire-box temperature with less air of dilution but sufficient air admitted through the grates to allow reasonably complete combustion. With the high duty of the fire-box heating surface, as compared with flue-heating surface, the former absorbs a large proportion of the heat of the high temperature fire-box gases which is further diminished in temperature by the heat absorbed in the flue-heating surface, so that, although the smoke-box temperature is probably higher than that in the boiler with a lower rate of combustion, and the passage of the gases from the fire-box to the smoke-box also being freer on account of the ratio of the grate area to the flue area, a rapid transfer of heat through the sheets of the fire-box and tubes results in a very high duty of the heating surface. The efficiency depends principally on the difference of temperature between the fire-box and smoke-box gases, so that this boiler would indicate a design which is well adapted to be forced to high duty with relatively good economy.

Comparing type B, the extreme example of wide fire-box construction with moderate forms indicated by types A, C and D, it will be seen that

1. The ratio of heating surface to grate area is large, compared with engines A and C.

2. The ratio of tube-heating surface to fire-box-heating surface is large.

3. The ratio of grate area to tube area is but slightly larger than that in the other wide fire-box engines.

This boiler gave the most efficient performance, due probably to the relatively large heating surface in proportion to the fuel consumed and the slow rate of combustion, while the duty of the heating surface was relatively low.

It would appear generally that as the rate of combustion is increased the circulation of the fire-box gases is heightened, and if a corresponding increase in the circulation of the water in the boiler results from the increased circulation of fire-box gases, which may generally be expected, there would be but a small decrease in the efficiency of the boiler itself. It is to be remembered, however, that in obtaining forced combustion in locomotive practice it is necessary to diminish the power of the locomotive and hence affect the efficiency of the machine as a whole, for the reason that such forced combustion is obtained by means of an increased back pressure in the cylinders resulting in a corresponding loss in effective work. The design of the boiler for the locomotive is primarily fixed by the allowable limits of the weight of a certain type of engine, and in a general way it should be remembered in choosing a high rate of combustion that such forced combustion affects both boiler efficiency and engine efficiency.

Within reasonable limits, however, the economy of the boiler and the engine may not be expected to vary widely if the proper proportion of grate area to heating surface, fire-box heating surface to flue heating surface, and flue area to grate area are maintained.

The latter proportion in a general way has some effect on the circulation of the gases, as is indicated by the fact that in large boilers with a large number of flues some of them may become stopped up, resulting in but little depreciation in the steaming capacity, whereas, in the small boiler, such as the E engine, if the flues are not kept clean the steaming capacity is materially interfered with; probably also on account of diminishing the heating surface.

Wide fire-box boilers of practically the same capacity of narrow fire-box boilers give more trouble in actual service from leaking. This is probably due to the wide fire-box being more difficult to fire and to keep covered with a uniform thickness and temperature of fuel, resulting in fluctuations of temperature in the fire-box which affects sheets by alternate expansion and contraction, resulting in more or less leakage and deterioration of the boiler itself.

If it were possible to obtain the same efficiency in the boiler with a small grate by increasing the rate of combustion within reasonable limits, this disadvantage of the wide fire-box engine might be overcome to some extent, but improvement in this direction is more to be looked for by the education of

the fireman than by a change of design, which results in less efficiency for the locomotive as a whole.

The efficiency of wide fire-box boilers in ordinary operation in road service should not be based on the actual amount of coal consumed while they are hauling a train, but rather on the basis of the total coal consumed, including the coal used at delays in firing up and at terminals.

and engine crew wages by the installation of heavy power, it seems probable from the statistics of these two railroads (which are representative) that not only is a saving in expenses to be looked for by the installation of the heavy power, but that an actual saving in the cost of repairs and fuel will also result when based on the power developed by the locomotive.

Considering compound engines, as compared with simple engines, the modern compounds, types A, B and D, showed much better efficiencies than the simple engine, C, in the tests that were made. An increased economy in steam in the cylinders of the engine will require a less demand for steam for a given power on the boiler, resulting in increased economy for the compound engines by increased efficiency of the boiler, giving a combined efficiency for the two, and, therefore, a higher average performance of the locomotive as a whole. It is probable that some proportion of the economy of the compound engine is due to a less back pressure in the cylinders to maintain a sufficient draft on the boiler to supply the requisite amount of steam, so that generally the higher the draft required the less efficient the boiler and less efficient also the engine. This, in a measure, also affected the showing made by the wide fire-box engines. The wide fire-box engine requires a milder draft, giving, as shown by the boiler tests, a higher boiler efficiency and resulting also in diminishing the back pressure in the cylinders, the combined effect of which would give a high efficiency.

TABLE II.

| Engine number. | Total coal used running. | Total coal used at delays. | Average time of delays. (hrs. min.) | Total coal used to fire up. | Average time to fire up. (hrs. min.) | Per cent. of coal used to fire up and at delays to total amt. |
|---|---|---|---|---|---|---|
| *606 | 14,106 | 1,037 | 2—17 | 1,410 | 5— 6 | 14.8 |
| *601 | 18,198 | 1,167 | 3—38 | 1,555 | 4—13 | 13.0 |
| *1,051 | 14,822 | 863 | 1—54 | 1,662 | 6—16 | 14.5 |
| 565 | 15,815 | 1,155 | 3—15 | .... | .... | ... |
| *175 | 12,366 | 598 | 2—35 | .... | .... | ... |
| †923 | 16,041 | 1,234 | 5—58 | 1,200 | .... | 13.2 |
| †839 | 81,797 | 765 | 3—55 | 1,250 | 4—40 | 9.7 |

*Average of 5 trips.
†Average of 12 trips.

In this respect Table 2 indicates for the engines tested the relative amount of coal consumed by these delays and at terminals. In a general way it will be seen that the narrow fire-box engine has an advantage in economy for standby losses and in firing up, so that in considering the ultimate worth of the two designs, remembering that within reasonable limits of rates of combustion the maximum consumption is 120 lbs. of coal per square foot of grate per hour, the performance of the boilers does not vary considerably, the ultimate performance being based on the total amount of coal used to determine the relative merits of the two designs when compared in actual road service.

*Results Given in Operation by Large Locomotives.*

The usual method for comparison of the performance of engines is generally stated as the cost of repairs per engine mile or per ton mile, usually the former, while the fuel consumed is more generally based on the latter. As these statements do not present a definite value, since they do not take into account all the important conditions which affect the performance, it is probable that such comparison would be more accurate if based on the approximate power which the locomotives develop in service.

A comparison of the relative increase of number and size of locomotives, cost of fuel and repairs by years from 1897 to 1903, inclusive, for a comparatively mountainous road shows that from a fuel standpoint while the total tractive force in seven years increased 79.1 per cent., the average tractive power per engine has increased 30.7 per cent., the freight ton mileage has increased 86.7 per cent., and the freight ton mileage per engine 35.2 per cent., whereas, the total coal used by engines increased 79 per cent., which, based on the pounds of coal per 1,000 ton miles, decreased 4 per cent., showing that the increase in the size of power was in this instance accompanied by a decrease in fuel consumption on a ton mile basis. This was accompanied by a decrease in the cost of engine repairs on a ton mile basis, with a slight increase on an engine mile basis.

A more striking instance of the saving due to the installation of heavy power is shown in the case of a comparatively level road. On a basis of fuel consumption, with an average increase in tractive force per engine of 95.77 per cent. in 1903 over 1897, the freight ton miles per pound of tractive force decreased but 5.76 per cent., the total coal used by locomotives increased but 78 per cent. and the pounds of coal per 1,000 ton miles decreased 3.75 per cent.

Aside, therefore, from the saving in train

The cost of repairs to fire-boxes of the wide and narrow type on engines of the same size is a matter on which the committee has not secured definite information. The prevailing opinion seems to be that the cost of repairs in the roundhouse for wide fire-box engines is more than for the narrow and the shop cost about equal for wide and narrow fire-boxes, principally on account of flues. The expense for heavy engines is greater than for light engines, but the tons hauled is a larger percentage with less engine miles, one road reporting the figures as follows: The total engine expense for consolidation engines was 32 per cent. greater than for ten-wheel engines on the same district, the tons handled was 50 per cent. more and the miles run 22 per cent. less. This on a division where the ten-wheel engine is a strong favorite. The tractive power of these consolidation engines is 80 per cent. more than the ten-wheel engines and their general average will run 65 per cent. more tons per mile.

*The Large Locomotive as an Aid to the Operating Department and Its Relative Advantages in Operation.*

The large capacity locomotives lose their efficiency unless they can be loaded to their maximum capacity. The difficulties in governing traffic are not entirely in the hands of the operating officers, which results in some instances in using heavy engines on comparatively light trains. Generally the assignment to any district is proportional in a measure to the capacity of the engines, so that with large engines and a variable traffic, the expected efficiency will not be attained. Under these conditions probably light engines will suit better.

Large engines with a comparatively heavy train cannot go into side tracks as rapidly as small engines with short trains without damage to equipment nor run for meeting points with as much assurance of making them, resulting in more serious delays along the road, yet, from the fact that the large engines are hauling more cars and tons with fewer miles run for the same total cost per engine, including the interest on the large investments, it appears that where traffic conditions warrant heavy power, it is both economical from a fuel, repair and operating standpoint. It must be remembered that with heavy engines a given amount of tonnage may be moved with fewer trains, resulting in fewer meeting points to be made and consequently fewer chances for delays in this respect.

As the capacity of the locomotive has increased, its usefulness as a unit increases proportionately, so that any defects which exist on the road become more serious with heavy power than with light power. The utmost care in design, to prevent breakdowns on the road, should be exercised when building locomotives, and their proper care and maintenance when in road service is essential to good operation.

With the increased capacity of locomotives sufficient care has not been given to road maintenance and the prevention of failures on the road. With the growing demand from year to year for power, not only has the pressure brought to bear on the builders required them to furnish engines as expeditiously as possible, but proper arrangements have not been made to maintain such engines when they have been put into service.

*Conclusions.*

The increase in efficiency of enginemen and firemen in road service depends largely on the employment of suitable material to fill the position of fireman. For numerous reasons, proper consideration has not been given to this matter in the past few years and has led to diminished efficiency in coal consumption, influenced also by the method generally followed of pooling the engines without proper facilities to maintain them in such handling.

The relatively large boiler results in economy, not only in itself, but also economy in the engine, so that it is desirable to have as large a boiler as the limitations imposed by the engineering department will warrant for any particular design of locomotive.

The grate area of the locomotive boiler should be limited to a certain rate of combustion per square foot of grate. Small decrease in efficiency in boilers is obtained by increasing the rate of combustion within a maximum limit of 120 lbs. of coal per sq. ft. of gate per hr., yet due to the fact that with a slow rate of combustion a milder draft will serve. The large grate with a slow rate of combustion has an advantage in increasing the efficiency of the engines.

The loss of fuel at delays is probably greater as the area of the grate increases. This is in a measure offset by the fact that large grates are found on large engines. With the large engines fewer trains are required to move a given tonnage and consequently delays are diminished. This would have a tendency to counterbalance the increased fuel consumption due to increased grate area. There should be a design of grate of sufficient area to compromise between the loss due to delays and at terminals from the large grate and the loss in effi-

ciency while running due to the small grate.

The introduction of designs of locomotives with a large proportion of the weight on trucks and trailers has resulted in efficient performance as regards fuel economy for both boiler and engines. Generally with this design the capacity of the boiler is relatively increased in proportion to the available power developed by the cylinder (which is limited by the weight on drivers) and consequently such designs are best adapted to give efficient performance where a relatively high horse-power is to be maintained for a comparatively long time, such as, for instance, in passenger service or in through freight service.

The relative worth of a large unit of power to a small unit warrants the maintenance of large engines to a higher standard than small engines and to accomplisb this proper facilities should be provided.

The methods of comparison of locomotives in road service from a standpoint of fuel economy should be such as to eliminate as far as possible the influence of variable conditions which might lead to erroneous conclusions from statistics now compiled. The value of fuel consumption should be proportional to the power developed by the locomotive.

The report is signed by H. T. Herr, Chairman; R. L. Ettinger, S. K. Dickerson.

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IMPROVED TOOL STEELS.

*(From a paper by W. R. McKeen.)*

The following tests of tool steels were not made on specially devised castings or forgings, nor were any machines arranged in special reference to these tests. All ob-

*Carbon Steel.* *Alloy Steel.*

**Tools Used on Cast Iron.**

servations were made on work going through the shop during regular working hours and on actual locomotive parts being put through the shop; these same parts being afterward applied to locomotives. The tests were conducted according to the directions of the chemist and engineer of tests, and under the supervision of the general shop demonstrator; the electrical readings were taken by the local electrician, and the machines were handled in their regular course by the mechanics assigned to each class of work. Turning and planing tools were forged and tempered by the regular toolsmith, and the twist drill and milling cutters were made in the local toolroom. Under these conditions a much fairer comparison as to the actual benefits obtained from alloy tool steel in regular shop practice can be made than where special test conditions are followed.

Three lines of comparison were taken, namely: First, the speed, cut and feed; second, the durability of the tools; third, the amount of power expended in keeping a tool up to its proper capacity. The first depends upon the volume of output; the second on the quality of steel and manufacturer's and toolmaker's skill; the third being

COMPARATIVE PERFORMANCE OF ALLOY AND CARBON STEEL.

| | *Machine and Equipment.* | *Metal Machined.* | Feed per Revolution. (Inches.) | Depth of Cut. (Inches.) | Speed. (Ft. per min.) | *Power to Run Machine.* Light. Volt. | Light. Amp. | Under Load. H. P. | Under Load. Volt. | Under Load. Amp. | Effective Metal. H. P. for Removed. Cutting. H. P. | Effective Metal. % of Total. | Effective Metal. Removed. Per Hour. | *Size.* Height-Width. (Inches.) | *Tool.* Angle. Top. | Angle. Front. | Angle. Side. | Kind of Steel. | Total Longitudinal Feed. (Inches.) | Time of Test. (Minutes.) | Condition of Tool after Test. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Planer, 60"x60"x30'..... | Soft steel side rods | ¼ | 1 | 16 | 219 | 43.8 | 12.9 | 219.4 | 71.1 | 20.9 | 8 | 38 | 780 | 97.5 | 2½x1½ | 60° | 80° | 80° | Alloy | 4 | 42½ | Very good. | Limit of machine. |
| 2 | 20-h.p. Westinghouse motor... | 4" long cut. | ½ | | 16 | 219 | 43.8 | 12.9 | 212 | 56 | 15.9 | 3 | 19 | 288 | 92 | 2½x1½ | 60° | 80° | 80° | Carbon | ¾ | ¾ | Burnt ½" | |
| 3 | Wheel lathe, 100" swing..... | Old and badly worn Standard | 5-16 | | 23 | 228 | 12 | 3.7 | 226 | 21.2 | 6.4 | 2.7 | 42 | 96 | 36 | 2½x1½ | 82° | 78° | 85° | Alloy | 4 | 17 | Very good. | |
| 4 | 15-h.p. Westinghouse motor.. | Gear driving wheel | 3-32 | | 6 | 226 | 6 | 1.8 | 228 | 7.6 | 2.3 | .5 | 22 | 15 | 30 | 2 x1 | 82° | 78° | 85° | Carbon | ⅞ | 27½ | Burnt up. | |
| 5 | Pond engine lathe, 42"..... | Hard cast iron tires, 70" dia. | 1/4 | | 22 | 227 | 25 | 7.6 | 228 | 38 | 11.6 | 4 | 34 | 180 | 45 | 2 x1 | 60° | 80° | 80° | Alloy | 6 | 8 | Good. | |
| 6 | 20-h.p. Westinghouse motor.. | Cylinder, Bushing, 28" dia. Countershaft. | 3-16 | | 11 | 228 | 24.5 | 7.4 | 228 | 32.6 | 10 | 2.6 | 26 | 51 | 20.7 | 2 x1 | 60° | 80° | 80° | Carbon | 4 | 14 | Burnt up. | |
| 7 | Vertical milling machine.... | Cast iron locomotive shoes. | .00674 | ..... | 45 | 222 | 6 | 1.8 | 222 | 15 | 4.4 | 2.6 | 59 | 195 | 75 | 1¼" dia.x3½" face | ... | ... | ... | Alloy | 20 | 6 | Very good. | |
| 8 | 10-h.p. Westinghouse motor... | | .00975 | ..... | 45 | 222 | 6 | 1.8 | 219 | 10.7 | 3.1 | 1.3 | 42 | 82 | 63 | 1⅛" dia.x3½" face | ... | ... | ... | Carbon | 20 | 14½ | Burnt. | |
| 9 | Radial drill..... | Medium hard | .012 | Mean 23-64 | 100 | 230 | 4.5 | 1.4 | 228.6 | 16.6 | 5.6 | 4.2 | 75 | 88 | 21 | 1 7-16" dia. | ... | ... | ... | Alloy | 6 | 1.50 sec. | Very good. | Limit of machine. |
| 10 | 3-h.p. Vertical Westinghouse motor..... | Medium iron blocks, 5" dia. | .007 | Mean 23-64 | 64 | 230 | 4.5 | 1.2 | 228.3 | 8.5 | 2.6 | 1.4 | 54 | 61 | 36.4 | 1 7-16" dia. | ... | ... | ... | Carbon | 6 | 2.55 sec. | Burnt. | |
| 11 | Radial drill..... | deep hole bushing. | .012 | Mean 23-64 | 100 | 230 | 4.5 | 1.4 | 222.9 | 16.1 | 4.7 | 3.3 | 70 | 88 | 26.7 | 1 7-16" dia. | ... | ... | ... | Alloy | 6 | 6 | Very good. | Limit of machine. |
| 12 | 3-h.p. Vertical Westinghouse motor..... | Soft steel cutter blanks, 4" deep hole. | .007 | Mean 23-64 | 64 | 230 | 4 | 1.2 | 227 | 10.9 | 3.3 | 2.1 | 63 | 51 | 24.3 | 1 7-16" dia. | ... | ... | ... | Carbon | 2 | 14½ | Burnt ½" | |

*Planer Tests.*—Alloy steel necessitated 20.9 horse-power removing 780 lbs. of metal per hr., as against 15.9 horse-power with carbon steel and only 288 lbs. metal removed per hour.

*Wheel Lathe Tests.*—Alloy steel necessitated 6.4 horse-power with 96 lbs. metal removed, as against 2.3 horse-power with carbon steel and 15 lbs. metal removed.

*Lathe Tests (Cylinder Bushing).*—Alloy steel necessitated 11.6 horse-power and 180 lbs. of metal removed, as against 10 horse-power with carbon steel and 54 lbs. metal removed.

*Milling Machine Tests (Locomotive Shoe).*—Alloy steel necessitated 4.4 horse-power and 195 lbs. metal removed, as against 3.1 horse power with carbon steel and 82 lbs. metal removed.

*Radial Drill Tests (Cast Iron Blocks).*—Alloy steel necessitated 5.6 horse-power and 88 lbs. metal removed, as against 2.6 horse-power with carbon steel and 51 lbs. metal removed.

Improved, or alloy, tool steel has increased the output of railroad shop machines from 25 per cent. to 100 per cent., and in certain cases as much as 200 per cent., and while, with increased output, the horse-power required to turn out work has increased, this increase of horse-power absorbed is not in proportion to the increase in output. The use of alloy steel, where machines have been driven by motors already worked up to capacity, will necessitate 25 per cent. to 50 per cent. larger motors, as has been evidenced by our own experience.

The strength and capacity of our present machines are almost universally overtaxed, for the reason that they were not designed for the new conditions. Our experience has shown conclusively the necessity for heavier and more substantial design of all machines; steel pinions instead of cast iron; longer bearings for shafts and increased diameter. Furthermore, it clearly demonstrates the economy of scrapping old-style machinery.

Our best record on locomotive driving wheels is a 56-in. pair in 1 hr. and 27 mins. Steel-tired car wheels formerly required from 5 hours up to turn and true to size; the present minimum time in our shops is 55 minutes, the average being about two hours. While these reductions in time are largely due to the alloy steel, improved shop methods and system have also entered largely into the economies mentioned.

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TECHNICAL SCHOOL GRADUATES.

*(From a paper by R. D. Smith.)*

The majority of the problems which confront the civil engineer in his work on the railroad are engineering problems. Most of the problems which confront the mechanical officer are not straight engineering, but are rather combined engineering and business. On this account, while the technically educated man may be familiar with the principles of the construction of locomotives and cars, yet there are a great many things which require something more than an engineering knowledge in order to handle them successfully. This led to the introduction of what is called the special apprentice.

The object of the special apprentice course is to make the man a specialist in railroad work. The indications are, however, that we have not gone far enough. His instruction has covered the whole mechanical field and at the end of his apprenticeship we have not the specialist we desire. Have we not been trying to do too much when we try to familiarize the man with half a dozen or

more trades, the operation of car and locomotive shops and of engines on the road in four years' time? Better results would be obtained by not trying to do so much, but doing what was done more thoroughly, so that at the end of the four years the man would be a specialist. This could be done by offering different courses, each covering a separate field. These courses should be arranged to cover the following work:

(1) Car building and repairs: The four years' work could be divided as follows: Six months in the freight car shop on truck and body work; six months in the passenger car shop; four months in the paint shop; four months in the wood mill; four months in the car blacksmith shop; six months in the car machine shop; four months in the yard; four months in the drawing room; four months in the test room and the last six months at large. (2) Locomotive building and repairs: The four years' work could be divided as follows: Ten months in the machine shop; six months on the floor; nine months in the boiler shop; nine months in the blacksmith shop; four months in the drawing room; four months in the test room, and the last six months at large. (3) Locomotive operation: The four years' work could be divided as follows: Three months in the roundhouse as helper; two months in truck gang; one year as fireman; three months as boiler washer; six months with boilermaker; eight months with machinist; four months in drawing-room; four months in test room, and six months at large. The last six months of each course could be devoted to such work as the master mechanic saw fit.

The special apprentice system is, at best, a poor one. The technical graduate is put in the shop and is given the best of opportunities to learn. He is given a great deal more attention than the ordinary apprentice. He is favored, and what is worse he expects it. On this account in a great many cases we turn out men who would have been a great deal better off if they had been given to understand that their advancement depended entirely on their own exertions. We favor them and turn out a hothouse plant which, when finally transplanted, cannot stand the cold blast of competition. At the same time that the special apprentice is being favored, the general effect on the shop is not good. When the other men in the shop see the technical graduate rushed ahead they are not liable to be nearly so energetic as when they see that all men are being treated alike. The more you take away from a man his prospect for promotion, the less valuable he becomes. If every man in the service feels that his chance for promotion is as good as that of any one else you will have an organization which will do business and be free from discord.

In the February number of the *American Engineer and Railroad Journal* is a description of a plan by means of which the London & South-Western Railway hopes to obtain technically educated men from among its apprentices.

But the railroads are feeling the need of technical men, and the question is how to get them and keep them. If it is possible to hire these men without offering them any special inducement or making any promises I believe it would be the best way. This can frequently be done where a man is wanted for special work. He should be paid what he is worth, the same as any other man. By doing this the apprentices and journeymen's ambitions are not stifled, and at the same time the technical man is put on his mettle, because any advancement which he receives will be due solely to his own efforts.

### BEST PRACTICE FOR PAINTING LOCOMOTIVES AND TENDERS.

*(Submitted by the Master Car and Locomotive Painters' Association.)*

A dipping tank containing a solution of caustic soda, or potash, heated by a system of steam pipes, is of value in removing paint and grease from dismantled parts, such as drivers, dome castings, dome covers, front ends, steam chest casings and covers, number plates, grab irons, etc. The tank should be sufficiently large to hold the detached parts and admit of submersion. It should be placed underground conveniently near a hoisting crane. Where shops are provided for painting of tanks, stationary scaffolds are a convenience. All shops should be equipped with mixing benches and facilities for the proper care of tools and materials, and wherever the force warrants a stockroom with a custodian in charge is economical.

As passenger locomotives run with passenger cars, they should be finished in all respects equal to the cars. Freight locomotives should be painted mainly for durability. Castings and woodwork, on which a good surface is desired, should be made as smooth as possible before the application of paint. Locomotives should not be painted in roundhouses. For painting new parts the following is good practice:

First day, sand-blast and apply the priming coat of paint; second day, drying; third day, second coat; fourth day, putty and fill rough places with knifing surfacer; fifth day, first coat of rough stuff; sixth day, second coat of rough stuff; seventh day, guide coat and rub; eighth day, two coats of color; ninth day, stripe and letter; tenth day, varnish with finishing varnish; eleventh day, drying; twelfth day, varnish with finishing varnish.

For repainting locomotives undergoing repairs the following schedule is good: First day, prepare and apply priming coat where necessary; second day, putty and knifing surfacer; third day, color; fourth day, stripe and letter; fifth day, finishing varnish; sixth day, finishing varnish. On account of the difference in the condition of the paint and varnish on locomotives when they are returned to the shops for repairs, much should be left to the judgment of the foreman painter as to what operations can be added or omitted in order to expedite the work without detriment to its durability and appearance. The following labor-saving appliances and facilities are recommended: The sand blast; the material-saving paint sprayer; the potash vat; the stationary scaffold; suitable mixing benches; paint stockroom (where conditions warrant it).

The report is signed by A. P. Dane, Chairman; B. E. Miller, J. D. Wright, W. O. Quest, E. T. Congdon.

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### TON-MILE CREDIT FOR SWITCH ENGINES.

It is a comparatively simple matter to determine with reasonable accuracy the ton-mileage made by locomotives in freight and passenger service, but it is practically impossible to do this for engines in switching service. For this reason roads which base the statistics of their locomotives in road service on the ton-mile have not done this for their switch engines. It would, of course, be a simple matter to credit an arbitrary ton-mileage, in the same way that an arbitrary credit of miles per hour is now made, but this would have no advantage over the arbitrary credit of mileage, except that the statistics for all classes of locomotives would be on the same basis.

The best basis for railroad operating statistics is that which most closely measures the work done. The almost universal basis for switch engines is a credit of six miles an hour. It would require but little investigation to demonstrate that this credit does not even approximate the work done, and is far from ideal.

In the proceedings of the American Railway Master Mechanics' Association for June, 1903, is a report of a committee on ton-mile statistics, which gives the results of a series of tests made for the *Railroad Gazette* by Mr. George L. Fowler, a member of the committee, to determine the average mileage of switch engines. The tests were made on nine engines, five in freight service and four in passenger service; the average mileages for the different engines check reasonably close and there is no reason to doubt they are practically correct. The results show less than three miles an hour, the mileage of the engines in passenger service averaging somewhat higher than those in freight service. In the same report is given the result of a similar test made by Mr. E. T. White, Superintendent of Motive Power of the Baltimore & Ohio, a few years previously, which shows an average of 3.75 miles an hour. It, therefore, seems evident that our present arbitrary credit of six miles an hour for switch engines is far from representing the facts in the case, and, therefore, can not be even an approximate measure of the work done.

Even though the present credit of six miles an hour should be changed to three miles an hour, so as to more closely agree with the determined facts in the case, the result would be that an engine having a 10-in. x 20-in. cylinder would be credited with having done the same amount of work as one having cylinders 20 in. x 26 in., which evidently is not reasonable. It is also evident that, so long as the present credit of six miles an hour is given to all switch engines, or so long as the same credit is given all switch engines, regardless of their power or the work done, the resulting statistics will show that the larger the engine and the more work it does, the more expensive is fuel, oil and repairs, and the only practical advantage to be derived from keeping such statistics will be in comparing switch engines of the same weight and power. It is altogether likely that frequently an injustice is done a master mechanic responsible for the records of heavy switch engines when his records are compared with those of another man having a larger proportion of light engines in switching service, as it is evident that, provided each group of engines is in service the same number of hours, which is likely, the credit of work done, expressed in miles per hour, will be the same for all engines, though the larger engines may do twice the amount of work the smaller engines do and require twice the amount of fuel, oil and repairs.

If the actual number of ton-miles per hour could be accurately or even approximately determined, it is evident the unfairness and injustice of the present credit would be remedied, but so far no one has been able to develop a practical method of doing this. However, a unit has been proposed which, while by no means all that could be desired, we believe will result in a credit fairly approximating the facts and proportional to the work done, because proportional to the power of the engines. We refer to a credit of ton-hours, which is found by multiplying the weight of the engine, expressed in tons, by the number of hours it is in service.

The maximum tractive power of an engine in road service is seldom used, except in starting its train or on long grades, conditions prevailing but a comparatively small part of the time the engine is working. In

switching service, however, the maximum tractive power, or very near it, is used most of the time. In calculating this maximum tractive power only the boiler pressure, the diameter and stroke of the cylinders and the diameter of the drivers are used. These factors, properly used, give the maximum power the engine is capable of developing, but it is the weight on the drivers which limits the amount of this power which is available for useful work. It, therefore, seems evident that, with switch engines, the weight on the drivers furnishes a simple and reasonably accurate unit for measuring their capacity for work. If this weight on the drivers, expressed in tons, is multiplied by the number of hours the engine is in service, it furnishes a credit of work done, expressed in ton-hours, which closely approximates the actual facts.

On almost all switch engines the weight on the drivers is the total weight, so that, with very few exceptions, if the total weight of the switch engines in working order, excluding the weight of the tender, is used in all cases, the per cent. of error would be small. Because of the insignificance of the error and because a number of roads are using the total weight of their engines as a basis for judging the efficiency of their shops making general repairs, we see no good reason why the total weight of the switch engines, exclusive of the tender, should not be used in determining their credit of ton-hours.

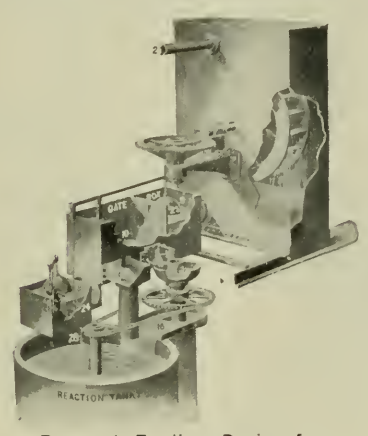
The ton-hour as a basis of statistics for switch engines has a number of advantages over the present credit of six miles an hour. The ton-hour is not arbitrary, but has a logical and reasonable basis; it is as easily figured as the mileage and will require the keeping of no records not now kept; it is a reasonably accurate measure of the work done and gives a basis from which to determine costs, which is proportional to the work done by the engines, because it takes into consideration both their power and the length of time they are at work.

The report is signed by C. H. Quereau, Chairman; G. R. Henderson, G. L. Fowler.

## Re-agent Feeding Device for Water Softeners.

The accompanying illustration shows an automatic device used by the Industrial Water Company for regulating the feed of lime water and soda ash used in the water-softening process. The operation of the device is as follows: The rain water from the pump or gravity supply enters through pipe "2" and passes over the water wheel contained in the casing and then flows through a short connection to the float compartment 9 of the gate box. From here it flows through the high, narrow gate 26 to the distributing compartment 10, whence it flows in two streams through the gates, 11 and 17. The gate 11 is adjustable as to width, so that any desired percentage of the total amount of raw water may be made to flow through it, and then, by way of the chute, the bowl 12, and the pipe shaft 5, to the bottom of the lime tank. The lime water so produced flows through the chute 16 to the reaction tank and there mingles with the remainder of the raw water, which, having passed through the gate 17, goes directly to the reaction tank. The height of water in the distributing compartment 10 will vary as more or less water enters the machine, but the construction of the gates 11 and 17 is such that each will conduct its own fixed percentage of the total water flowing, regardless of the height of water in the compartment 10, and therefore regardless of the rate the water enters the machine. Thus, the percentage of raw water converted into lime water for subsequent mixture in the reaction tank with the remaining raw water, is fixed.

The method of feeding the soda is as follows: The soda ash solution flows from a vat through pipe 21 to the regulating box 22, the level of the solution in this box being maintained at a constant height by means of a balanced float valve. From the regulating box the solution flows, through the gate 23 in the side of this box, to the chamber 27, and thence, by way of the pipe 28, to the reaction tank. The gate 23 is, in effect, a miniature of the gate 26. It is covered by a sliding plate 24 connected by a rod and lever to the float 25 in the float compartment of the gate box. When water is not entering the machine this float 25 is at its lowest position and the top of the slide 24 is raised to its highest point (i. e., to the level of the soda solution in the box 22), thus closing the gate 23 and shutting off the flow of soda solution. When water enters the machine the float 25 rises and correspondingly depresses the slide 24 in such a manner that, when the water is flowing through the lower half only, of the gate 26, the slide 24 will be depressed half way, thus opening gate 23 half way of its height for the outflow of




Re-agent Feeding Device for Water Softeners.

soda solution. Similarly, when sufficient water is entering the machine to submerge (and, therefore, to utilize) three-quarters, or any other fraction of the gate 26, just three-quarters, or the same other fraction of the gate 23 will be uncovered for discharge of soda solution, the height of this solution in the box 22 remaining constant. The amount of soda solution fed to the water is strictly proportional to the quantity of water flowing and accuracy in the soda treatment is attained. The gate 23 is of adjustable width.

It is claimed that these two devices make it possible to treat raw water with absolute certainty and uniformity under all conditions of rate of flow. The rate of inflow of the raw water is automatically controlled by the demand for softened water, so that the machine is wholly automatic.

## Chromic Myopia.

Dr. Mortimer Frank, of Chicago, has made some tests of the vision of that class of color-blind persons whose infirmity he calls chromic myopia; persons who can distinguish colors at a short distance, but not far off; and he gave some account of the tests in a paper read before the International Association of Railway Surgeons and the American Academy of Railway Surgeons at their recent joint meeting in Chicago. Incidentally, he noted the marked difference between signal glasses colored all the way through and flashed glasses. Of the glasses examined, he found red ones which transmitted some yellow and green rays, and greens which allowed red rays to pass through. Persons defective in color sense were confused by these glasses.

The tests were made to ascertain the relative transparency of a number of red and green glasses; to find the liability to mistake one color for another, and the distances at which the glasses could be seen. Of all the glasses tried, those made by John C. Baird, of Boston, proved the best, but that does not spoil the story. We need not give this portion of the report, as our readers are already acquainted with the merits of Mr. Baird's glasses.

In making the tests to determine how far a light of a given color could be seen, the observer moved back from the light until it was just on the point of vanishing in the darkness, and then measured the distance. Moving still further away until the light vanished, the observer now walked forward until the light was again visible, and the distance was measured. By repeating this several times, the relative vanishing distance was determined with accuracy. For the purpose of observation, regulation signal lanterns were used and stopped with a diaphragm having an aperture of ⅜ in., this corresponding to a distance of 20 ft. under a visual angle of five minutes. This size of opening was chosen so as to obtain a light feeble enough to disappear within the limits available for the purpose. In order to approach conditions of the railroad service, the tests were made at night and out of doors.

In the record below, A represents the examination of a person whose chromatic sense was good, when tested by Holmgren worsteds, but who was unable to recognize differences between colors at 20 ft. B represents the test of Dr. Frank himself.

VANISHING DISTANCES—RAILROAD COMPANY'S SIGNAL GLASS.

| | | |
|---|---|---|
| A. | Green | 20 ft. |
| A. | Red | 70 ft. |
| A. | White | 30 ft. |
| B. | Green | 45 ft. |
| B. | Red | 80 ft. |

NELS SIGNAL GLASSES.

| | | |
|---|---|---|
| A. | Green | 45 ft. |
| A. | Red | 95 ft. |
| B. | Green | More than 500 ft. |
| B. | Red | More than 500 ft. |
| A. | Nels yellow signal glass | More than 500 ft. |

No exact values can be given for the vanishing distances of the Nels glasses under "B," and for the Nels yellow under "A." This is due to the fact that only a distance of 500 ft. was available and the lights still identified themselves at that distance. The actual vanishing values will be reported later, when the experiments have been carried out on a long tangent.

To test the relative transparency of the corresponding colored lights, lanterns were placed side by side with results as follows:

| | | |
|---|---|---|
| A. | Railroad company's green signal glass disappeared as a light at | 80 ft. |
| | Nels green signal glass still visible as a light. | |
| A. | Railroad company's red disappeared as a light at | 75 ft. |
| A. | Nels red still visible as a light. | |
| B. | Railroad company's green disappeared as a light at | 80 ft. |
| B. | Nels green still visible as green. | |
| B. | Railroad company's red disappeared as a light at | 80 ft. |
| B. | Nels red signal glass still visible as red. | |

Photometric measurements of the relative

transparency of the glasses were made with a Bunsen photometer. Some colors affect the photometric readings more than others, but the results are nevertheless worth noting:

| | Per Cent. |
|---|---|
| Light transmitted by Nels yellow | 35.00 |
| Light transmitted by Nels green | 3.90 |
| Light transmitted by Nels red | 10.00 |
| Light transmitted by R. R. company's green | 1.5 |
| Light transmitted by R. R. company's red | 5.1 |

In conclusion, Dr. Frank called attention to the risk involved in trusting men who have chromic myopia to read signals in high-speed train-working. Even in the case of moderate speeds the shortening of the view of a green or a red signal, for instance, would, in the case of dense fog or snow, greatly impair the ability of such a person to regulate the speed of the train, as compared with the ability of the same person in clear weather.

## Forms for Concrete Work.

BY G. R. WADSWORTH.*

Now that concrete has come to be so extensively used for abutments, piers and retaining walls, the manner of finishing the exposed faces has passed through the experimental stages, until most excellent results, both in durability and appearance of the finished surface, are obtained. Since good practice does not sanction the application of a plaster finish after the concrete has finally set, the uniformity of texture and the accuracy of surface of the finished face must be obtained either by depending largely on the nicety of the forms, or by floating the surface of the masonry before the final set takes place.

Forms may be made, with great care, of selected lumber planed and sandpapered, with nails set and holes puttied. Bubble holes will generally appear in the finished face to a greater or less extent, depending on the amount of working the facing mortar received when applied to the forms. These are, of course, minor defects; a Portland cement wash brushed over the surface will eradicate most of them, and the result will be very satisfactory. Forms built as above are, however, expensive, both in labor and material, and less care is usually given to their erection, with the result that the demarcations of the boards, knots and often the grain of the lumber is apparent in the finished surface. At all events, forms of this type cannot be used a second time, on work where finish is an important feature, as the boards are split and dented when they are removed. In order to reduce the cost of forms per unit of masonry, at a greater first cost, if necessary, a panel type naturally suggested itself as being easy to erect and take down.

This panel type was first designed and erected under the direction of Mr. Hugh Latimer, Asst. Engineer on the New York Central Lines, and as first used in illustrated in Fig. 1. This section was designed only with the idea of repeated use of the panels, and not with the idea of removing the lower ones and floating the surface before final set. These panels were used 16 times before becoming unfit for further use.

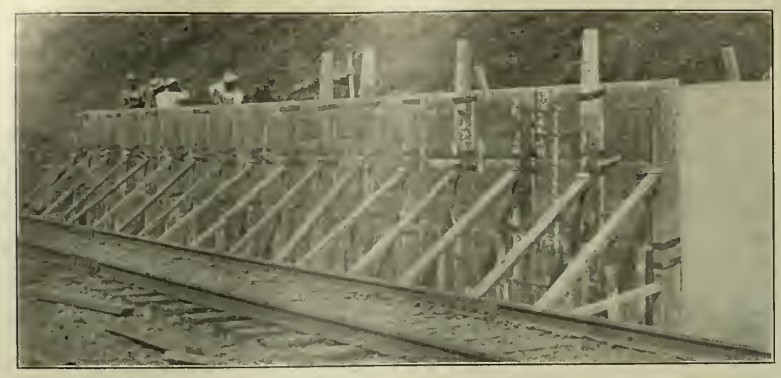


Fig. 1—Panel Forms, First Design—N. Y. C. & H. R. R. R.

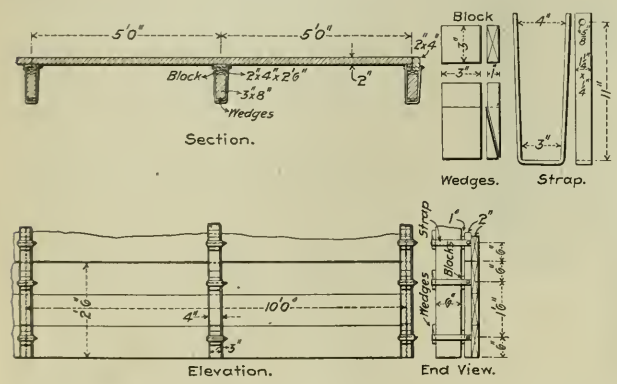



Fig. 2—Details Standard Panel Forms—N. Y. C. & H. R. R. R.†

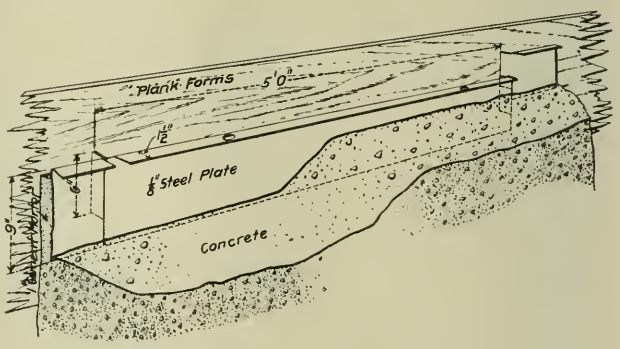



Fig. 4—Shield for Placing Facing Mortar.

Fig. 2 illustrates the details of this panel design as finally adopted. This type has been used with eminently satisfactory results on retaining walls and abutments of considerable length, although it is less practicable for small pieces of masonry. The strap, wedge and block permit the lower panels to be drawn out endways as soon as the concrete has set sufficiently, and the surface is thus exposed and may be floated.

Fig. 3 shows a section of the retaining wall of the east approach to the Hudson River Freight Bridge of the New York Central at Albany. The panels that have just been drawn appear piled up at the base of the finished section, and the last panel of the row is being withdrawn. Concrete is being placed for the upper courses of the section, the lower portion has been finished, and the middle portion is being floated. The photograph illustrates the various operations very well. The concrete wall is built in 50-ft. sections, with vertical expansion joints between. The 10-ft. length of panels lends itself readily to

Fig. 3—Standard Panel Forms in Use—N. Y. C. & H. R. R. R.

*Assistant Terminal Engineer, New York Central

†Uprights should in all cases be securely braced from the rear, and no wires should be used. Forms should be erected in 50-ft. sections of five panels each, care being taken to get uprights set to proper batter, and panels level. Only the lower panels for a 50-ft. section to be placed first, the second being fastened in position when the concrete has been placed nearly to the top of the first panel. After the concrete has become partially set, so that the mortar face has reached the consistency of rubber, the first panels should be removed by drawing the wedges, removing the one-inch blocks, and drawing the panels out endways. The section of the face thus exposed should then be finished at once with water and wood float (no cement wash to be applied) until it is of a uniform texture, and all ridges and other imperfections of surface have been removed.

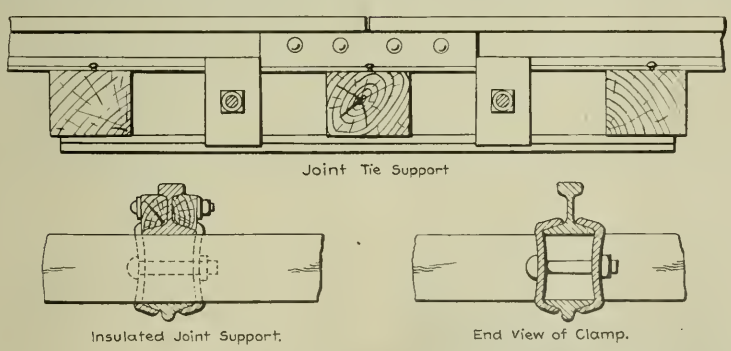
this procedure in sections of 50 ft., as six lengths will allow of 5 ft. lap on the preceding section and have room at the other end for the head forms for the section.

Fig. 4 illustrates a type of shield used with good results in connection with the movable forms, to insure a minimum thickness of facing mortar placed simultaneously with the backing. These shields are of sheet metal and are placed on the foundation course before beginning to place the concrete for the body of the wall. The mortar is placed between the shield and the wooden form, and after the 6-in. layer of backing concrete is placed, the shields are raised successively for each layer, and the backing concrete rammed so as to force it slightly into the facing mortar. The usual practice of placing the mortar against the forms with a trowel requires a much greater average thickness in order to insure a specified minimum thickness.

### The Dickey Rail-Joint Support.

The rail-joint support shown in the engravings was devised by Mr. G. W. Dickey, Chicago. It consists of a length of standard T-bar placed below the ties immediately under and parallel to the track rails, and secured to the latter by clamps, as shown. The T-bar, which weighs 10 lbs. to the foot, is shallow, and its flange width is approximately equal to the width of the rail base. For tie joints the bar is 4½ ft. long, and for suspended joints 5½ ft. The clamps weigh 5 lbs. each, and are tied together by 1-in. bolts 8 in. long. The same principle is applied to supporting crossings, a suitable length of T-rail being clamped under the discontinuous track rail. The inventor estimates that the life of a support will be seven years in rock ballast. In cinder ballast it would, of course, be less. The cost per joint is $1.50.

One of these supports was applied last summer to a joint in the Lake Shore road in the city of Chicago, which had been giving considerable trouble. It was thoroughly tamped up at the time, and though it has had no attention since, the joint is still up to a good surface, while adjacent joints have required looking after several times. The Chicago Terminal Transfer and the Santa Fe have each placed trial orders for the supports. Mr. Dickey's Chicago address is 6006 Lafayette avenue.




Elevation and Sections Dickey Rail-Joint.

The first year of the Swiss State railroads turned out very well, considering all the circumstances. There was a balance of only about $200,000 left; but the expenses include a sinking fund to retire the cost of purchase within 60 years, and the addition to employes' wages was about $700,000, and for maintenance and renewal of road and rolling stock $520,000. The working expenses were 65.53 per cent. of the gross earnings in 1903, against 61.11 in 1902. A further considerable increase in wages and a reduction of freight rates are to be made, which cause apprehensions for the immediate future.

### A Metal Railroad Tie.

A patent on a metal railroad tie has been granted to Mr. S. B. Hoover, of Roca, Neb. Two illustrations of the tie are shown, giving a good idea of its form and appearance. Several objects were sought in designing the tie, important among which were (1) to secure a simple and durable construction adapted to fasten the rails firmly in position and prevent them from becoming accidentally displaced or moved out of alinement; (2) to provide a tie which will be held firmly in place without the need of embedding it on the roadbed, and (3) to provide a tie which will remain fixed in the position in which it is placed without having to provide some securing means therefor.

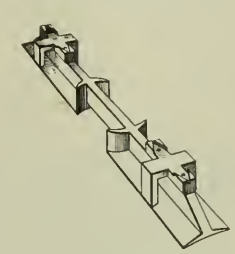


*Fig. 1.*

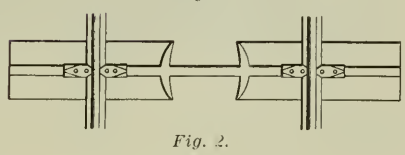


*Fig. 2.*

Hoover Metal Railroad Tie.

The tie, which is cast in one piece, consists of two similar end portions connected by a longitudinal rib or bar. This bar extends the length of the tie and is integral with a base having its lower face concaved, the object of which is to bring the edges firmly in contact with the roadbed and prevent lateral movement of the tie. To prevent longitudinal movement, laterally projecting wings at the inner end of each end portion are formed on each side of the central rib, their inner faces being concaved. The rail base rests on a table supported at the ends by standards extending upward from the edges of the base. Arms extend each way from the table along the top of the central rib, and the outer corners of these arms have angular lugs, which form a V-shaped recess on each arm. As will be seen from the plan view, Fig. 2, the rail is held by plates, which are steel and which fit into these V-shaped recesses, each plate being held by tap bolts, or other suitable means. The inner end of each plate fits over the rail base and abuts the web.

The inventor claims that it will be impossible with this tie for the track to get out of gage except by injury to the holding plates, in which case the latter may be reversed in position, both ends being formed to fit the V-shaped recess. Also that any chance to center-bind is avoided by the omission of the base at the center. Furthermore, that these ties will require only one-half the ballast that is needed with wooden ties because of the wings at the inner ends of the end portions, there being no need of ballast outside of these; and that being self-tamping and self-draining the track can be kept in better shape with less work than with wooden ties. The estimated weight of the tie is 156 lbs.

### The Argentine Railroads in 1900-1901.*

The Argentine railroads are making more favorable progress than formerly, and of late the railroad system has been extended, especially with a view to increasing railroad traffic with neighboring countries, and with Chile and Bolivia in particular.

In Argentina, as in our country, the railroads are the precursors of means of transportation. English capital soon recognized this fact and developed the railroad system. The government, too, assisted the movement by putting railroad materials on the free list and by guaranteeing interest as well as by subsidizing the railroads with land, both agricultural and mining. The government also subscribed to the capital fund. The first great railroad system built with the assistance of the government was the Central Argentine Railroad running from Buenos Ayres to Cordoba in the center of the country. This road received a guarantee of interest and also a substantial land grant and exemption from taxes, all with a view to attracting foreign capital to railroad building. In the case of railroads built later the government did not find it necessary to be as liberal in its subsidies, but still contributes largely to the cost of new lines.

The relation of the government to the railroads has been much influenced by the precedent of Germany, although government ownership in Argentina is practically out of the question, as it would entail an expenditure of about $650,000,000. Equally impracticable would be a policy similar to the Belgian method of paralleling the private railroads with government lines. The government in Argentina has followed the opposite course and has sold off some of its own railroads, but has striven to secure a fair degree of uniformity and harmony among the private lines. Conditions similar to those existing in the United States are apparent. Competition among the railroads and their growing monopoly has led to many difficulties, and legislation has been aimed at controlling this monopoly. Now railroads are chartered for a limited period of time, and are subject to government purchase at an appraised value. Moreover, the sale or lease of railroads is now subject to government approval. The government exerts itself to secure just treatment of the public and harmonious action among the various railroads. The separate local jurisdictions of the several provinces have created much confusion and have seriously stood in the way of developing through

*Abbreviated from the "Archiv für Eisenbahnwesen," May and June, 1904.

traffic. The government has done much to influence the rate policy with a view to encouraging traffic between the various provinces.

In general, the government has had little direct influence in fixing rates on the railroads. Nominally, it can interfere in the case of rates that enable the railroads to net more than a certain percentage on their capital. By decree of November, 1899, the existing "exceptional" rates are subject to the approval of the government. The matter of freight classification also comes within government jurisdiction, and some progress has been made in preventing discrimination.

The great difficulties to be contended with are the lack of uniformity in railroad equipment, the difficulty of securing through rates and the publishing of a uniform tariff schedule, besides which complaints are frequently heard of a lack of rolling stock and of warehouse and other terminal facilities. In the past few years there has been a strong movement toward railroad consolidation; for instance, the Santa Fe & Cordoba Southern Railroad was consolidated with the Rosario Railroad in 1900, and the West Santa Fe Railroad with the Central Argentine Railroad. This consolidation of railroads has strengthened the position of the private railroads against the government. The government railroads, as compared with the private railroads, have been far from financially successful. They have not been well managed and in some cases have been sold to private corporations. Much is expected as the result of opening a government railroad to Bolivia. The traffic in india rubber and various ores offers great inducement to a through route with that country. The engineering difficulties are serious. The government, however, hopes to build a profitable railroad northward into Bolivia and to compete successfully with the other routes to the seaports. In 1894, Bolivia and the Argentine came to an agreement about building this international railroad, the Argentine government furnishing the capital. Work was begun in 1896, but in 1902 the construction of the railroad was put in the hands of a private corporation.

The international railroad between the Argentine and Chile, across the Andes, is not quite completed. Both financial and strategic reasons have delayed its completion. The Argentine section is practically finished. It is a narrow gage road, and it is therefore of different gage from the railroads of the two countries it connects. Thirty-six miles of line are yet to be built. During the summer months, traffic by mule connects the two links of the complete railroad system. The eventual railroad is to cross the Andes by a tunnel nearly 16,000 feet above the sea level. The Chilian act of February, 1903, opens the way to the completion of the link. The government guarantees 5 per cent. on the capital of $7,500,000 for twenty years. The completion of this international railroad will not seriously affect the water transportation from the Atlantic to the Pacific, though it will shorten the distance from Europe to Chile by 6 or 8 days. Freight rates will necessarily be high, and freight will have to be transshipped at several points. Passenger traffic will be somewhat affected by the existence of this shorter route. Even in 1902 this land route was used by 5,000 people as against 1,000 persons who passed from the Atlantic to the Pacific ports in question by the Straits of Magellan.

## Rectangular Engine Houses at St. Louis.

Several references have already been made in these columns to the rectangular engine houses of the Terminal Railroad Association of St. Louis. There are three houses of 12 stalls each, served by four transfer tables, two in each pit. A view of one of these table sets, and of parts of two of the houses, is shown in the engraving herewith. The houses are brick, with gable roofs of low pitch, and have steel rolling doors.

The tables are 75 ft. long and of 175 tons capacity. They travel 125 f.p.m. loaded and 300 f.p.m. light. As they are used both night and day, an incandescent light, backed by a reflector, is placed at each end close to one side to enable the operator to line the track without trouble at night. Also, on top of the cab is a signal light which normally shows red, and inside is a tell-tale of the same color. When the table has been placed for a waiting locomotive the operator notifies the man in charge by changing the signal to green. The tables were furnished by Geo. P. Nichols & Bro., Chicago.

Rectangular Engine Houses with Transfer Tables.
Terminal Railroad Association of St. Louis.

## New Steamer A. W. Wolvin.

The new steamer A. W. Wolvin, shown in the accompanying photograph, is the largest vessel ever built on the Great Lakes, and is of especial interest because it is the first cargo carrier designed especially to meet the conditions of the new automatic ore unloaders which have been installed at Lake Erie ports for the purpose of transferring the bulk material wholly by mechanical means from the ships to the cars which convey it to the blast furnaces in the so-called Pittsburg district in Ohio and Pennsylvania.

The A. W. Wolvin—Largest Vessel on the Great Lakes.

In order to facilitate the operation of the "clam-shell" buckets of the automatic unloaders and enable them to scoop up the ore without the assistance of any hand shovelers the hold of the Wolvin is built in the form of a hopper with sides that slope from the main deck down to the tank top and the ends built on the same slope. This hopper extends in one continuous length of 409 ft. without bulkheads or divisions of any kind and is 43 ft. wide at the top and 24 ft. at the bottom. Several of the automatic unloaders may be operated simultaneously inasmuch as the deck of the Wolvin is pierced by 33 cargo hatchways, each measuring 33x9 ft. in the clear and spaced 12 ft. apart. These hatchways are fitted with a system of steel plate sliding hatch covers operated by steam engines.

The Wolvin is 560 ft. long over all, 540 ft. keel, 66 ft. molded beam at the widest part and 32 ft. deep amidships. Her length is just double that of the Cambria, the first steel vessel built on the Great Lakes, which went into commission in 1887. The main engine of the new vessel is of the quadruple four-cranked type, with cylinders 18½, 28½, 43½ and 66 in. in diameter and 42 in. stroke, designed for an indicated horse-power of 2,000 when making 80 r.p.m. Steam is generated in two Babcock & Wilcox boilers working at a pressure of 250 lbs. per sq. in. The vessel cost $480,000, has 500,000 cu. ft. of cargo space and will be capable of carrying 12,500 tons of coal or 401,000 bu. of grain on a draught of 18½ ft. The coal bunkers have a capacity of 360 tons and the vessel is fitted with electric lighting plants in duplicate, so as to be prepared for any emergency which would incapacitate one plant.

## THE TEHUANTEPEC ROUTE.

In another column Mr. E. L. Corthell, whose work on the Isthmus is well known, writes of the practical fulfillment of the project for a traffic route across the Isthmus of Tehuantepec, which for nearly four centuries has been the dream of those desiring access from the Atlantic Ocean to the Pacific and from the Pacific to the Atlantic short of Panama or the Straits of Magellan. Like all the trans-Isthmian projects—in number legion—this present Tehuantepec railroad, now so nearly completed, has been beset with many difficulties. The Vera Cruz & Pacific road, which occasioned a Baltimore banking institution so much trouble last fall, connects with this same Tehuantepec railroad, but was born too soon to gain thereby as an independent project, and now becomes part of the government through route from the north. As Mr. Corthell says in his paper, it is not to be expected that the Vera Cruz & Pacific will share very heavily in the trans-Isthmian traffic, because of the greater length of the Vera Cruz route, as compared with the straight route across from Salina Cruz to Coatzacoalcos; but, viewed purely as a Mexican and not as an interoceanic road, it would seem likely that it might pick up its share of a very pretty traffic to and from the City of Mexico. The suggestion which Mr. Corthell throws in, that this government majority ownership of the merger route from the United States border to Salina Cruz forms a long link in the proposed intercontinental system from New York to Buenos Aires does not strike us as important, for reasons which need not be entered into at this time except to point out in the briefest possible way that such a railroad, if ever the unsteady governments involved could get together and build it, would have to compete for through traffic with a deep-water route of about the same length. But it seems reasonable to expect that this new railroad unification in Mexico in connection with the trans-Isthmian route may develop a very important traffic indeed for points not quite so far distant as Buenos Aires.

As Mr. Corthell points out, the Tehuantepec project has not been confined in the minds of its advocates to an ordinary freight and passenger railroad. The canal idea has been much investigated and much urged. Mr. Corthell makes reference to the explorations and surveys made under the directions of the United States Navy Department by Captain R. W. Shufeldt, and published in 1872. Captain Shufeldt was impressed at that time by the fact that the Gulf of Mexico could be held against any foreign power and he pointed out that the channels between Cuba and Florida and Cuba and Yucatan on the south, being in the aggregate not more than 200 miles wide, could always be effectively closed by the navy, holding Key West and Tortugas as the base of operations. The chief engineer of that expedition, the late Mr. E. A. Fuertes, well remembered by readers of the *Railroad Gazette*, rejected the previously advocated canal plan of Señor Moro for feeding the summit level of a ship canal by means of the junction of the rivers Chicapa and Ostuta, as being impracticable, not only because a joint delivery of these two streams would have been insufficient, but because it would have been quite impracticable to effect the junction. Mr. Fuertes recommended the River Corte, or upper Coatzacoalcos, as a feeder, and proposed a canal 144 miles long with 140 locks. This canal was to be 22 ft. deep, 60 ft. wide at the bottom and 162 ft. wide at the top, but it would have required a 27-mile aqueduct feeder, which would have had to run under mountains, with three miles of aggregate tunneling and some heavy cutting. The true mean elevation of Tarifa, the lowest and most available pass in the mountains traversing the Isthmus from east to west, was 72 ft. higher than the river counted on to furnish the water, as measured in the dry season. The proposed dam to raise the elevation 72 ft. was only a small part of the difficulties which this route involved, and, after all had been done, the Fuertes survey only provided for a 22-ft. minimum depth in the canal, while the depth of the Suez Canal, which, in spite of its enlargement is too small to admit of the practicable passage of our large present day steamers, is 31.2 ft.

The interoceanic route described in Mr. Corthell's present paper involves trans-shipment of goods from steamer to wharf and from wharf to steamer, a serious obstacle. And yet, the writer points out how quickly this may be done with improved appliances, and he balances off the time of a Panama passage with the time of a Tehuantepec trans-shipment much to the advantage of the Tehuantepec route. We are disposed to consider this trans-shipment as a difficulty considerably more serious than it appears to Mr. Corthell, but it should in any event be possible and feasible to transfer passengers and valuable goods in this manner, so that the approaching completion of the present Tehuantepec railroad is an event of real and of great importance.

## THE ECONOMIC LIMITS OF LEGISLATIVE AUTHORITY.

The most potent legislative body cannot exercise effectively every power with which it may nominally be endowed. The monarch who attempted to order the tides was no more impotent to force them to obey his will than the Parliament which sought by statute to prevent the workmen of England from obtaining the enhanced wages that were the natural consequence of the scarcity of labor caused by the ravages of the black death. Beside the inexorable law of supply and demand the fiat of the most august legislative assembly is a vain and useless expenditure of effort. But that which cannot be accomplished by direct means can sometimes be brought about by indirect measures. If the markets of the United States were open to foreign producers, no statute could enforce a price of $30 per ton for steel rails at a time when similar rails sold in Canada for $20 per ton, or in England for $15 per ton, but by fixing a tax on imported rails of $20 per ton the high domestic price might, we do not say it would, be maintained. No statute could effectively fix the wages of common labor at $3 per day, but arbitrary restriction of the labor market might, temporarily at least, make it impossible to conduct enterprises which could not afford to pay that rate.

We are moved to these reflections upon the plain teaching of the economic history of the world by a sentence contained in an article contributed to the *North American Review* for June by Hon. Charles A. Prouty, a member of the Interstate Commerce Commission. Mr. Prouty declares that "the only way to regulate railroad rates is to regulate them," by which he evidently means that the Commission of which he is a conspicuous member ought to have rate-making authority. Such a declaration clearly arrays its author with those who, in spite of the lessons of experience, believe that legislation is all-powerful and who would fall back upon the law-making power for relief from every ill of industrial life. It is all the more surprising coming from a member of the body which for seventeen years has struggled with varying degrees of ineffectiveness, to secure the observance of rates named by the carriers themselves, for it would seem that the plainest teaching of that experience ought to be the fact that railroad transportation will, in the end, sell for the price (or rate) which those who desire it and can afford to pay for it are willing to pay. How can it be imagined that rates made by statute of Congress or by a Commission entrusted with a part of the Congressional authority over interstate commerce can be enforced if all of the agencies of the Commission and of the Federal Department of Justice have for nearly two decades proved powerless to compel the railroads to sell transportation at the rates named in schedules promulgated by their own officers? The Interstate Commerce law requires that every participant in interstate railroad transportation shall publish schedules showing all its charges and shall file copies of every schedule and every charge in such schedules with the Commission. Deviations from the rates named in these schedules are misdemeanors always punishable by fine, and during most of the seventeen years they have also been punishable by imprisonment. Yet every annual report issued by the Commission has its story of wholesale departures from the legal rates. One after another, in annual succession, the Commission has devised and recommended new safeguards against such violations of law. Some of the amendments suggested have been adopted and at least one of them has been repealed as well in accordance with a later suggestion from the Commission. But rate-cutting has not stopped, although during the recent period of heavy traffic it was greatly reduced. The law in regard to evidence was amended so as to remove the opportunity to avoid testifying in regard to rate-cutting on the ground that it might be self-incriminating, and the courts have been invoked, as in the Brimson and Brown cases, but there has been no complete disappearance of the practice. Even injunctions and the Elkins law have been avoided by means of allowing excessive divisions to industrial railroads and special allowances to the owners of private cars. What can all this mean, unless it is that rates which lack the eco-

nomic sanction, that is, those which fail accurately to express the actual relation between the supply of railroad transportation and the demand for it are unstable and are sure to be discarded in favor of those which meet the requirements of the situation? Yet Mr. Prouty thinks that the Commission can prescribe rates for the two hundred thousand miles of railroad and the billions of dollars of annual traffic of the United States. The railroads employ hundreds of traffic experts, men whose lives have been devoted to the study of industrial needs and often those of restricted sections or particular classes of traffic. These experts have formulated schedules of rates, and the whole power of Congress, supplemented by the wishes and commands of railroad owners, has failed to secure the observance of the rates named in these schedules. Is it reasonable to assert that where these experts have failed invariably to discover the stable rate, a body of five lawyers, however distinguished and able, can succeed? Yet that is precisely the conclusion to which Mr. Prouty's article leads. He overlooks or wilfully rejects the proposal to secure reasonable stability by removing the incentive to rate-cutting, that is, by permitting agreements to maintain rates and to divide tonnage or earnings, and chooses the direct, arbitrary and universally ineffective method. He proposes legislation on an exact par with that against which Adam Smith directed the strongest portion of "The Wealth of Nations," the successive failures of which are so skilfully recorded by Thorold Rogers.

## RAILROAD SHOP TOOLS.

The design of machine tools is being revolutionized by the perfection of high-speed steels. Cutting feeds and speeds have been greatly increased, with the result that most tools designed even five years ago have developed serious defects and weaknesses. Machine tool builders, at first, attempted to meet the demand for more powerful machines, by merely increasing the weight of the parts without altering the design, but this expedient has in most cases failed. The result is that the modern machine tool has been entirely redesigned with due regard for the magnitude and character of the stresses which it will be called upon to withstand. For example: in the case of many heavy driving wheel lathes the face plate is driven directly by a gear meshing with teeth on the face plate instead of being driven through the spindle. This design does away with the torsional strains in the spindle which produce chattering and which increase the liability of failure. Boring mills, lathes, planers, etc., have also undergone many radical changes in design. In giving to our readers a series of articles describing modern machine tools for railroad shops, we hope to perform a useful service. Only such tools as represent the best modern practice are being described, and the selections are by experts on the subject. The art is, of course, in a state of transition, but when the entire series has been completed it will embrace the important tools used in the several departments of railroad shops. The subject is one that is of great importance to those interested in the efficiency of railroad shops, but the machine tool is not the only element in shop organization that requires attention. Good organization is an important factor, and it is about as unreasonable to equip a shop with powerful high speed rapid reduction lathes, if they are not worked to their capacity, as it is to buy a powerful high speed locomotive if the condition of the permanent way is such that speeds higher than 30 miles an hour are impossible. Good organization and good tools are both desirable and necessary if the highest possible efficiency is to be obtained.

A full extract is given elsewhere in this issue of Mr. von Schrenk's Bulletin on the use of screw spikes and dowels. From the standpoint of common American conditions, the obvious criticism to be made is that a tie must be creosoted or otherwise preserved before the economy to be effected can be expected to balance the additional first cost. Where untreated ties are used, the limit of service is generally occasioned by decay elsewhere than around the spike hole. The decay in white oak ties, starting in the heart of the wood, spreads out radially, eventually loosening the hold of the spike, and the use of dowels might be expected to increase their service somewhat. But the scarcity of white oak leads to the restriction of its use to points of special strain, such as on curves, and it is not thought desirable to prolong the use of a tie in such a position after decay has spread to any extent. Yellow pine ties, in much more common service, decay from the bottom up, and the spike holes, after they have been plugged and the spikes redriven through the plug, commonly hold well until it becomes necessary to replace the tie on account of trouble elsewhere. Therefore wherever untreated ties are used, their eight or nine years of service would probably not be much extended or bettered by the use either of screw spikes or of dowels. With treated ties, the conditions are quite different. The difficulty in all preservation processes is, at reasonable cost, to make the creosote or other preservative penetrate deeply into the wood. Generally speaking, the spike hole is a channel through the protective armament to that part of the tie which has received the least treatment, and moisture finds its way in, causing decay around the spike. The dowel, well saturated with creosote throughout its entire length, effectively checks this, and is itself protected by its absence of fibre ends, since the grain of dowel runs parallel to the direction of the spike. Where treated ties are used, it seems well worth while to imitate foreign practice in this method of protecting the exposed part from decay. Although this comment refers particularly to the use of dowels, much the same argument applies to screw spikes. So long as the edges of the spike hole are firm around the driven spike, it does its work satisfactorily, and the additional cost of screw spikes and of their application seems hardly justifiable. Therefore, when ties are used that decay from the bottom up, before the tie is rejected on account of deterioration of its spike-holding qualities, the chief value of the screw spike lies in the fact that it may lessen the work of caring for a stretch of track which has been heaved by frost. When it becomes necessary to place shims under a rail, a turn or so with the key would raise the head of the spike without tending to break its hold, and it could afterwards be tightened again in a similar manner. But the special value of the screw spike, like that of the dowel, would seem to be its use in preserved timber, where the wood around the spike hole is the weakest part.

The rear collision at Midvale, N. J., last Sunday, killing 16 passengers, makes two passenger train horrors of the first magnitude in this month, and so lengthens the list for the last 12 months as to discourage the notion that the law of averages would soon ease up. The railroad traffic of this country is now so enormous and increases so steadily that unless our methods are improved our fatalities are sure to increase. The officers of the Erie, at this writing, seem not to have decided whether to believe the signalman or the engineman as to which made the fatal error in this case. That such cases sometimes remain forever undecided, is familiar to all who read the English blue books on accidents, and to railroad superintendents from their own experience. Reflections on this case must therefore be postponed until the inquiry is finished. In the meantime it is well to bear in mind that the interesting question whether automatic block signals are safer than the simple "telegraph block system" is by no means settled by a single case of this kind, or even by repeated cases. The track circuit, now a vital feature of all our automatic signals, has undoubtedly many times performed its function, preventing collisions, when a human guardian would have failed. Whether the failures of the track circuit, plus the errors which enginemen have made with automatics, but would not have made if watched by signalmen, have equaled or exceeded the errors of signalmen under a similar volume of traffic no one knows. But we do know that manual signaling has made a fine record in England, and that our manual signaling cannot fairly be condemned on principle unless it can be shown to be inferior to the practice in England. And, if inferior, what is the reason? The Erie has consistently stuck to the manual system while all of its important neighbors have adopted automatics. The first question, therefore, in the present case, is not one of systems but, rather, whether the system used was managed in the best possible way.

### The Detroit Southern Receivership.

The appointment of a receiver for the Detroit Southern, announced in these columns last week, could scarcely have come as a surprise to those who have followed the history of the road. The Detroit Southern was chartered in May, 1901, as successor to the Ohio Southern and the Detroit & Lima Northern railroads, forming a line from a point not far southwest of Detroit, running through Lima and Springfield, Ohio, to Wellston. A little property known as the Iron Railway, affording an entrance into Ironton, was also bought, but financial difficulties have prevented this link being coupled on to the others. Lacking a Detroit terminal on the north and a connection through to Ironton on the south, the Detroit Southern was compelled to pay heavily for trackage, and was in the unfortunate position of a line with neither head nor tail, in a country served by many com-

peting railroads which did not labor under this disadvantage. Of the two links forming the main portion of the route as reorganized in 1901, the Detroit & Lima Northern, opened from Lima to Adrian, Mich., in 1896, was in chronic difficulties, and went into the hands of a receiver on a contractor's suit in 1898. The Ohio Southern, organized in 1881 as successor to the Springfield Southern, was also an unfortunate property, recording a deficit in 1895, 1896, 1897 and in 1898, in which year it was sold under foreclosure of the first mortgage. The consolidation of these two defaulting properties, with insufficient funds under the reorganization to put the new line in order and give it an entrance into Detroit and a through line to Ironton, did not start auspiciously, and the first annual report issued by the Detroit Southern for the year ending June 30, 1902, complained of things which were certainly to have been looked for under the circumstances; shortage of motive power and other equipment, and bad condition of such equipment as the company owned, for the reason that neither of the component companies had been able to spend the requisite amount on maintenance or renewals. The per diem rule also fell upon the company most inopportunely, with the result that all its bad order equipment was brought back and left on its doorstep, and, besides these discouragements, the first year of the reorganization saw a dry season, when the streams on which the company was compelled to depend for water supply for its engines were very low, and the quality of the water so extremely bad as to be ruinous to boilers. Another difficulty apparently not anticipated, was that during the receivership of the Detroit & Lima Northern the scale of wages paid the employees was only 65 per cent. of that paid on the Ohio Southern and by other roads in the same territory, so, after the consolidation, this unfortunate discrepancy had to be done away with at considerable cost to the new company.

The 1902 year passed with a deficit from the year's operations of $73,205, but in 1903 hope was renewed by quite an increase in the gross earnings, so that the 1902 deficit as carried forward was reduced somewhat by a small surplus from current operations, and on the first of November, 1903, gross earnings were $100,000 ahead of the year previous at the same time. But during that month the road's troubles began again. The locomotives were again seriously hurt by bad water, causing a loss of over $100,000 in net earnings, and by the time these conditions had been overcome the severe winter weather set in. Besides this, the bituminous coal business of the Jackson district, normally furnishing over 50 per cent. of the total tonnage, was extremely unsatisfactory. In consequence of these things, taken together with general depression, the company was unable to meet the interest on the 50-year, first-mortgage, 4 per cent. bonds, due June 1, and Samuel Hunt, President of the road, has been appointed receiver.

This receivership, involving some 500 miles of line, is the most important of any which has occurred for several years. The only other noteworthy receiverships created this year have been that of the Tennessee Central, 308 miles, which was only in existence a short time before a satisfactory arrangement was made for resuming operation on the former basis; the Atlantic & North Carolina, 95 miles, which is now being operated by the State of North Carolina, its principal owner, pending court action in the fall; the Quebec Southern, 139 miles, and the Brunswick & Birmingham, 109 miles. The other four roads for which receivers have been appointed since the first of January are small and unimportant properties, aggregating only 103 miles. In view of the quite prevalent depression of the last few months, this record is an extremely good one, comparing with 13,730 miles of line worked by the 58 roads which were sold under foreclosure in 1896, and the 12,831 miles worked by 52 roads sold under foreclosure in 1895. It shows, what was already known and commented on, that the roads of the country in general are in far better shape to withstand a dull period than they have been at previous times of depression. The Detroit Southern receivership comes less as the result of an operating failure than as an unsuccessful attempt to redeem a previous failure.

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The advance sheets of the report of the Interstate Commerce Commission for the year ending June 30, 1903, give the total single-track railroad mileage in the United States on that date as 207,977 miles, an increase of 5,505 miles over the report for the year ending June 30, 1902. This is the largest increase reported by the Interstate Commerce Commission since 1890. The operated mileage for the year was 205,313 miles, which includes 5,902 miles of line on which trackage rights were exercised. The total length of railroad mileage, including second, third and fourth track and sidings, was 283,822 miles. This total shows an increase of 9,626 miles in the aggregate length of all tracks operated. The number of railroad corporations included in the report was 2,078. Of this number 1,036 maintained operating accounts. 805 were classed as independent operating roads and 231 as subsidiary roads. The number of locomotives in service on June 30, 1903, was 43,871, an increase of 2,646. These locomotives were classified as follows: Passenger, 10,507; freight, 25,444, and switching, 7,058. The total number of cars in service was 1,753,389, an increase of 113,204 over 1902. This rolling stock was classified as follows: Passenger, 38,140 cars; freight, 1,653,782 cars, and the remainder, 61,467 cars. These latter were employed directly by the railroads in their own service. Of the total number of locomotives and cars in the service of the railroads (which was 1,797,260), 1,462,259 were equipped with train brakes and 1,770,558 were equipped with automatic couplers. The number of employees on the payrolls of the railroads in the United States on June 30, 1903, was 1,312,537, or 639 per 100 miles of line. These figures, when compared with the corresponding ones for 1902, show an increase of 123,222 in the number of employees, or 45 per 100 miles of line. The par value of the amount of railroad capital outstanding on June 30, 1903, was $12,599,990,258, or a capitalization of $63,186 per mile. Of this amount, $6,155,559,032 was stock and the remaining portion of $6,444,431,226 consisted of mortgage bonds, income bonds, car trust certificates and miscellaneous obligations. Of the total capital stock outstanding, 44 per cent. paid no dividends. For the year ending June 30, however, the amount of dividends paid by the railroads in the United States was $96,728,176. The number of passengers carried during the year was 694,891,535, an increase of 45,013,030, as compared with the year ending June 30, 1902. The number of tons of freight carried was 1,304,394,323, which was an increase over the tonnage of the previous year of 104,078,536 tons. The ratio of operating expenses to earnings was 66.16 per cent., as compared with 64.66 per cent. in the previous year. Gross earnings for the year were $1,900,846,907, or an increase of $174,466,640 over 1902. Operating expenses were $1,257,538,852, or $141,290,105 more than in 1902. Net earnings amounted to $643,308,055, being an increase of $33,176,535 over 1902. The total number of casualties to persons on the railroads for the year ending June 30, 1903, was 86,393, of which 9,840 represented the number of persons killed and 76,553 the number injured. The statistics show that one passenger was killed for every 1,957,441 carried, and that one was injured for every 84,424 carried. In respect to the number of miles traveled, however, the figures show that 58,917,645 passenger miles were traveled for each passenger killed, and 2,541,096 passenger miles for each passenger injured.

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Most of those who took part in the discussion of the advisability of using screw reverse mechanism for large modern locomotives, at the last Master Mechanics' convention did not believe that the screw mechanism was practicable. Quick reverse being a vital consideration, it was held that the screw reverse mechanism could not be made to meet the requirements. The two principal advantages of the screw mechanism are, first, the possibility of obtaining any rate of expansion, and, second, the ease with which the valve mechanism can be moved. The principal objection to its use is that the engine cannot be reversed quickly. Its use would probably cause confusion in case of emergency, because American enginemen have been trained to use the lever reverse mechanism. For switching service, screw mechanism would never be favorably considered. Furthermore, all freight locomotives have considerable switching to do on the road, and even passenger engines are frequently pressed into such service. Although power brakes enable quick stops to be made without using the reverse lever, certain kinds of flying switches, "spotting" the engines at coal and water stations and on turntables, etc., require work with the reverse lever. With a screw mechanism many of these operations would be difficult, while, at best, considerable loss of time would occur. The best solution of this problem, especially since valve mechanisms have become more and more unwieldy, would be some power device for moving the lever quickly and positively. A good many devices of this sort have been designed, but none have been generally used because of inherent defects, so that the hand operation of the reverse lever has remained the preferred method. The device on the Mallet compound built for the Baltimore & Ohio, and described in these columns May 27, 1904, is simple in design and positive and effective in action. An air, or steam, cylinder, placed tandem of an oil cylinder, is used, the oil serving to govern and retard the motion. This principle is not new, but the present application is such as to give very satisfactory results. A complete reversal from the front to the back corner of the quadrant can be made quickly and without exertion on the part of the engineman. The reverse lever is a good indicator to the engineman of the condition of the valves of the locomotive. By unlatching the lever he can tell if the valves are sticking.

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## TRADE CATALOGUES.

*The Baldwin Locomotive Works* has issued an illustrated pamphlet descriptive of their exhibit at the St. Louis Exposition. A brief history of the works is given, which includes such information as the number of men employed, the horse-power required to operate the works, the consumption of coal in tons per week, and the total area of floor space in acres, etc. An interesting account is also given of the first locomotive made

by the company. This locomotive was built in 1832 for the Philadelphia, Germantown and Norristown Railroad. The company up to the present time has built 24,000 locomotives. An illustration and description of the locomotive completing each 1,000 is given. The twenty-four-thousandth locomotive was built in March, 1904, for the Atchison, Topeka & Santa Fe. This is a four-cylinder balanced compound of the Atlantic type and is part of the exhibit at St. Louis. Following these descriptions are a number of illustrations and dimensions of typical locomotives. The remainder of the pamphlet is devoted to the Baldwin-Westinghouse electric locomotives and to electric motor trucks.

*The Link Belt Engineering Co.*, Philadelphia, has just issued their 1904 edition of the Renold silent chain booklet. A detailed description and illustrations of the recently patented bushed type of chain is given. It is claimed that this type of chain is practically non-elongating. The book is illustrated with views which show some of the applications of the Renold chain which are in actual service throughout the United States. The last few pages are devoted to a number of questions which will help the customer in ordering this type of chain. The same company issues a booklet on "Retail Coal Pockets," in which is given some comparative costs of the pocket system and other methods of storing coal. The book is illustrated with photographs of plants which are in operation, and also contains a number of detailed line drawings in which the operation of these plants are clearly shown. In the back of the book is given a partial list of retail coal pockets equipped with the company's machinery.

*The Chicago & North Western* has published an attractive and useful pamphlet on "The Lakes and Summer Resorts of the Northwest." It is intended as a tourist's guide to the summer resorts and hunting and fishing grounds reached by the North Western. It contains a fine lot of half-tone views and three large detail maps. There is also, in the back, a list of hotels and boarding houses at all of the resorts and fishing and hunting grounds, giving rates, capacity, distance from station, etc. The printing and engraving and the general get-up of the volume are excellent.

*The Philip Carey Manufacturing Co.*, Lockland, Cincinnati, Ohio, issues a catalogue descriptive of Carey's magnesia coverings. The book is illustrated throughout with views of buildings and power plants in which this company's covering is used. The first few pages are devoted to a brief but interesting description of magnesia and asbestos. The following pages set forth the economic and other advantages of its use.

*Charles Engelhard*, 41 Cortlandt street, N. Y., issues a booklet descriptive of the Le Chateliers pyrometer. This instrument is used for measuring temperatures in ovens, cupolas, boilers, etc. It will register temperatures from 0 to 2,920 degrees Fahrenheit. A detailed description and drawings are given. The book also contains tables of the melting and boiling points of various substances, and other useful data.

*The Magnolia Metal Co.*, New York, has issued an illustrated handbook of useful information for those who use that metal. A number of tests of magnolia metal, as well as other anti-friction metals, are given. A few illustrations showing the proper method of applying this metal to the various types of bearings are also shown.

*Ingersoll-Sergeant Drill Company* (Pneumatic Tool Department) has published a pamphlet containing a full description and illustrations of the Haeseler "axial valve" hammers. Reference is made in the pamphlet to the scope of a recent decision of the Supreme Court bearing on the patented features of pneumatic hammer handles.

*The Goldschmidt Thermit Company* has issued an illustrated pamphlet which describes the application and use of Thermit in foundry practice. The compounds include Titan-Thermit for molten iron, Lunker-Thermit for steel castings, and the Anti-Piping Thermit to prevent piping in steel ingots.

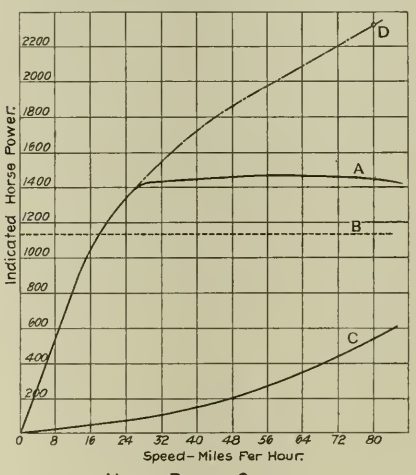
# CONTRIBUTIONS

## Heating Surface and Boiler Power.

Philadelphia, June 28, 1904.

To the Editor of the Railroad Gazette:

The article by Mr. L. B. Jones, on the above subject, published in the issue for June 24, describes a run which is remarkable chiefly because it was made in regular service and represents an almost everyday




Horse Power Curves.

performance. The present writer was on the train, and independent timings taken between stations check up very accurately with the speed curve presented by Mr. Jones.

In considering the performance of this locomotive, it is interesting to compare it with what would ordinarily be expected of an engine of its nominal capacity. In a catalogue issued by the Schenectady Locomotive Works in 1901 are given factors showing the relation between piston speed and mean effective pressure, and from these have been figured the drawbar pull and horse-power and the total tractive effort and indicated horse-power speed of 80 miles per hour. Similar calculations have been made, using the formula of Prof. Goss, which was published in the *Railroad Gazette* of January 17, 1902. The results, together with the figures actually developed in the run under consideration, are given in the following table:

| | Draw bar pull. | Draw bar horse-power. | Total tractive effort. | Indicated horse-power. |
|---|---|---|---|---|
| Schenectady factors... | 3108 | 663 | 6807 | 1453 |
| Prof. Goss's formula.. | 2819 | 602 | 4250 | 1133 |
| Actually developed.... | 6160 | 1322 | 10830 | 2325 |

These figures are interesting chiefly because Prof. Goss's formula is based principally on the heating surface, while the factors given in the Schenectady catalogue refer to mean effective pressure only. To develop 2,325 horse-power at 80 miles per hr. this engine requires a mean effective pressure of about 80 lbs., while the Schenectady factor at that speed allows but 50 lbs. While 80 lbs. may be rather high, it is evident that the steam distribution of class $E_2$ is very fine. The engine is equipped with balanced slide valves driven by the Stephenson link motion. A special feature is the double-link suspension, there being a hanger on each side; a device which has been used with good results on all heavy engines recently built for this road.

Prof. Goss' formula is based on the expression $T = 161 \frac{H}{S}$, where T is the total tractive effect, H the heating surface and S the speed in miles per hour. This equation may be transformed to read:

Indicated horse-power $= \frac{H}{2.33}$, and hence for class E2, I. H. P. $= \frac{2640}{2.33} = 1133$.

This formula is based on the assumption that 2.33 sq. ft. of heating surface are required per horse-power, and if we allow an average of 26 lbs. of water per horse-power the rate of evaporation will be $\frac{26}{2.33} = 11.16$ lbs. per square foot of heating surface per hour. These figures are doubtless correct for average practice, but in the present instance the rate of evaporation was very much greater.

The accompanying diagram shows horse-power curves for the engine under consideration. Curve "A" was plotted from the Schenectady factors, curve "B" from Prof. Goss' formula, while curve "C," which was plotted from the same formula, developed to give the drawbar pull, shows the power required to run the engine and tender alone. The actual power developed (2,325) is plotted at point "D". It is interesting to note, as shown by the dot and dash line, that this point is on the natural continuation of the Schenectady curve before the sharp change in direction occurs at a speed of about 30 miles per hour. The writer has seen records of tests made with locomotives in which the horse-power varied directly as the speed, and it is not unfair to suppose that this engine is capable of producing a similar horse-power curve. In other words, what has been called the "critical speed," or the point where the horse-power begins to decrease with an increase in speed, is not met within the limits of ordinary running; and the boiler is capable of maintaining full pressure at the highest speed.

The development of the Atlantic type locomotive on the Pennsylvania, since the introduction of Class E, in 1899, has been most interesting, and the various classes have been characterized by boilers having ample grate area and provision for free circulation, with a moderate heating surface; also the use of balanced slide valves, plenty of weight on the drivers, and a careful attention to details. The latest example is Class E3a, which is similar to Class E2; the principal difference being the cylinders, which are 22 in. x 26 in., and the weight on drivers, which reaches the very high figure of 118,000 lbs. The heating surface and grate area remain the same as in the earlier engines. Class $E_2a$ is working most of the express traffic on the Pittsburg and Philadelphia Divisions, where severe grades are encountered;

and is practically doing the work of a six-coupled engine. The Pennsylvania has tried six-coupled engines in passenger service, but it is believed that, in some cases, a four-coupled type. Six-coupled locomotives are doing magnificent work on many roads, but it is believed that, in some cases, a four-coupled engine would be preferable and would result in economy. The writer's attention was recently called to a case where a fast train of four cars was being hauled by a "Pacific" type locomotive of the largest class. What percentage of the total power developed was realized at the drawbar, it would be rash to state, but the fireman's description of the engine as a "coal hog" was probably not far from the point.

PAUL T. WARNER.

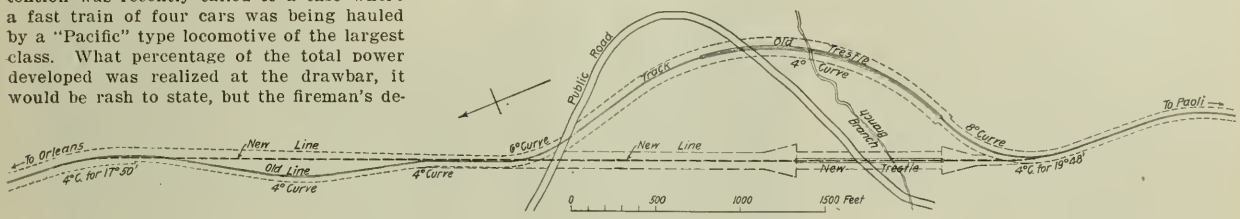
## Paoli Trestle on the Monon.

BY A. E. KEMMER.*

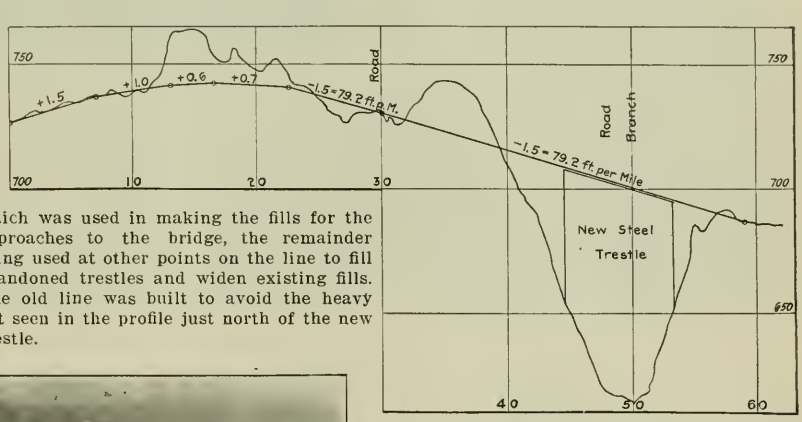
O, Indianapolis & Louisville has ...npleted some heavy improve-...ding over about a mile of track ...leans, West Baden & French Lick ...near Paoli, Ind. The work was begun ...r, 1903, and was finished last June. ...changes made, which are shown in the general plan of the improvement, included the elimination of 190 deg. 20 min. of curvature and 12 ft. of rise and fall and the track was shortened about 180 ft. A pine trestle 1,567 ft. long and 78 ft. high in the center was abandoned and a new steel trestle 870 ft. long and 87 ft. high in the center was built for the new line. About 65,000 cu. yds. of excavation were taken out, a portion of which was used in making the fills for the approaches to the bridge, the remainder being used at other points on the line to fill abandoned trestles and widen existing fills. The old line was built to avoid the heavy cut seen in the profile just north of the new trestle.

The new steel trestle, which spans a wide ravine and a small stream, was the most important feature of the work. The abandoned wooden trestle and the new structure are shown in the illustrations. About 4,300 cu. yds. of first class masonry are included in this work. It consists of two abutments and 36 small piers, four piers being used to support each tower of the trestle. Bedford

*Assistant Engineer C., I. & L. Ry.



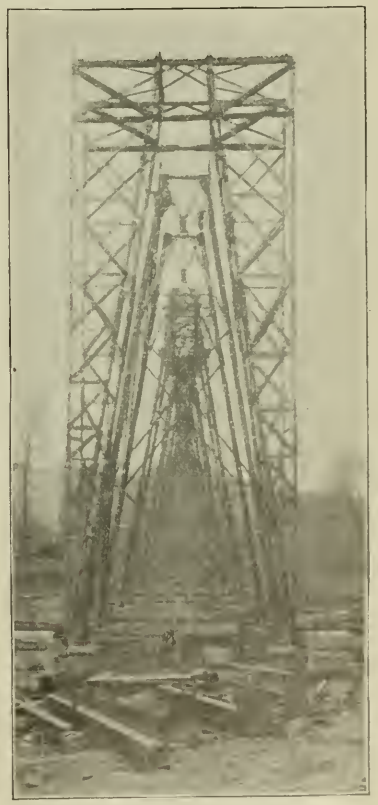

Plan of Monon Improvements near Paoli, Indiana.




Profile of New Line—Monon Improvements.

Abandoned Wooden Trestle on a Curve.

New Steel Trestle Replacing Old Wooden Structure.



Erection View of Paoli Trestle.

oolitic limestone and Lehigh Portland cement were used in the construction of the masonry, which was built upon solid rock foundation, 3 to 12 ft. below the surface. The abutments are each 8 ft. x 20 ft. on top, with parapet wall 7 ft. high, and wing walls at 45 deg. to fit a slope of $1\frac{1}{2}$ to 1. Measuring from top of parapet wall to foundation, the abutments are respectively 57 ft. and 62 ft. high, and 19 ft. and 23 ft. thick at foundation. The piers are each 3 ft. 6 in. square, covered by coping 4 ft. square, and extend from 2 to 7 ft. above the surface of the ground. Two anchor rods, each $1\frac{1}{2}$ in. in diameter, are placed in each pier and extend entirely through the pier into solid rock. These rods are split and wedged at the bottom and grouted with a 1 to 1 sand-cement mixture, and were all placed and rigidly grouted before placing any of the steel superstructure.

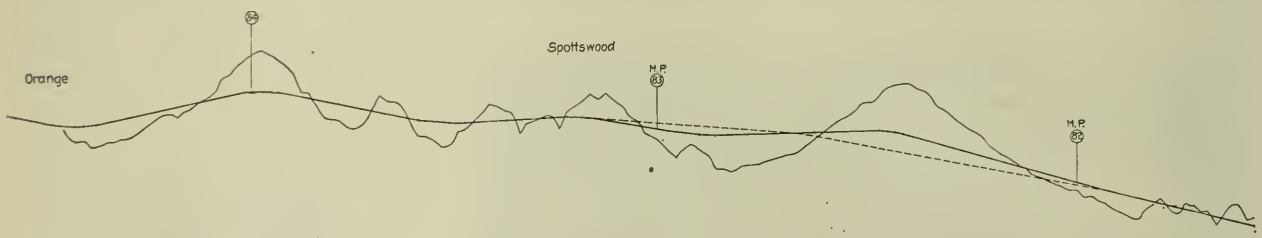
One of the illustrations shows the traveler, 105 ft. high, used in erecting the steel work. The girders are alternately 60 ft. and 30 ft. in length, 7 ft. center to center, and 6 ft. deep. The columns of the towers have a batter of 1 to 6, and rest on heavy cast-iron shoes. The trestle is designed to carry two 159¾-ton engines followed by a live load of 4,500 lbs. per lineal foot, and is made of medium open-hearth steel. The specifications used were those of the American Bridge Company. The trestle is built on a grade of $1\frac{1}{2}$ per cent. and the alinement is tangent. The total weight of the steel and iron work, including castings, is 1,091,000 lbs.

The steel trestle was designed by Mr. Andrews Allen, of the Wisconsin Bridge & Iron Company, which company built and erected the trestle. The design was checked by Mr. Ralph Modjeski, Consulting Engineer, Chicago, who also inspected the work as it was completed in the shops of the bridge company. The masonry was pronounced by those erecting the structure to be the most perfect, from an engineering standpoint, upon which they had ever placed a bridge. The surveys and general plans for the work were made by Mr. W. A. Wallace, Division Engineer of the Monon, assisted by the writer, who also acted as Assistant Engineer in charge of construction.

Rock Cut near Culpeper, Showing Drilling in Progress.

## Second Track Work on the Southern Railway.

The purpose of the second track and revision work now being done by the Southern is to make that road the best freight and passenger route from Washington to the commercial centers of the South, by doing away with the heavier grades and high curves on the present line. The work, which was begun two years ago, consists not only of revision of the present line, but also in building of a second track between Alexandria, eight miles out of Washington, and Orange, 78 miles. This is only part of the final plan, however, as it is the intention of the railroad company to eventually extend the double track to Charlotte, N. C., 300 miles from Orange. This will enable the Southern Railway to successfully cope with the large increase in freight and passenger traffic to all points in the South. An example of how large this increase has been may be obtained from the last three reports of the company, which shows that in 1901 the freight tonnage was 14,121,181 tons, in 1902 16,811,538 tons and in 1903 19,197,484 tons, or an increase of nearly 33 per cent. in three years. Similarly passenger traffic increased 29 per cent. in the same period. This shows quite clearly the possibilities for increased traffic which will be developed when this improvement work is finally finished.



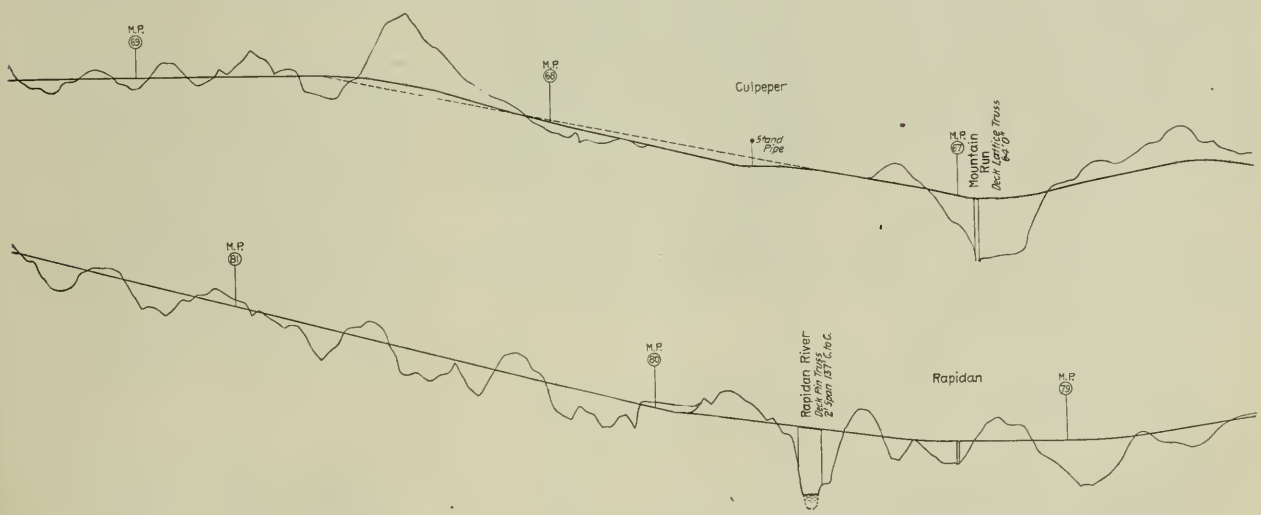

Profile of Southern Railway Second Track Improvement Work at Spottswood, Va.

The section between Alexandria and Manassas, 26 miles, has been in operation for over a year. Between these points the most important work has been done; a large number of curves have been eliminated, and grades have been materially reduced. The second track runs parallel to the present main line on an even grade from Alexandria to Edsalls, seven miles. At this point it strikes an ascending grade of .5 per cent. for about half a mile, until it reaches Springfield. From here an entirely new line has been laid out, running to mile post 18. This revision has necessitated a number of cuts, including one 45 ft. deep. From Sideburn to mile post 20 the new line follows the present line very closely and runs on a grade of about 1 per cent. until it reaches Manassas. From Manassas to Orange the work has consisted of paralleling the present main line, except at Culpeper and Rapidan. The ruling grade southbound on this section is 1 per cent., while the ruling grade

Sixty-Foot Cut at Culpeper, Va.—Southern Railway.

northbound is .8 per cent. There are 18 bridges on the section, the largest ones of which are located as follows: Broad run, a pin truss bridge, 113 ft. long, with two spans; Cedar run, a deck pin truss, 156 ft. long; Rappahannock river, a through pin truss, with three spans, measuring respectively 113 ft., 124 ft. ¾ in. and 152 ft. 4⅞ in. in length; Mountain run, a deck lattice truss bridge, 64 ft. long. At Cannon branch there is a 35-ft. concrete arch and at Kettle run a 55-ft. concrete arch has been built. All the other arches on the line average about 12 ft. The maximum cut on this section is 60 ft. and the maximum fill is also 60 ft. The line from Manassas to Culpeper, 34 miles, did not involve much heavy work, but from Culpeper to Orange a large amount of heavy work was made necessary by the rock formation which was encountered. At Culpeper no attempt was made to parallel the existing main track, as the present cut is of rock. In order to take this out without interrupting traffic, it would have been necessary to quarry the material, which would have been extremely expensive. An offset line was, therefore, adopted, using one track for northbound traffic and the other for southbound traffic. At Rapidan the old line was abandoned for a distance of about four miles owing to the fact that the present line is down grade at this point and on a curve approaching the bridge, making it very dangerous from an operating standpoint. To aid in avoiding this, concrete abutments were put in, raising the new line 10 ft. above the former line. The new bridge over the Rapidan river is of deck pin truss construction, with two spans, each measuring 137 ft. long. The heaviest cuts on this section are at Culpeper and Spottswood, the former necessitating the removal of about 120,000 cu. yds. of earth and the latter about 150,000 cu. yds. In both these cuts several strata of rock were encountered and it was necessary to do a large amount of blasting, as shown in the accompanying photograph. The entire line is now practically completed and will probably be thrown open for traffic in the fall. The general excavating work has been done by W. J. Oliver & Co., Knoxville, Tenn. The new line will enable the Southern to successfully carry the large amount of freight and passenger traffic which daily passes over this line for the South.

We are indebted to W. H. Wells, Engineer of Construction, for the drawings and photographs shown.




Profile of Southern Railway Second Track Improvement Work at Culpeper and Rapidan.

## Pig Iron Feasts and Famines.*

Eight times within the last eighty years the industries of the United States have been subjected to the blighting influences of an iron famine. During these famines, all shapes of iron and steel have undergone an enormous advance in prices. These famines have not resulted from the falling off in the volume of production, but from the rapid increase in consumption, and from the impossibility of supplying the demand. It requires a year to a year and a half to build a furnace for producing iron. The average stock of iron carried in the United States for the last 20 years has been less than three weeks' production. Under these circumstances when the demand for iron has increased largely and quickly, say 100 per cent. within four or five months, it has left an unsatisfied demand—a void, which could not be filled, and in the ensuing struggle among the many consumers to get what little iron was produced over and above what was pledged by contract, these enormous advances have occurred. The late Hon. Abram S. Hewitt had for 40 years predicted these wonderful increases in consumption on the cumulative increase in the per capita consumption, together with the rate of increase in population. In 1855, for instance, the population was about 27,000,000 and we consumed about 100 lbs. per capita; in 1890 it was about 62,000,000 and we consumed about 300 lbs., and in 1902 it was about 81,000,000 and we consumed about 500 lbs. per capita. All of Mr. Hewitt's predictions have been more than verified. In his address to the American Institute of Mining Engineers, in 1890, when the production was about 9,000,000 tons, he said that this country would require at least 14,800,000 gross tons of iron per annum in 1900, and made it perfectly clear that there was no more doubt that this result would be realized than there was that the growth of the country would continue. With such evidences of what was to be expected, it is hard to understand why, in 1895-96-97, producers did not run their furnaces to the utmost capacity, sell as little iron as they could, and pile up as much reserve as possible on which to reap the benefit of the high prices so certain to come. What they actually did was exactly the reverse: In nearly every iron producing district, meetings were called for the purpose of bringing about an agreement to restrict production, with less than 1,000,000 tons of stock on hand, and when the country was on the eve of a return of prosperity which required 37,000,000 tons above the ordinary annual product. The furnaces might have piled up a stock equal to several months' production, and still have realized an enormous advance. In Scotland there was an advance of 75 per cent. in 1889, with a reserve stock in warrant yards equal to a year's production, but it would have prevented the advance of 200 to 300 per cent. which actually occurred, and from which we are now suffering the logical results.

In attempting to explain why a large stock was not accumulated in the United States, in the face of seven such experiences and the oft-repeated warnings that the increase was so sure to recur as the country was sure to continue its growth, I find nothing which seems to hit the nail so squarely on the head as the view of the Scotch ironmaster, which in substance is that Americans are too busy to take long views of business, and as evidence of this he cites the fact that our newspapers (which proverbially give the public what it desires) rarely ever quotes prices and conditions back for more than a month or a year. In discussing the Scotch pig iron warrant system, a Glasgow gentleman said, in effect, that the warrant system has been to us a great educator. Through it we have learned to take broad views of business. We look upon prices and stocks of iron not in the light of a month or a year, but in the light of 10 or 50 years. We argue that what has occurred in the past will be repeated in the future, if the same causes exist in the future. We have learned that every few years there is a sudden and great increase in the demand for iron, with a corresponding increase in its price, and we shape all our business calculations to take advantage of these periodic conditions, with little regard to what the conditions are for the current year. The delusions which result from looking at the iron business in the light of a month or a year are many. For instance, each time that pig iron has experienced several years of low prices in the United States, there has come a general belief that the price of iron would never again reach abnormally high figures. If one attempted to combat this belief, his arguments were swept aside by the declaration that "conditions are different now from what they ever were before," but the high prices

*Extract from a paper read by Geo. H. Hull at the Atlantic City Convention of the American Society for Testing Materials, June, 1904.

have never failed to come again, notwithstanding, and always from the same cause. Many conditions are always "different" in a growing country, but the working of the law of supply and demand has never changed, and never will.

Then again, we have in this country utterly false views of what constitutes large and small stocks. With us, 1,000,000 tons of pig iron is regarded as a large stock; 100,000 tons is regarded as a small stock. Neither of these views is necessarily correct. Large and small are relative terms. They have no significance except in connection with the things and conditions to which they relate. To speak of one owning a large diamond and living in a small house, does not necessarily imply that the diamond is larger than the house. A million is comparatively a large number of tons, and a hundred thousand is comparatively a small number, but it is not the number of tons on hand which determines that the stock is large or small. One case of prints might be a large stock for a cross-road store, while one thousand cases might be a small stock for a New York jobbing house. Whether a stock is large or small depends upon whether it is more than sufficient, or less than sufficient, to supply the demand which is to be made upon it. If the amount of iron on hand, added to the amount which can be produced in a given time, is not sufficient to meet the demand during that time, then the stock is small; it matters not how large the number of tons may be. If the commodity being considered is one the production of which can be increased quickly enough to supply any sudden large demand, then a small quantity may be ample stock; but if it is an article the consumption of which may increase 100 per cent. within four or five months, and the production cannot be increased in like proportion under 12 to 13 months, then nothing short of several months' production would be ample stock.

Among all the causes which tend to prevent an accumulation of a reasonable reserve stock of iron in the United States, probably the most powerful one is the strike and accident clause, which in the last fifteen or twenty years has gradually crept into nearly all contracts for iron and steel. It reads something like this: "Shipments and deliveries subject to strikes, accidents, deficient transportation and all other causes unavoidable or beyond our control." Under this clause an iron producer may make contracts for everything he expects to produce a year ahead, and yet not be obliged to carry a single ton of reserve stock. Whereas, without this clause, if he sold ahead, he would be obliged to keep on hand enough stock to insure keeping up his deliveries during any unforeseen interruption in the operation of his works. One powerful influence which results in the large accumulation of large reserve stock of pig iron in Scotland is to be found in the positive and binding nature of all iron contracts made in that country. If anyone fails to deliver, no matter from what cause, he must suffer the loss incurred; hence, no one makes contracts without carrying a reserve stock. Ask anyone who sells to foreign countries for future delivery, if he is permitted to employ the strike or accident clause in his contracts with foreign buyers. You will find that none of them are. If, for instance, an American exporter sells a million bushels of wheat for shipment to a foreign port a few months ahead, he immediately protects himself against any advance in prices by making a contract on Exchange for wheat certificates covering a like amount. When he gathers up the grade of wheat needed to fill his contract, he simultaneously sells his Exchange contract. If a cotton spinner makes a contract with an exporter for a thousand cases of cotton goods deliverable ahead, he protects himself against advance in cotton by buying cotton contracts on Exchange. Before he makes his goods, he picks up the particular grade of cotton he needs, and simultaneously sells his cotton exchange certificates. Thus, in the United States, in nearly every business in the great staples, except iron and steel, people make positive contracts and protect themselves against advances by Exchange contracts.

In Scotland, when anyone makes a contract for work which requires a large amount of iron and steel, he immediately protects himself against the advance in price of those materials by making a contract with an iron dealer for an equal quantity of iron by warrant; as he needs the iron and steel, he buys them in the open market, and simultaneously sells an equal quantity of his iron warrants.

Strange as it may seem at first glance, the prudent business men, who deprecate speculation in business are the backbone of exchange dealings in commodities, and it is because of this aversion to speculation that they are so. Anyone, for instance, who takes a contract, deliverable over a long period, involving the use of a large amount of iron and steel, has entered into the most dangerous kind of a speculation, but if he protects himse'f by immediately making an exchange contract for a like amount of iron by warrant, he eliminates this speculative feature, and thereby insures his legitimate business profit, no matter how scarce iron may become or how much it may fluctuate in price during the fulfilment of his contract.

The whole tendency of the warrant system in Scotland is to accumulate reserve stocks of iron, and lessen its extreme fluctuations in price. The tendency of our American custom is just the reverse.

Recently, the Hon. Edward Atkinson has predicted that the consumption of iron in the United States will reach 40,000,000 tons per annum between 1910 and 1913. This prediction, like those of Mr. Hewitt's, is not a fanciful outburst of imagination; it is simply the result of a mathematical calculation based upon the exact growth of the past, and its fulfilment is as assured as is the future growth and expansion of the country. If in 1910 the stock on hand is one million tons the production 18 millions, and the demand 40 millions, then the supply will be 21 millions short of the demand the first year of the boom, and no human power can prevent another iron famine.

## Copper Tubes for Locomotive Boilers.*

The fire-box stays of the locomotive-boilers on the London & North Western are copper; the inner casing of the fire-box and the tubes generally are also of that metal, which is found to be more economical than steel, in durability and evaporative power. Soon after the general introduction of copper boiler-tubes it was observed that certain tubes had a much longer life than others; in fact, the life of tubes by the same maker often varied considerably. Chemical analyses of both good and bad tubes were made

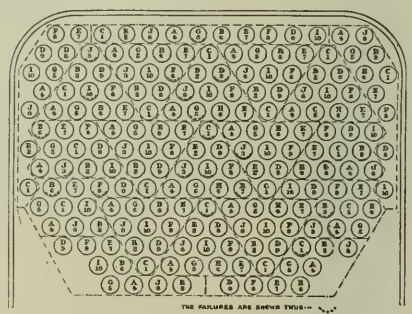


Fig. 1—Method of Grouping Tubes for Testing—London & North-Western.

from time to time, and it was generally found that the most durable tubes contained some hardening element, such as arsenic or nickel; and also that the life of a tube depended upon how it had been worked. The tubes usually fail through being worn thin by the corrosive action of the furnace-gases and the abrasion of the cinders, the pressure inside the boiler then causing them to collapse at the corroded part. Others fail by breaking immediately behind the fire-box tube-plate, a result which is often due to brittleness.

In order to ascertain the composition of the copper tubing most suitable for use in locomotive-boilers, a set of tubes (198) by ten different makers (20 by each of eight makers and 19 by each of two makers) was put into the boiler of engine No. 1,213, "The Queen," a four-wheel coupled passenger engine. Each make of tube was so placed in the tube-plate as to get the same amount of abrasion by cinders and corrosion by furnace-gases; this was insured by arranging them in 20 groups, each group containing

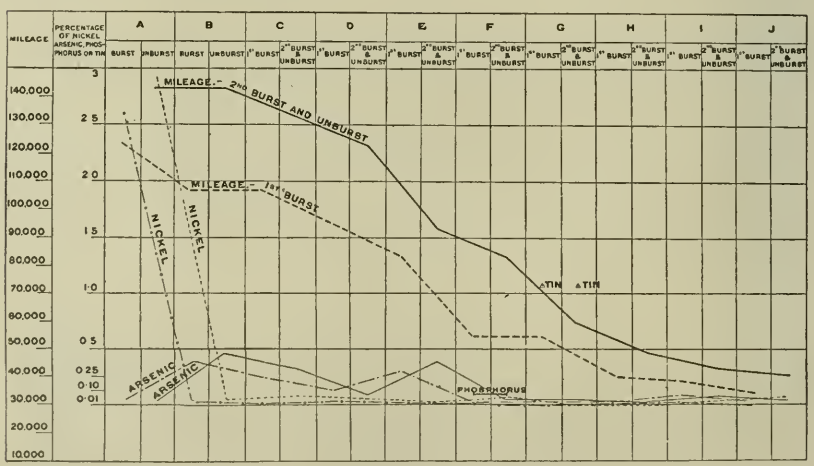



Fig. 4—Tests of Copper Locomotive-Boiler Tubes.

*Abstract of a paper by Francis W. Webb, presented to the Institution of Civil Engineers, London.

one tube of each make, with two exceptions, in which nine makers only were represented in each group. The method of grouping is illustrated in Fig. 1. The tubes were numbered consecutively 1 to 198, and the different makes were numbered 1 to 10.

The boiler fitted with the experimental set of tubes commenced work in October, 1898, and finished in December, 1901. During that time the engine ran 142,348 miles. In order to determine the relative merit of each make of tube the following rule was observed. When a tube failed, it was taken out of the boiler and the mileage of the engine was noted; and when a second tube of the same make failed, the whole of the tubes of that make were removed from the boiler and the engine-mileage up to the failure of the second tube was noted. While the experiment was in progress, the tubes were re-rolled and re-ferruled and the ferrules were knocked up several times.

The first tube failed after the engine had completed 34,067 miles, and the second tube of the same make at the end of 40,612 miles; whereas the first and only failure of the make which stood the best did not take place until the engine had completed 123,896 miles. Of the tubes second in order of merit, only one tube failed, and that at the end of 107,507 miles. When the engine had completed 142,348 miles, it was decided to stop the experiment, although the experimental tubes remaining in the boiler, by two makers, were still in fairly good condition.

It was observed that, with one exception the failure of the tubes was due to their having worn thin from the inside, invariably at the bottom and within 6 inches of the fire-box end of the tube, the pressure inside the boiler causing them to collapse. The one exception was that of a tube which cracked during re-rolling. It is singular that the inside of the tubes should invariably wear thin at the bottom. Doubtless, this unequal wasting of the tube is due either to the sulphurous acids from the sulphur in the coal condensing on the bottom of the tube near the fire-box end during the lighting-up of the boiler, and thus corroding the metal; or to a portion of the cinders striking the top, inside of the ferrule, and being deflected downwards against the bottom of the tube. A typical example showing the unequal wasting of the tube just beyond the ferrule is illustrated in Fig. 2, and the shape and thickness of a typical "burst" tube are shown in Fig. 3.

Chemical analyses of each of the tubes that failed, and of the average of the tubes that did not fail, were made. The results of the analyses, together with the mileage of each make of tube, arranged in order of mileage—and therefore of merit—and are shown diagrammatically in Fig. 4. There is practically no difference in the chemical composition of tubes of the same make, whether they failed or not; and that the two makes of tubes which stood the best are hardened with nickel and arsenic respectively. Of the tubes marked C in order of merit, two failed (Nos. 146 and 178) at the same time; hence, three tubes of this make are shown as having failed.

Taking the quantity of arsenic present as determining the hardness of the tube, and the hardness as representing its life, the tubes E should, at least, be one place higher in order of merit. However, the make which stood the best is quite different from the others in chemical composition. The most satisfactory copper tubes for locomotives are those containing either 3 per cent. of nickel, or at least 0.5 per cent. of arsenic. Copper tubes hardened with nickel are now being put into locomotives on the London & North Western, and good results are expected.

Three samples of seamless copper tubes, said to contain 3 per cent. of nickel, 0.5 per cent. of arsenic, respectively, which have been made as the outcome of the foregoing investigation, have been submitted to the

Fig. 2—Tube Showing Unequal Wasting.

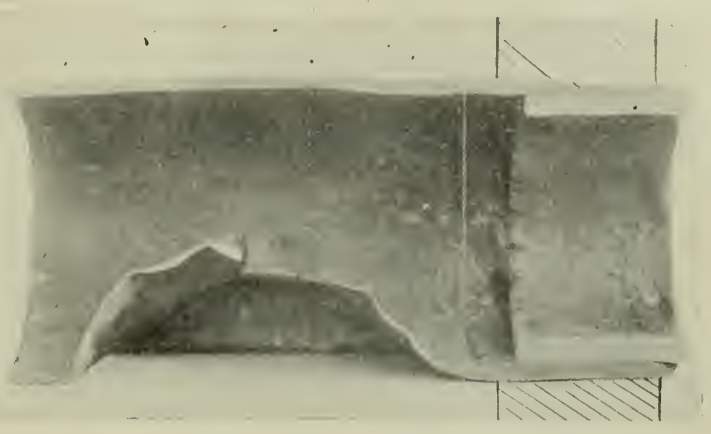


Fig. 3—A Typical "Burst" Tube.

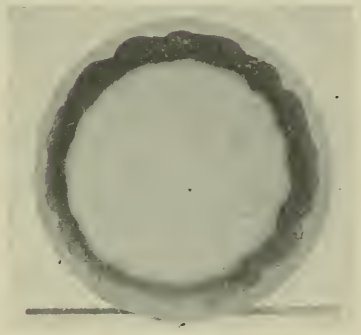


Fig. 6—Worn Ordinary Tube.

Fig. 5—Elevation and Section of Worn Fluted Tube.

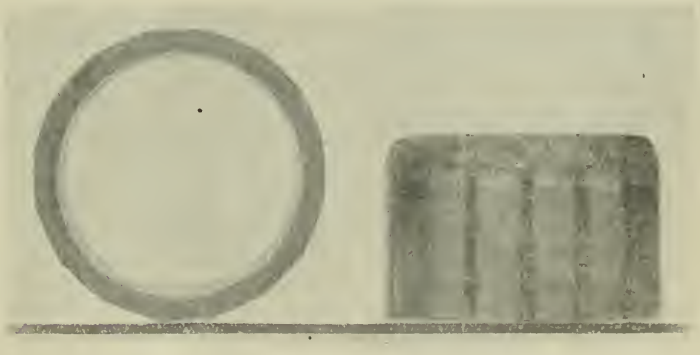


Fig. 7—End View and Elevation of Steel Ferrule.

author. Mechanical tests indicate that the tubes are softer than the average of 32 samples of ordinary copper tube taken from consignments received from time to time. Nevertheless, on cutting them with a chisel they do not show particularly soft metal.

Some time ago experiments were conducted at Crewe with fluted copper tubes, Fig. 5, but it was found that the ridges inside the tube suffered abrasion, especially at the commencement of the ridges, just beyond the ferrule, which were rather quickly worn through; consequently the use of such tubes had to be abandoned. An ordinary copper tube which has suffered abrasion rather severely, as will be seen from the corrugated appearance of the inside surface of the tube, is illustrated in cross-section in Fig. 6.

In conclusion, a form of steel ferrule, introduced by the author at Crewe some time ago, may be mentioned. The ferrules, which are stamped from mild-steel sheet, are, in the fourth of the five operations of manufacture, forced into a die which forms 16 small ridges, $^1/_{16}$ in. in width and about $^1/_{64}$ in. in depth on the outside. These ferrules, having a taper of 1 in 80, in addition to the ridges, are found to hold better in the ends of the tubes, which are rolled with parallel sides, than the plain turned ferrules with a taper of 1 in 40. An elevation and an end-view of this improved ferrule are shown in Fig. 7.

## The Tehuantepec Route.

BY E. L. CORTHELL.

After 384 years—Cortez to Diaz—with projects without number and failures many, and with persistent efforts on the part of Mexico; after the expenditure of large sums of money, the end is in sight, for the railroad across the Isthmus of Tehuantepec, from ocean to ocean, will be ballasted complete by the end of this year. There will be a depth of 22 ft. through the Coatzacoalcos bar in the Gulf at the end of 1905, with 33 ft. to follow. The Salina Cruz harbor on the Pacific will be protected by its two breakwaters in the sea and the inner port be ready for business, and at that time lines of steamships will be operating from both ports to the coastwise ports of Mexico and the United States and to other countries. The works from sea to sea are being prosecuted with all the energy possible by one of the most energetic and experienced contracting firms of the present day—Messrs. Pearson & Sons, of London—who are also the contractors for the four East River tunnels of the Pennsylvania Road between New York City and Long Island.

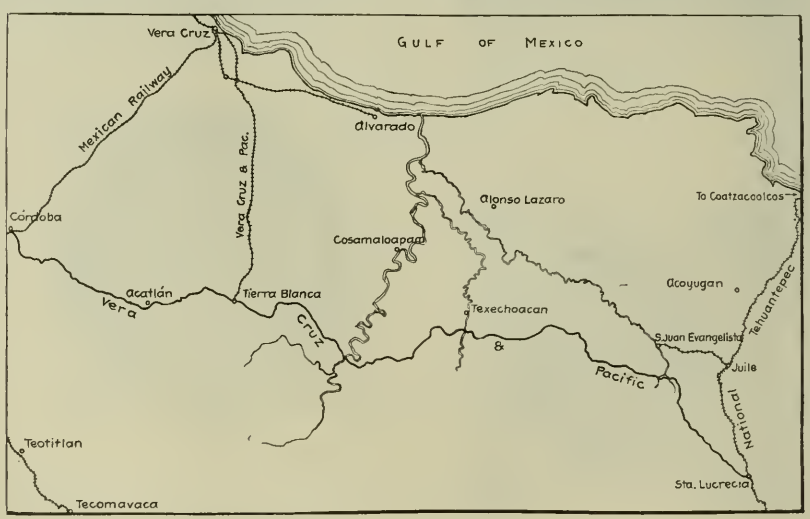
There are still—dating from November, 1903—over ten millions gold to expend on the two harbors and ports facilities. When the work is finally complete there will be open to the world's commerce a truly interoceanic route. The fact that the Mexican Government is a partner with Pearson & Sons in the construction and operation for 40 years of this route and that the Government by a "merger" with certain railroad companies now controls the operation of important systems extending from Laredo to Salina Cruz makes it important for the *Railroad Gazette* to briefly review the history of the project—dating back nearly 400 years, and to present advantages claimed for this route by President Diaz and his advisers. Their view, resolutely held, is that the Tehuantepec Route will be entirely completed and in full operation with its own lines of steamships eight years before the Panama Canal can possibly be opened to interoceanic traffic; that the Tehuantepec Route has immense geographic and navigation advantages over Panama and that it can easily draw to itself in the eight years all the traffic naturally tributary to it, and that, even after the opening of the Panama Canal, its excellent facilities for the prompt and economical handling of freight from ship to car and car to ship, will enable it to hold all it will have acquired; also that the ever-increasing volume of the world's commerce and of interoceanic traffic will enable the Tehuantepec Route to acquire its share of this increase, sufficient to make the great investments of the Government yield a fair return. It may be stated also that the Government of Mexico and its people have always believed it was their duty to the world to develop what they believe to be the natural and most advantageous route for the commerce of the world to pass between the oceans.

In 1520, as soon as Cortez, through the hospitality of Montezuma, was installed in the Aztec national palace, he inquired of the king if he had any charts of the coast. The king produced them and the eagle eye of Cortez at once lighted upon the mouth of the Coatzacoalcos river. Immediately a reconnoitering party was sent to explore it. The report was so favorable upon this land-locked harbor and the great river stretching many miles into the interior that Cortez urged upon the Emperor, Charles V. of Spain, to make this the route to Cathay. Cortez was so sure that it would be an interoceanic route some day that he asked for and received the grant of an immense tract of land in the interior of the isthmus and was made Marquis of the Valley of Oaxaca. The route of the railroad of the present day passes through the lands of his descendants. They are called the Marquesanas—or estates of the Marquis. They embrace about 200,000 acres.

There is evidence that Cortez built a military road from the city of Tehuantepec on the Pacific to the headwaters of the Coatzacoalcos on the Atlantic, and that it was in use for a hundred years. A century later the Spanish viceroy was petitioned to declare Coatzacoalcos a port of entry and a great depot of commerce instead of the port and city of Vera Cruz.

The first real survey was made in 1774 by a civil engineer named Augustin Cramer by order of the Viceroy. He reported that, "It would not be a work of great difficulty, nor excessively costly to effect a communication between the two seas across this isthmus." In 1814 another project for a canal was brought forward and the Spanish Cortes authorized the opening of "a canal across the Isthmus of Tehuantepec in preference to Nicaragua and Panama." In 1824 a survey was made by Col. Orbegozo, appointed by the General Government. This was three years after Mexico became an independent republic. In 1842 President Santa Anna granted a citizen of Mexico, José de Garay, the right of way across the isthmus for a communication between the Atlantic and Pacific. This was about the time of the advent of railroads, and the grantee had the privilege of building a canal or to use "railroads and steam carriages." The survey for the route was made soon afterward by Gaetano Moro.

This concession was extended several times, and in 1848 Garay transferred his concession to an English company, and they in 1849 assigned it to Mr. Hargous, of New York. The Tehuantepec Railroad Company, of New Orleans, organized under the Garay concession, assigned to Hargous and began an exhaustive survey for a railroad in 1850, under the charge of Gen. J. G. Barnard, Topographical Engineer, assisted by Mr. J. J. Williams, C. E. Mr. Williams arranged and prepared the results of the survey in a published work of about 300 pages and a book of maps. This work gave a "résumé of the geology, climate, local geography, productive industry, fauna and flora of that region." This very interesting work has formed the basis of all later studies. It was published in 1852. However, before work could be undertaken the Mexican Congress, in 1851, declared the concession granted in 1842 and amended in 1846 null and void on the ground that the acting-president had exceeded his powers.




Map Showing Vera Cruz & Pacific Railroad.

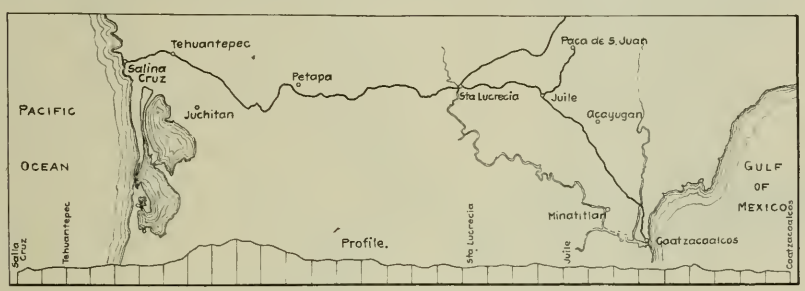
During all the intervening five years there had been not only distrust of the people and Government of the United States, but for two years a war, leaving a fear of the overshadowing influence of the greater republic. They did not wish to have at Tehuantepec a repetition of what had just happened in Texas. This distrust was strengthened by some filibustering invasions of the border States of Mexico.

The distrust and the failure to conclude a treaty of neutrality over the Isthmus of Tehuantepec, which the United States Government would have been glad to celebrate, and the evident determination of the Mexican Government not to recognize the charter to Garay, which had come into the hands of United States citizens, led parties in the

latter country interested in Isthmus transit to apply to the Government of Granada for a concession. This was granted with a treaty between the two governments to build a railroad across the Isthmus of Panama, which was begun in 1850 and finished in 1855.

Had it not been for these conditions, no doubt the railroad would have been built at Tehuantepec at that time and none would have been built at Panama and no canal would have been built there; and Tehuantepec would now be the world's highway of commerce between the oceans, either by a railroad, as now; or by a canal, which Capt. Shufeldt declared entirely practicable after extended surveys, or by a ship railroad, as proposed by Capt. Eads.

After annulling the Garay grant the Mexican Congress in 1812 arranged for propositions on an international competition to open a route across the Isthmus. A company composed of Mexican and American citizens obtained the contract. Mr. A. G. Sloo was the moving spirit in this project, but nothing came of it, and it was annulled in 1857. In the same year a grant was made to the Louisiana Tehuantepec Company. This was twice extended, until in 1861 Napoleon III. instructed his minister in Mexico to secure the grant which this company had just forfeited, and this stood on the records until October 12, 1866, when Emperor Maximilian extended the time, but three days later—October 15—President Juarez,




Route and Profile of Tehuantepec Railroad.

not recognizing the authority of Maximilian, granted the right of way for a railroad and telegraph line to the "Tehuantepec Transit Company" and annulled the charter of 1857.

The headquarters of this last mentioned company was in New York City, but this charter also was later forfeited. In 1867 the President of Mexico gave a grant to Emilio de la Sere, an American citizen. A company was organized in Vermont by Act of the General Assembly of that State. Some amendments by the Mexican Government followed and in 1870 an additional right was granted this company to build a canal also. One of the earnest and indefatigable workers in this project was Simon Stevens, well known in New York as a persistent promoter of this project. He was President of the company. He published a book of 90 pages with maps and illustrations on the subject of Tehuantepec.

About this time the United States Government sent a party to the Isthmus in command of Capt. Shufeldt "to ascertain the practicability of a ship canal between the Atlantic and Pacific Oceans." The results were given in a quarto sized book with numerous illustrations and mape, 190 pages of text and 20 maps and profiles. The principal Civil Engineering assistant to Capt. Shufeldt was the late Prof. E. A. Fuertes, Dean of Engineering of Cornell University. The physical and hydraulic conditions were found to be favorable for the construction and operation of a canal 22 ft. deep—about the depth contemplated by the plans of the Government at Nicaragua at that date—60 ft. wide at bottom and 162 ft. at the top. The total length was to have been 144 miles and there were to have been 140 locks, all of very low lift, compared with modern lifts. The harbor conditions were reported to be very favorable on both sides of the Isthmus. As bearing on the entire subject of transit across the American Isthmus, the report of Admiral Shufeldt gives important testimony, and may be quoted here with advantage to the appreciation of the subject:

"I have, therefore, regarded canal communication through this hemisphere as American and local in its main object, incidental only as to the rest of the world. Viewed from this standpoint, a single glance at the map demonstrates not only the necessity of a canal, but its location. Each isthmus rises into importance as it lies nearer to the center of American political and commercial influence, and the intrinsic value of this eminently national work ought to be based upon the inverse ratio of the distance from that center. A canal through the Isthmus of Tehuantepec is an extension of the Mississippi River to the Pacific Ocean. It converts the Gulf of Mexico into an American lake. In time of war it closes that Gulf to all enemies. It is the only route which our Government can control. So to speak, it renders our own territory circumnavigable. It brings New Orleans 1,400 nautical miles nearer to San Francisco than a canal via Darien."

After several extensions and many failures to raise the money, the grant to La Sere finally was forfeited by act of the Government on May 31, 1879. In the meantime Mr. Edward Learned, of New York City, obtained a concession in 1879 with a subsidy of $7,500 per kilometer. This grant was terminated in 1882 for failure to complete the road in the time specified in the contract, only 35 kilometers having been finished. The Government settled with the company, taking over all its property on the Isthmus and paying $125,000 in Mexican silver dollars and $1,500,000 in United States gold. From this time on the Government itself undertook to build the road.

First it appointed a representative who was really an agent to buy the material and do the work on account of the Government. A contract was then made with this agent—Mr. Belfin Sanchez, a Mexican citizen—with a subsidy of $25,000 per kilometer of road built, but the work did not progress well and the contract was abrogated on April 25, 1888. Most of the work under this contract was on the Pacific side, that under the Learned contract being on the Atlantic side. The Government paid $562,910 as the value of the work done and material furnished, and $170,225 as representing the contractor's profits.

The President had been previously authorized by Congress to build the road, and under this authorization the Government issued 5 per cent. gold bonds, the total issue being $13,500,000, which were sold to a German syndicate of banks at 70 per cent. of their face value. A contract was signed with Edward McMurdo, of London, to build the road. He, however, died before he could enter actively upon the work. In 1892 the contract was abrogated, with about $2,000,000 silver remaining from the proceeds of the issue of bonds.

The Government made a contract on February 27, 1892, with Messrs. Stanhope, Hampson and Corthell to spend this amount in an attempt to unite the rails. The amount was not sufficient and Mr. Stanhope himself afterward arranged for enough to accomplish this out of a special Government loan, and he expended on the work $1,111,035. In 1898 the Government entered into a partnership contract with T. Pearson & Sons, of London. This was amended in 1902. This partnership, or "sociedad" was given the name of the "National Railroad Company of Tehuantepec." The contractors are the administrators or managers of the company's affairs.

The working capital is $5,000,000. The profits and losses of the operation are to be divided between the partners. The contract will terminate in 1953 and it contemplates the construction of the harbors and ports on both oceans, the installation of port and terminal facilities and the entire rehabilitation of the railroad, cutting down steep grades, taking out objectionable curves, ballasting the road complete from end to end, establishing yards and sidings and equipping the road with sufficient rolling stock for a large interoceanic traffic. Special attention is being given to the terminals—a deep channel entrance to the natural protected harbor at the mouth of the Coatzacoalcos river and a protected harbor with an interior port at Salina Cruz on the Pacific. Those ports will be provided with the most modern appliances for handling cargo with the greatest possible despatch and economy. There will be 10 meters (32.8 ft.) of water at both terminals with wharves and docks sufficient for the largest ocean vessels.

By the courtesy of Sir Weetman D. Pearson and the Hon. Leandro Fernandez, Minister of Communications and Public Works of Mexico, we are enabled to present the plans of the works, including the map of the route and a map of its connections with the Mexican and Interoceanic railroads, and also the plans of the harbor, ports and terminal facilities. As will be seen by the topographic map, the ascent from the Gulf of Mexico is gradual, over slowly rising land, to the table land, where the summit is about 924 ft. above sea level. The descent to the Pacific plains is much more abrupt. The plains on the Atlantic slope are, however, undulating and are traversed by many lateral streams of considerable size, tributary to the Coatzacoalcos, which is the main drainage of an extensive country subject to an annual rainfall of about 100 inches. The irregularities required in the preliminary construction an undulating grade and considerable sharp curvature. The heavier grades were from 1¼ to 2 per cent. and the maximum curvature about 9 degrees about 600 ft. radius. The work of the present contract consists largely in cutting down unnecessary grades and in improving the alinement. The whole length of the route is 290 kilometers (180 miles). The gage is the standard of the United States—4 ft., 8½ inches.

The rail originally laid was 56 lbs. per yard. That required by the present contract is 80 lbs. The original rail is all being renewed. The bridges were mostly

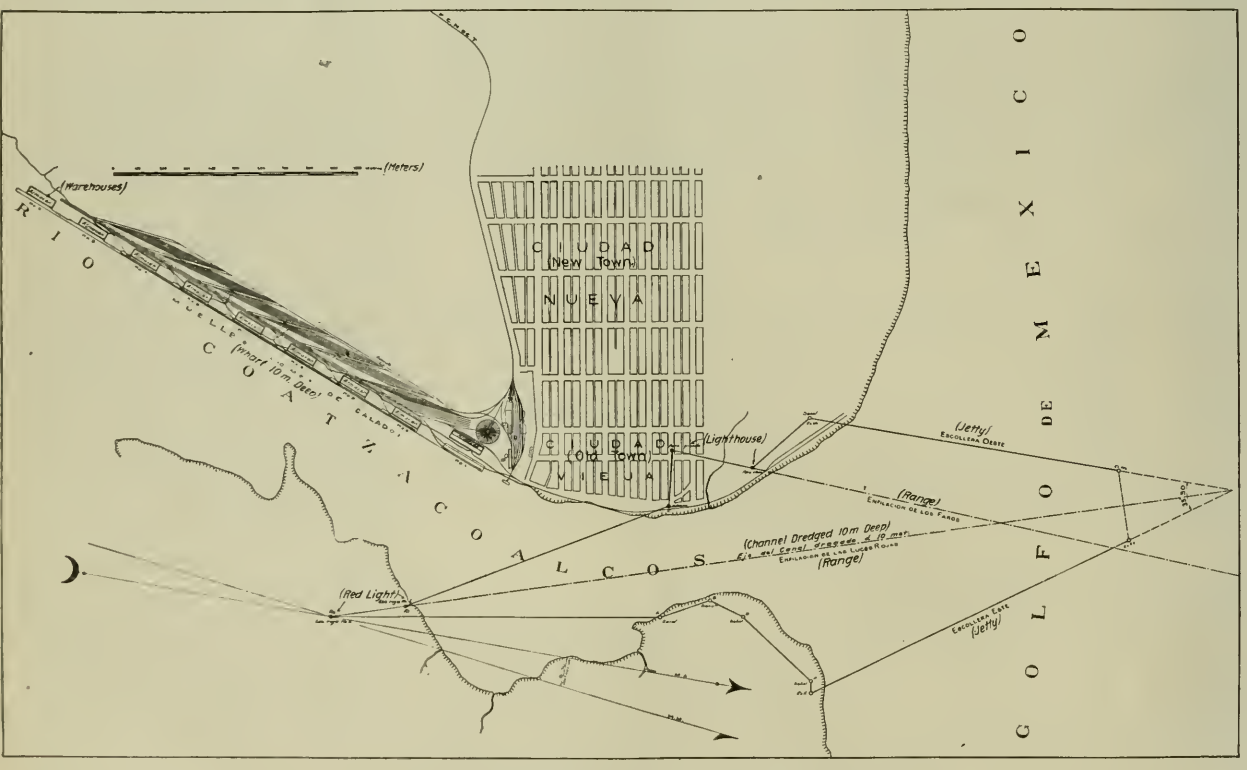
wooden trestles and pile bridges, except over large rivers. Permanent structures, masonry or steel, are now being substituted for them. The entire line is being ballasted, sidings are being lengthened, yards laid down and the whole route put into shape for a heavy interoceanic traffic, and the rolling stock is being supplied to meet the requirement.

About 126 kilometers (78 miles) from the port of Coatzacoalcos the Vera Cruz & Pacific Railroad joins the Tehuantepec Railroad, at the station Sta. Lucretia. This is the terminus of the former line, as shown by the accompanying map. By the courtesy of the Minister of Communications we are able to show this Vera Cruz line and the other lines centering at Vera Cruz as well as the line to Cordoba on the Mexican Railway.

It is not probable that the line of Vera Cruz will have much of the Isthmian traffic, for the reason that from Salina Cruz on the Pacific to Vera Cruz the route is 200 kilometers (124 miles) longer than from Salina Cruz to Coatzacoalcos. There is, however, likely to be an important passenger traffic and Mexican freight traffic, via Vera Cruz, due to the fact that the Mexican Government has recently entered the railroad arena by arranging the "merger," previously referred to, of several systems in which it has lately obtained a controlling interest by purchase of a majority of stock. By those negotiations the Government has a majority ownership in an extensive system, reaching from the United States border to Salina Cruz, via the Mexican National to the City of Mexico; the Interoceanic, from the City of Mexico to Vera Cruz; the Vera Cruz & Pacific from Vera Cruz to Sta. Lucretia; and by its absolute ownership of the National Railroad of Tehuantepec from Sta. Lucretia to Salina Cruz. This is a long link in the proposed intercontinental system from New York to Buenos Aires. The fact that there is rail connection from the United States to the Tehuantepec Railroad is an important advantage to that railroad as an interoceanic route.

It is important in outlining the conditions of the Tehuantepec Isthmus route to know what has been planned, what has been done and what is yet to be done at the two terminals, for the value and real importance of this route as an interoceanic factor will depend upon the character of the terminal facilities.

At Coatzacoalcos the Government by a contract with Pearsons made a dredged channel through the sea bar at the mouth of the Coatzacoalcos river between the extensive deep basin inside and the deep water outside. The bar in its normal condition had about 14 ft. of water on its crest. The channel was deepened to 32.8 ft. and 328 ft. wide. A rise in the river, bringing down the usual amount of silt and debris shoaled the channel in 14 days to 14 ft. The plan then decided upon and now being carried out as rapidly as possible is to build two permanent, substantial jetties of stone and concrete blocks on the location shown on the plan.




Port of Coatzacoalcos, Eastern Terminus of Tehuantepec Railroad.

As will be seen, those dikes converge from a width of about 3,445 ft. at the shores to 919 ft. at the sea ends, about 3,280 ft. from the western shore. The plan contemplates a permanent channel through the bar 656 ft. wide and 32.8 ft. deep at low tide. If the works do not produce and maintain this channel no doubt dredging will be resorted to to accomplish it. At this writing somewhat over one-third the length from shore of the west jetty has been built; no work has been undertaken on the east jetty as yet. The plan also shows the extensive and well designed railroad terminal at the port. A natural depth of over 30 ft. is within 100 ft. of the shore line for a distance of over a mile. The wharf frontage planned extends over a mile and a quarter, with nine warehouses about 400 ft. long each, back of which is a railroad yard sufficient to handle the large number of cars required for an important traffic between rail and water. Four of the nine warehouses and the wharf in front are completed.

At Salina Cruz the conditions are entirely different. The waves of the Pacific beat upon the shore. There is no river to offer its basin for a harbor; only a long, curved shore line, with a promontory of porphyry rock 250 ft. high on the west, jutting boldly into the sea. This became naturally the base to which to tie a breakwater made out of the rock of the bluff. The stone blasted off became the foundation of a massive work formed of huge concrete blocks put in place by a powerful titan, which moves on the completed work. This dike is completed to within 100 meters (328 feet) of the sea end. The water deepens very rapidly, so that the dike will rest at the end in about 18 meters (59 feet) of water.

The east dike is built in the same manner and the two when completed leave an entrance about 656 ft. wide. The east jetty is built by carrying the materials along the shore from the promontory and depositing them by a second titan that operates on this work. About one-third the distance from the shore has been completed at this date. The plan clearly shows the details of the port itself. The ground where it is located is a low, flat marsh, which can be easily dredged. Across the rear of the protected area extends a line of wharfing with an opening for the passage of vessels into the interior basin. On this wharfing are six warehouses with railroad tracks on each side for handling goods between rail and ship. Back of an extensive interior basin is a row of piers and slips, which are to be built as the traffic requires it. This basin has a depth of 32.8 ft. and there is none less anywhere in the outer port in front

of the warehouses. It will be seen by a glance at this plan that an important business is expected.

The costs of the harbor, port and terminal facilities, not including the railroad tracks, yards, etc., are as follows:

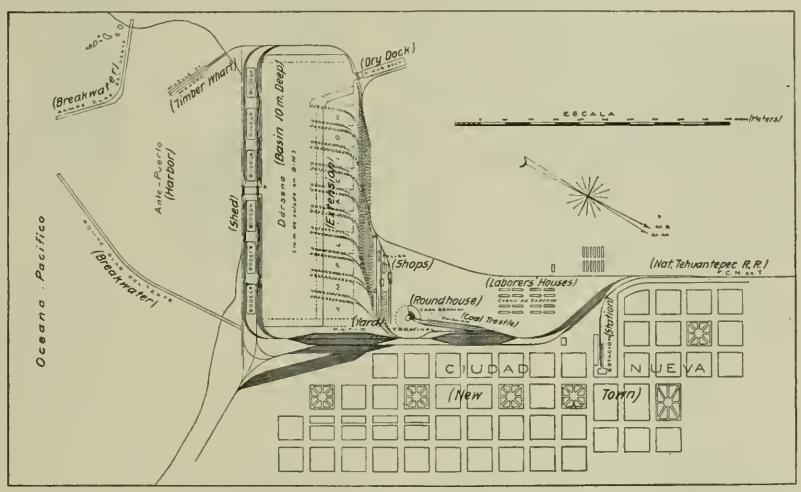
| | | |
|---|---|---|
| Coatzacoalcos.. | | |
| | Total estimated approximate cost.... | $8,959,786 |
| | Completed to November, 1903 ..... | 3,928,579 |
| | Remain. to be done. | $5,031,207 |
| Salina Cruz..... | | |
| | Total cost.....$24,983,615 | |
| | Completed to November, 1903..... | 8,602,570 |
| | Remain. to be done. | $16,381,045 |

These amounts are all in Mexican silver, the present rate of exchange being about 42 cents. As near as we can estimate the total amount in gold dollars which the Mexican Government will have expended, including interest paid out, from the beginning of its efforts to build the railroad under the Learned contract to the entire completion of the route ready for interoceanic traffic will be about $33,000,000.

As stated by Admiral Shufeldt, the fact that Tehuantepec is nearer the "Axial line" of commerce of the world—Hongkong, Yokohama, San Francisco, New York, Liverpool—gives this route great advantages over Panama. An inspection of a globe will show that the shortest ocean route from Panama to the East—Yokohama and Hongkong—must pass along our coast to at least off San Francisco. In fact, the shortest line—the great circle—drawn between Panama and Yokohama passes through the Gulf of Mexico at Corpus Christi, more than one hundred miles east of San Francisco and through the Aleutian Islands. We may assume that the average saving in distance by the Tehuantepec Route over Panama to all points on our Atlantic coast and Europe is about 1,250 miles. The ordinary freight steamer makes about 10 miles an hour, or, say, 250 miles per day, requiring five days longer via Panama, assuming the time of crossing the two isthmuses to be the same. It will take a steamer about one day to pass through the Panama Canal and the freight about two days to pass over Tehuantepec from ship to ship, leaving still four days to the advantage of Tehuantepec.

It is assumed that at Tehuantepec the methods of handling cargo are the best and the quickest now employed anywhere. If the steamers built for this route are designed like the Morgan line steamers running to New Orleans and Galveston from New York, they will be able to discharge or load 5,000 tons of freight on board cars or on board ship in 10 hours. This is done regularly at Algiers, opposite New Orleans. Each of the three under decks for freight has great side ports hermetically sealed on the voyage, but opened up as the steamer lightens up in discharging. These ports are high enough so that a gang of men can truck the freight out of the ship into the cars, which have their floors at the level of the wharf floor. When the upper deck has been unloaded, the ship lightens up out of the water sufficiently to allow the next set of side ports to be swung open, and so on to the third. Heavy freight—machinery, etc.—which cannot be readily trucked out is stored near the hatchways and lifted out by the ship's tackle and loaded on flat cars, which stand on a track immediately under the ship's side. The steamers are loaded from the cars in the same manner and in the same time. Ten hours will suffice to transfer a cargo of 5,000 tons from the steamer to a train of cars and start it on its journey over the Isthmus.

As to grain, instead of the long voyage of 16,552 miles around Cape Horn from San Francisco to Liverpool, the sailing ships that carry it could run into Tehuantepec, transfer their cargoes by the method above described, if the grain is in bags, as is usual on this route, or by elevators at the two terminals, if in bulk, and save 8,250 miles, really 12,000 miles, for actual *sailing* distance is generally 50 per cent. greater than *steaming* distance.




Salina Cruz, Western Terminus of the Railroad.

This brings up another important matter which should not be lost sight of, viz.: the nautical advantages of Tehuantepec. It is safe to say that sailing vessels will never use the Panama Canal. They cannot reach it or get away from it. They always avoid the region of calms that prevail on both oceans opposite Panama. The opinion of Lieut. Maury still holds good. He summed up the nautical advantages as follows:

"Should nature by one of her convulsions rend the American Continent in twain and make a channel across the Isthmus of Panama or Darien as deep, as wide and as free as the straits of Dover, it would never become a thoroughfare for sailing vessels, saving the outward bound or those that could reach it by leading winds."

It is a mistake to assume that the sailing vessel is passing and soon to give way entirely to steamers. The sailing fleet of the world, while diminished in numbers, is still an important factor in ocean commerce, and as to the coastwise commerce of this country, it is still more important. Probably the coastwise tonnage in sail is twice that of steam, even figuring the steam ton as four times the sail ton. As to the relative cost of transportation over the two routes, this will depend in part upon the tolls and rates in each case, but as both routes are operated by governments we may assume that there will be competition and the rates scaled to secure all the business possible.

The extra cost of the four days to a steamer, say, $2,000, plus the canal tolls, would make a 5,000-ton cargo cost about $10,000 via Panama. No doubt the cost by Tehuantepec would be no greater and there would still be the saving in time of four days, which, to quick freight, is of great importance in this age of rapid transportation. Many estimates have been made of the tonnage to be expected over a trans-isthmian route. Some of these have been carefully worked out on a correct basis and some have been guessed at. Assuming 6,000,000 tons, which is about an average of the estimates, there is no doubt that, during the eight years when the completed and equipped Tehuantepec Route will be in operation before the Panama Canal will be ready to receive traffic, this route will draw to itself at least one-half of the tributary tonnage, and it is reasonable to expect that even after the Canal has opened it will hold all the tonnage acquired which is tributary to this route.

## Bending Moments in Rails.*

Wheel effects of moving locomotives are resolved into negative and positive bending moments by the rail when depressed from its unloaded position in the trackman's surface to its loaded condition in the "general depression." From a continuous beam resting on numerous cross-ties, as flexible supports in the ballast, and the latter upon a compressible subgrade, the rail, by the progressive loading, is converted into a "constrained beam," strengthened and stiffened to carry and distribute the driving wheel loads and the tractive effort. The cross-ties are flexible supports depressed more directly under the wheels than in the wheel spacing, and do not control the span of the bending rail, as generally supposed.

The wheel spacing and the wheel loads, loading the rails at intervals of two or three cross-ties, become the more important factors in fixing the span of the bending rails. When the rail is well spliced and stiff, it may be strengthened and stiffened by parts of the load of the locomotive for carrying and distributing the loads, etc. This favorable action of the rail as a beam loaded in the "general depression" (unique in mechanics) is in part due to the flexible supports upon which it is depressed by the several wheels of the subdivided total load, each wheel load causing conjoint strains in the metal of the section, which assists to check deflections under adjacent wheels. The foundation is also favorably loaded and restricted in its movements.

A single pair of wheels in a long wheel spacing, independent of the conjoint action of other wheels on the rail, has a limited "general depression" confined to one specific deflection under the wheel. The looseness of the track not being reduced by preceding wheels, the positive bending moment is constrained only by the superstructure, instead of adjacent wheel loads.

In some stremmatograph† tests the total static load of the locomotive was 220,000 lbs., drawing a train of four cars, total weight of 430,000 lbs. In another test the total static load of the locomotive was 282,900 lbs., draw-

*Extract from a paper by P. H. Dudley read at the Atlantic City meeting of the American Society for Testing Materials, June, 1904.

†The stremmatograph is an instrument devised by Dr. Dudley for measuring the deflections of rails under moving loads.

ing a train of nine cars, weighing 910,000 lbs.—over twice as heavy, yet with its closer wheel spacing of the engine, the inch-pounds of the positive bending moments were less per pound of static load and were constrained by more efficient bending moments than for the lighter locomotive. In other words, the foundation or subgrade was more favorably loaded by the 10-wheel type of engine. These tests confirm the American theory and practice of the importance of distributing the wheel loads by well-designed wheel bases.

For the 10-wheel engine the positive bending moment for the wheels in good condition was 9.82 inch-pounds per pound of static load. Under a Consolidation type of locomotive drawing freight trains, even more favorable results are obtained. With the 12-wheel type of freight engines the results are still more favorable as to the distributed load through the rail section in loading the foundation. Details of the tests show the negative bending moments occur in the wheel spacing, and constrain the positive bending moments, which are nearly or directly under the wheels. At the points of flexure in the rail, shearing strains in the web connect the negative and positive bending moments between and under the wheels, making the action of the metal of the rail continuous in the "general depression" for the entire wheel base of the locomotive and under the first truck of the passenger coaches.

In freight service, with 60,000, 80,000 or 100,000 lbs. capacity cars, with an inside wheel spacing of 18 to 20 ft. only, the "general depression" is continuous for the entire train length.

The magnitude of the constraining negative bending moments in the wheel spacing for a given unit fiber strain, under the positive moments, depends upon the stiffness of the rail section, and looseness of the track, the latter being one of the variables in the permanent way. A closer comparison is more easily made between the unit fiber strains of the negative than of the positive bending moments.

In 4½-in. 65-lb. rails under switching engine No. 1 at the Grand Central Station, New York, having 125,000 lbs. upon three pairs of drivers, the unit fiber strains for the negative moments ranged from 1,800 to 2,500 lbs. for the unit fiber strains of 30,000 to 45,000 lbs. On the 6-in. 100-lb. rails, for similar unit fiber strains for the negative moments, the positive bending moments only had unit fiber strains varying from 6,000 to 8,000 lbs., the ratio of constraint being many times greater.

Limber rails have large unit fiber strains, but carry only small negative bending moments, and are also limited in the positive bending moments which they can sustain without exceeding the elastic limits of the metal. As the stiffness of the rail increases, with no greater unit fiber strains, larger bending moments are carried by the rails in distributing the wheel loads to the crossties, ballast and subgrade.

While it is easy by the construction of the wheel base of the locomotive to distribute a large total load on a stiff rail, the intensity of the pressure between the wheel contacts and the head of the rail is increased by the heavy axle loads, and the metal in our present rails under the rolling wheel contacts has much more work to do than was the case with the lighter wheel loads and more limber rail sections. The same physical properties which would sustain the light wheel loads for a large tonnage show a much greater rate of wear under the present wheel loads. The increased work of the stiffer rails and doubled wheel loads, with greater expended tractive power of the engines, should receive the attention and consideration it deserves, for our present service.

## Screw-Spikes and Dowels.*

The Bureau of Forestry has lately tested the pulling strength of spikes at its timber-testing station at Purdue University. A special holder was constructed, contrived to grip the heads of the spikes in a manner like the action of the rail, and to pull them from the tie in the direction of their length. The load at which the spikes pulled out from the ties was measured in pounds. Common spikes were driven into actual ties by an experienced track foreman to a depth of 5 in. and then pulled out by a testing machine. The screw-spikes were screwed into the same by hand, after a hole had been bored in the wood of a diameter equal to the diameter of the screw-spike at the root of the thread, namely, five-eighths of an inch. The load at which the screw-spikes pulled out was also measured on the testing machine.

The common spikes were 5½ in. long, 9/16, x 9/16 in. cross section, and weighed 170 to the hundred pounds. The screw-spikes were machined spikes, 5½ in. long, with a diameter at root of thread of five-eighths inch. The size of the thread was ⅛ x 7/32 in. and the pitch of the thread 2 in.; 85 spikes to the 100 lbs. The average force in pounds required to pull from the several ties the screw-spikes and common spikes was found to be as indicated in the following table:

| Kind of wood. | Force required to pull spike. Screw-spike. Pounds. | Common spike. Pounds. | Ratio of resistance of screw-spike to common spike. |
|---|---|---|---|
| Chestnut | 9,418 | 2,980 | 3.10 |
| Oak | 11,240 | 4,342 | 2.50 |
| Longleaf pine | 10,558 | 2,296 | 4.63 |
| White oak | 13,026 | 6,950 | 1.87 |
| Loblolly pine | 8,504 | 3,474 | 2.45 |

Other tests made to determine the relation of the pulling strength of common spikes to the depth inserted in the wood showed that the pulling strength varied directly as the depth of insertion into the tie.

In order to determine what is the effect of a side blow such as comes on a spike from the rail in service, and what tends to spread the track, a short piece of 50-lb. rail was spiked to a shortleaf pine tie by two spikes on opposite sides of the flange. The rail was then turned sidewise so as to receive on the inside the blow of a falling weight, and a 500-lb. weight was dropped against the side of the rail head, thus tending to jerk the inside spike from the tie and produce a side pressure on the outside spike. A drop of 3 in. produced the following effects on the common spike:

*Test No. 1.*—First blow pulled inside spike 1 in.; second blow pulled inside spike far enough for the rail to drop out.

*Test No. 2.*—First blow pulled inside spike ¼ in., second blow pulled inside spike far enough for the rail to drop out.

*Test No. 3.*—First blow pulled inside spike ½ in., second blow pulled the inside spike out far enough for the rail to drop out.

The same 500-lb. weight was dropped 3 in. on the head of a rail secured to the tie by two screw-spikes in the manner related above. Seven blows of the hammer did not start the inside screw-spike perceptibly, but gradually bent the head of the screw-spike over until the rail came out. The inside spike was slightly bent after the test.

Similar drop tests were made to determine the effect of a blow similarly delivered on the pulling strength of the spikes. One blow of the hammer from 3 in. high delivered to the side of the rail head fastened with two common spikes pulled the inside spike out about ½ in. The rail head was then removed, and the pulling resistance of the spikes was determined in the testing machine. The inside spike, which had been started ½ in., pulled out at 3,250 lbs., and the outside spike at 4,870 lbs.

Three blows of the hammer from 3 in. high were delivered to the rail head fastened with screw-spikes. The resistance of the latter against pulling out was then 8,930 lbs. for the inside spike, and 10,300 lbs. for the outside.

As the pulling strength of the common spike when not subjected to side blows was 4,380 lbs., and that of the screw-spike was 9,360 lbs., it appears that the pulling strength of the inside spike was diminished in each case, and that of the outside spike was increased. The latter effect was due to the bending of the spike. The effect of a great number of blows would undoubtedly be to diminish the pulling strength of the common spike because of the gradual destruction of the ends of the fibers of the wood in the hole.

The above results show that under the action of a side blow, such as comes on a rail, a common spike is pulled out from a fourth to a half inch, while the screw-spike is not perceptibly started.

### Application of the Screw-Spike.

The screw-spike is now used on practically all of the Continental European railroads in one form or another, either exclusively or in connection with bolts or ordinary spikes. The manner in which the screws are put into position differs only in unimportant details in various countries, and it will be sufficient to describe their man-

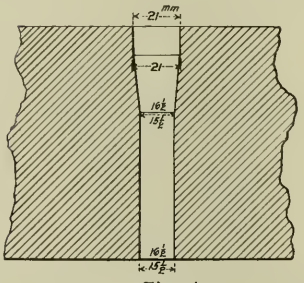



Fig. 1.

Shape of Hole bored in the tie for the Insertion of Screw-Spikes; French Eastern Railway.

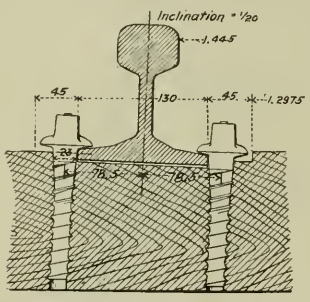



Fig. 2.

Section of Rail and Tie on the French Eastern Railway.

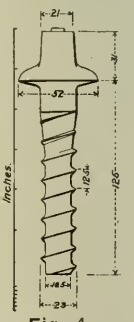



Fig. 4.

Screw Spike Used on the French Eastern Railway.

*Extract from Bulletin No. 50, U. S. Dept. of Agriculture, Bureau of Foresters, by Hermann von Schrenk.

ner of application for one. For this purpose the Eastern Railway of France is chosen as exemplifying a high type of work. The new ties are run through a machine at the treating plant before treatment. This machine adzes and bores holes in the tie. The upper part of the hole is wider, to admit the upper portion of the screw-spike. The ties are then treated with creosote and shipped out upon the line. When a tie is ready to be laid, the screw-spike is dipped in tar oil (of which each section crew has a bucket on its car) or tar oil is poured into the hole, and it is placed in the hole, the larger opening at the top of this hole allowing the screw to drop into it so as to stand practically vertical. The key is then applied and the screw is turned in by two men. Great care is taken in making the final turn of the screw not to turn it too far, which would destroy the thread made in the wood. When it becomes necessary to unscrew any of the spikes, either for the purpose of moving the tie along to secure its proper spacing after several years' service or for the

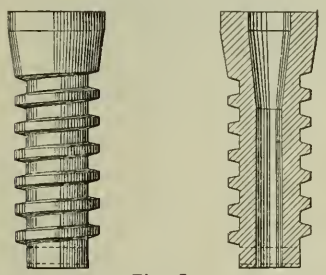


Fig. 5.
Screw Dowels, Shown in Face View and in Longitudinal Section.

purpose of inserting a tie-plate, one or two turns are made so as to allow the rail to spring up, and when the tie has been moved, or the plate inserted, the screw is once more firmly bedded. The two screws on the inside always correspond to one on the outside and vice versa, and if there are two screws on the inside of one rail there will be one screw on the inside of the other rail on the same tie. In rare instances screws are put in with an electrical machine used principally for putting in dowels. Where long stretches of track are laid, such machines are very useful, but ordinarily for simple maintenance work the key is used. In a subsequent paragraph a hand machine for putting in these spikes is described in full. The relation of the screws to the rail is shown in Fig. 2, which represents a section of the rail, a wooden tie-plate, and a tie as used on the French Eastern Railway.

After the screw-spikes are once put in little work is required to keep them in proper condition. The wood is compressed by the threads as the screw enters, and the pressure of the core upon this highly compressed wood opposes a resistance to the loosening of the spike. However, after the spikes have been in position for a few weeks they have to be tightened. This is not because the screws have loosened, but because the ties tie-plates and rails have settled so as to come closer together because of the pressure of moving trains. After the screws have been tightened they remain so for long periods of time. Once a year the section crew goes over the track with great care, testing and tightening each screw, and, if any of the screws no longer hold, they are taken out. The hole is then filled with a plug, a new hole is made in the plug, into which tar oil is poured, and the screw is replaced. The wearing out of threads of the screw does not occur very often.

It is impossible at this time to give any exact and trustworthy information as to the relative cost of maintenance of tracks equipped with ordinary spikes and with screw-spikes. In view of the fact that the screws do not work out of holes, as do the spikes, which means a less frequent replacing not only of fastenings, but of ties, it would appear that the cost of maintenance would be very much lower for the screw than for the spikes, and the condition of the track generally better. The first cost of putting the screws into position is somewhat higher than that for placing spikes.

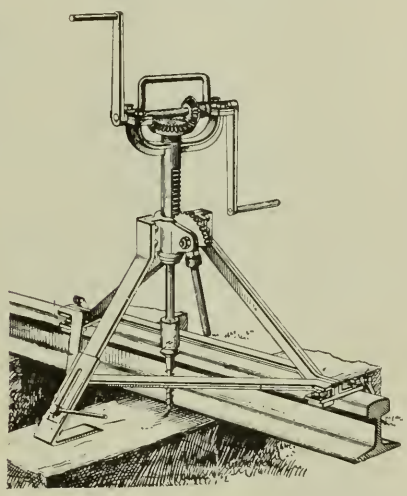


Fig. 3.
Perspective View of Screw Spike Driving Machine in Operation.

This is principally due to the longer time which the operation takes.

As already described, the method of putting in the screws used on the European railroads requires an ordinary key operated by two men. It was foreseen that this would probably prove too slow for American conditions, and on that account a machine was devised which would allow of a

Fig. 7.
Cross Section of Pine Tie Through the Dowel.

more rapid screwing in than with the laborious horizontal machine. Such a machine is the one illustrated in Fig. 3. The detailed design for this machine was drawn by Prof. A. L. Smith, of the Worcester Polytechnic Institute, Worcester, Mass.

A recent test made on the Pennsylvania lines with this machine showed that one could put in two screw-spikes while three spikes were being driven. While this operation requires a little more time than the placing of a spike, it must not be forgotten that the saving made possible by the absence of tearing the tie to pieces is very much greater than the loss of time. The chief objection which can be urged against the screw-spike at the present time is the matter of boring holes. In Europe this is done almost without exception at the treating plants, by the same machine which adzes the ties. In this country, with the numerous different rail sections used on almost every railroad, it will not always be practicable to bore holes in advance, and some method will have to be devised for boring holes out on the track by machinery. It is probable, however, that for stretches of new track, boring at the treating plant will be the simplest way to manage the problem.

Where single ties are renewed it will be possible to bore holes with the machine used for putting in the screws. All that will be necessary will be to replace the screwing key with a bit. It is expected that the tests now under way with screw-spikes on various roads in this country will enable a close estimate to be made of the actual cost of placing screws, compared with that of putting in spikes.

The screw-spikes manufactured in France and Belgium now cost about $4.45 per 100 kilos (220.46 lbs.). Each spike weighs

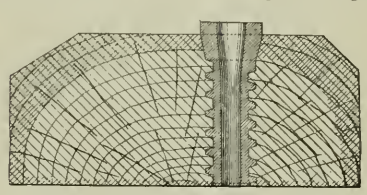


Fig. 6.
Screw Dowel in Position in Tie.

about 18 ozs. It is expected that these screw-spikes will cost about 4 to 4½ cents in the United States.

CONCLUSIONS AS TO SCREW-SPIKES.

*First*—The type of screw-spike which it is believed in the light of European experience will give the best service is that shown in Fig. 4. This screw combines the advantages of ease of making, cheapness and longer service than the other types of screws, and, moreover, wears out the thread of the wood less closer than wound screws. Tests with this screw are now under way on several of the roads in the United States.

*Second*—It is suggested that these screw-spikes be placed in two ways—four screws per tie and six screws per tie—according to the European model.

*Third*—As the screw-spike forms one of the proposed modifications of the present method of fastening, it is desirable that screws be tested on a broad-based rail without any plate, and also with steel and with wooden plates.

*Fourth*—In buying screw-spikes, only such as show a sufficient strength of head should be accepted. Most screws hitherto used have not had strength enough to stand the vertical blow upon the head.

*Fifth*—Recent tests show that the ratio of the holding power of the screw-spike, as compared with the common spike, ranges from 1.87:1 for white oak to 4.63:1 for longleaf pine.

The result of lateral impacts shows that under the action of a side blow, such as comes on a rail a common spike is pulled out from one-fourth to one-half inch, while the screw-spike is not perceptibly started.

DOWELS FOR SCREW-SPIKES.

One of the greatest difficulties with soft timbers lies in the fact that the wood around the spikes wears out with considerable rapidity after the new tie has been put in ser-

vice. This wearing out not only destroys the tie, but also makes the track unsafe, since the rails are no longer held to the tie. A recent invention by a French engineer has already shown such remarkable results in the way of preventing wear around the spike that it is deserving of study and trial.

In 1896 this engineer called attention to a cylindrical screw dowel which he had devised for use with soft wood ties. This dowel (illustrated in Fig. 5) consists of a cylindrical piece of wood formed into a screw with a very wide thread. At the upper end the dowel is somewhat larger than at the lower, so that when it is screwed into place water cannot enter between the dowel and the tie. A hole is bored in the center to admit either a screw-spike or an ordinary spike. The dowels are made out of carefully selected pieces of such woods as beech or birch, which have been seasoned for several years, and are heavily creosoted. The dowels are screwed in by hand where only a small number are needed, but where the number is large machinery is used. Electrical machines have for several years been in use at the treating plant of the French Midi Railway. The machine consists of a small, 5-horse-power motor with a flexible shaft, mounted on four wheels, the gage of which can be varied at will. In actual practice a 5-horse-power and a 3-horse-power machine are used. The 5-horse-power machine bores the holes and shapes the screw-thread, and the 3-horse-power machine screws in the dowels and cuts off the heads. One man can easily manipulate one of these machines. Near Bordeaux, in Southern France, an average of 2,400 ties per day are provided with six dowels each. With hand tools the German company estimates that one man after brief practice can provide 15 ties with six dowels per tie in one day. Since four men can work with one set of tools, one man boring the hole, one cutting the screw thread, one screwing in the dowels, and one cutting off the top, it is possible to provide 80 to 90 ties with six dowels each in a day with two sets of hand instruments. From the greater rapidity with which Americans work, it will probably be possible to increase this number here.

One of the greatest advantages of the dowel lies in the fact that it can be applied to ties in which the spike holes have worn out. This is done by increasing the size of the old spike hole to the necessary diameter of the dowel and placing the dowel in position much as for the new tie.

The dowels fit very tightly into the wood. The great lateral pressure against the wood fibers is illustrated by the fact that when some ties which had been provided with dowels for five years were sawed through the pieces of the dowels were sprung out from the tie. Fig. 7 shows a dowel and new tie cut through the middle. The dowel had been in position in this tie about three months. It will be noted that some of the creosote with which the dowel had been treated had already penetrated laterally into the soft wood of the tie. Great stress is laid upon this, for it proves that the wounding of the tie made by screwing in the dowel is of so light a character that not only is there little space for water to enter, but the dowel itself helps to make the wounded surface impervious to the action of water, and protects it against fungi.

A large number of tests have been made to show the higher resisting power to both vertical and lateral pulls of screw-spikes and spikes when inserted in the dowel. A very much greater resisting power of the spike or screw-spike within the dowel is at once evident. A further valuable fact is that not only does the dowel protect the surrounding wood against the wear of the screws or spikes, but the heads of the dowels serve partially as tie-plates. The experience of the last five years on the Paris-Lyons-Mediterranean Railway of France with soft French southern pine is worthy of note. On stretches of track over which an average speed of 100 kilometers (62.1 miles) was made, a number of old ties were provided with dowels in 1896, and at the same time a number of new ties without dowels were laid. In 1902 the new ties had already been worn out, while the old ties with the dowels showed practically no wear. If this should prove true in this country, it might be possible to do away with the expensive steel plates now generally in use. The following estimate made by a German engineer shows how the European engineers who have tried dowels look at the matter:

Estimating the price of a treated pine tie, including the placing of the same, at 4 marks (95 cents), the annual charge at 3½ cents with interest would be about 55 pfennigs, if it is assumed that such a tie lasts ten years. The price of providing one tie with six dowels can be estimated at 1.10 marks (26 cents). If one uses old ties which have been taken out of the track and provides these with dowels instead of replacing the old ties with new ties, the cost of providing ties with dowels will already pay for itself after two years' use of a doweled tie. It has already been proved at this date that the increase in the length of life is very much more than two years. If the increased length of life be estimated at from eight to ten years, about 4 marks (95 cents) per tie will be saved.

The best proof of the high estimation in which Europeans hold the dowel is the great extent to which they are being adopted. The Prussian State Railway this year provided 350,000 old ties with dowels, and the Paris-Lyons-Mediterranean Railway of France has for several years been putting dowels in its ties. The same is true of a certain number of Spanish roads which have been putting in 250,000 to 300,000 dowels annually. On the Marienfelde-Zossen stretch, on which the high speed tests of the Prussian Government were made recently, all the ties were provided with dowels. The increased strength thereby given to the track is testified to by the military authorities in charge of track construction.

There can be no question but that the introduction of the dowel is one to be welcomed by all engineers. The great increase in holding power which it gives both to ordinary spikes and to screw-spikes cannot be questioned, and any device tending toward increased stability ought to be welcome. The adoption of a device of this kind in the United States will depend largely upon the ease with which it can be applied. It is believed that the great problem of how to make a spike hold in soft wood ties as well as it would in an oak tie may at least be partially solved by the use of this device. If it turns out that it is possible to make a soft wood like loblolly pine or red oak serve the same purpose as the harder white oak or longleaf pine, an important step in the utilization of our forest resources will have been made.

## Railroad Shop Tools.

(*Continued.*)

### WHEEL PRESSES.

The hydraulic wheel press shown in Fig. 1 is made by the Niles-Bement-Pond Company. This machine has a capacity of 200 tons and will take wheels 44 in. in diameter. The machine is mounted on a base plate, but no strains are transmitted to this plate—all of the pressure being taken by the tie-bars. The cylinder is lined with copper, expanded into place and burnished. The piston is packed with leather. The pump is double acting, with two sizes of plungers, and has three speeds of delivery. The delivery may be instantly stopped by trip-valves without shifting the belt. The ram is counterweighted for quick return when the release-valve is opened. The safety valve can be set to open at any desired pres-

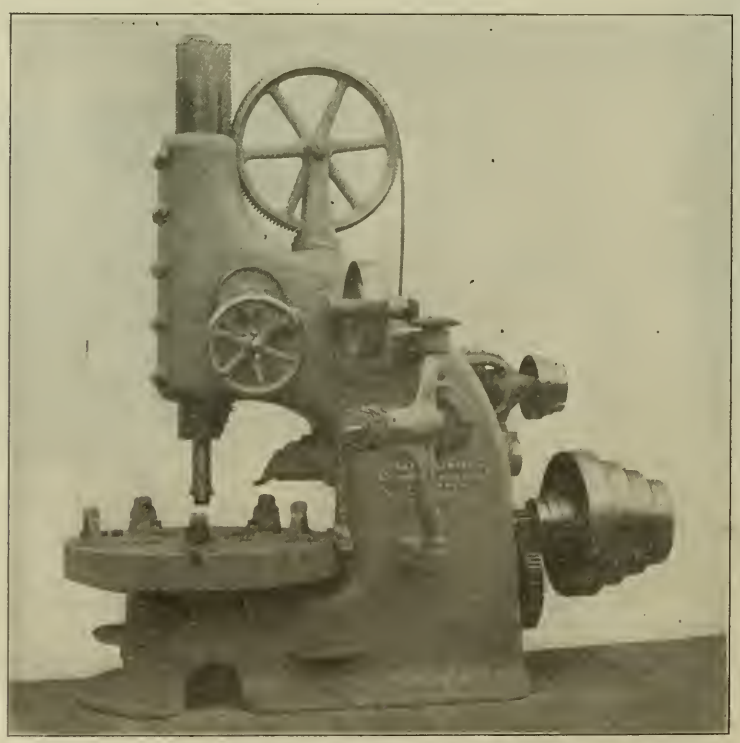


Fig. 3—The Putnam No. 2 Car Wheel Borer.

sure and is protected from tampering by a lock box cast on the cylinder. The pressure gage is graduated for total tons pressure and for lbs. per sq. in. A water tank which supplies the pump and takes the discharge is bolted under the cylinder. The resistance head is supported by rollers running on ways on the base of the machine, and is held

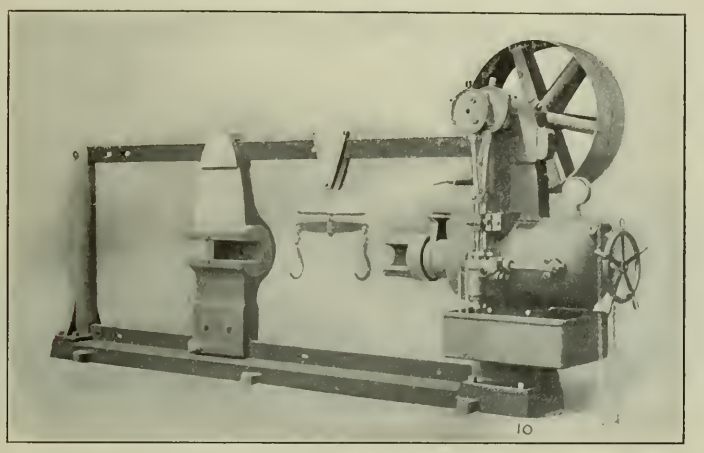


Fig. 1—Niles-Bement-Pond 44-in. Hydraulic Wheel Press.

in position by steel keys placed in the tie bars. The driving pulley is 36 in. in diameter for a 6-in. belt, and should run at 100 r.p.m. When desired, this machine can be run by a direct connected motor.

The 96-in. hydraulic wheel press shown in Fig. 2 has a capacity of 400 tons and is used for locomotive driving wheels up to 90 in. in diameter. The distance between the tie-bars is 96 in. The maximum distance between the ram and the resistance head is 8 ft. 8 in. The opening in the resistance head is for axles 12 in. in diameter. The double-acting pump has two sizes for plungers and three speeds of delivery, which are under instant control. This machine is equipped with an elevating mechanism by which the machine may be raised to any desired height above the floor, so that wheels of different diameters can be rolled into position, thus avoiding the necessity of handling the wheels by cranes. The machine is guided by two stands carrying guide rods. A motor operates the pump and elevating screw. When this machine is set up in the shop, all of the lower part shown in the illustration is placed below the floor.

This machine is made by the Niles-Bement-Pond Company.

BORING MILLS.

The Putnam Machine Company's No. 2 car-wheel borer is shown in Fig. 3. This machine will receive wheels from 15 in. to 48 in. in diameter, and will bore either straight or tapered holes. The chuck has five steel jaws operated both universally and independently. The chuck runs in a babbitt-lined case, and the chuck spindle is hollow, which allows the borings, chips, etc., to fall into a pit in the interior of the machine. The vertical pressure and end thrust of the cutter head is received on an anti-friction ball-bearing having steel seats. The driving cone has four changes for a 5-in. belt, and the countershaft is so arranged that the momentum is checked by a friction brake when the machine is stopped. The vertical boring spindle is provided with take-up bolts and has six changes of speed, ranging from $^3/_{16}$ to $^5/_8$ in. The spindle can be run up into the frame so as to clear the throat of the machine and give full play to the crane when setting up the work. The boring spindle is equipped with a safety stop which automatically stops the machine, after the cutters pass through the wheel. The hub facing spindle can be worked by hand or can be operated automatically with the boring spindle. Each machine is furnished with one patent cutter head carrying six cutters of high speed steel. The weight of the machine is 18,500 lbs.

The accompanying illustrations, Figs. 4 and 5, show the 34 in. vertical boring and turning mill made by the Colburn Machine Tool Company. This mill will take work 34 in. in diameter and the clearance under the cross rail and the turret is 14 in. and 22 in. respectively. The machine has 16 changes of speed ranging from 2⅜ to 68⅜ r.p.m. Both vertical and horizontal feeds are positive gear driven and are provided with adjustable automatic stops. The chuck is both universal and independent. To pre-

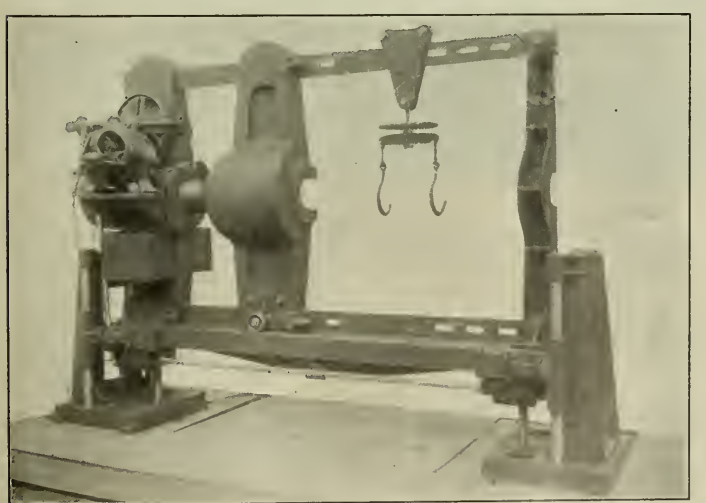


Fig. 2—Niles-Bement-Pond 96-in. Hydraulic Wheel Press.

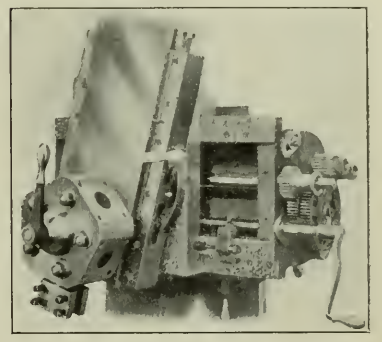


Fig. 5—Detail of the Colburn Mill.

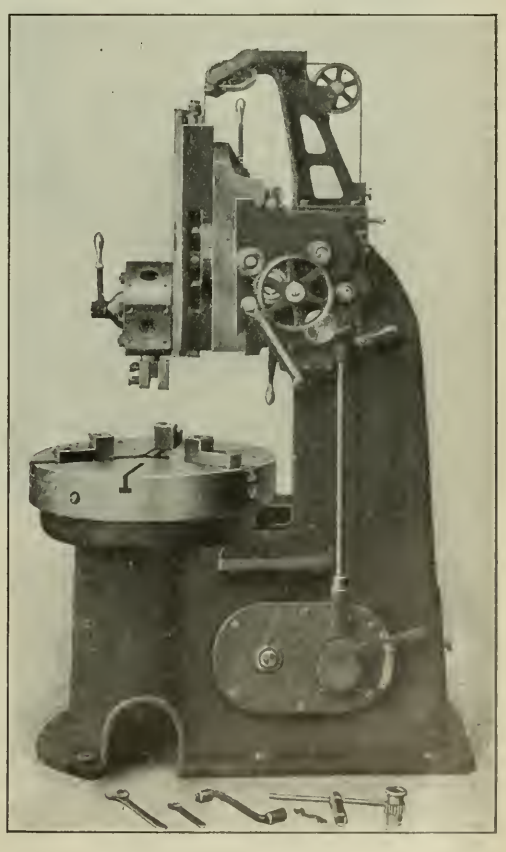


Fig. 4—The Colburn Boring Mill.

vent any possibility of the chuck jaws slipping, interlocking teeth are milled in both the jaws and the slides. The driving cone shaft is placed parallel with the cross rail, and is belted back to the countershaft, thus leaving a clear space overhead for crane service. A cast-iron gear is bolted to the chuck, so that there is no twisting strain on the spindle and it is driven by a steel pinion through a train of gears. The ratio of the constant train is 7½ to 1, and the ratio of back gears is 45 to 1. The 16 changes are graded to give a perfect geometrical progression. The spindle is 6 in. in diameter and runs on a bronze shoulder ring. The vertical slide has a travel of 18 in. and can be operated either by hand or power. It is carried on a swivel saddle attached to the cross slide by a central stud and is clamped to the cross slide by four bolts, working in a circular T slot. A graduated scale 18 in. long is attached to the turret slide cap and is parallel with the turret slide. The turret slide has an adjustable pointer which moves over this scale and indicates the travel of the turret. The turret slide can be swiveled 30 deg. either side of the perpendicular. The cross slide has a travel of 15½ in. and can be operated either by hand or power feed. An adjustable automatic stop is provided for tripping the feed. The slide can be clamped to the cross rail without having to use a wrench. The turret is 10 in. in diameter and has five sides. Each side is 5⅝ in. long and has a hole to fit tool shanks 2¼ in. in diameter. A micrometer dial is set over the collar on the cross feed screw. This is useful for finer adjustment of the cut. The machine is arranged so that a thread cutting attachment can be applied. The floor space required for this machine is 4 ft. 6 in. x 5 ft. 1 in. The net weight of the mill is 5,500 lbs.

*(To be continued.)*

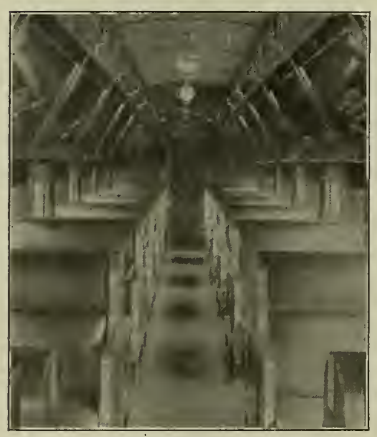
## Canadian Pacific Tourist Sleeping Cars.

The Canadian Pacific is building 27 tourist sleeping cars in its Montreal shops. Eight of these cars have already been finished and put into service between Boston, St. Paul and Vancouver. A number of new features have been embodied in the design and the cars are as substantial and comfortable in everyway as the standard sleeping cars without, of course, having such luxurious interior appointments. They are 79 ft. 10 in. long over vestibules and 9 ft. 10½ in. wide over side sills. The framing is Canadian Pacific standard with ⅝-in.x7-in. iron flitch plates in the side sills, ¾-in.x7-in. plates in the end sills and ½-in.x6-in plates in the side and end plates. In addition to this all the end posts have ⅜-in. x 4-in. iron flitch plates built into them and these are lapped over and bolted and riveted to the sill and plate flitch pieces, making the end of the car practically non-telescopable. The car body is stiffened with 1¾-in. truss rods, which pass under cast-steel queen posts riveted to the 8-in. steel deck-beam needle beams.

The body side framing is yellow pine. The posts are 1¼ in. x 4⅛ in. with the outside corners rabbeted ¾ in. deep to receive the whitewood siding which is laid on flush. This siding is carried up from sill to plate and over it is laid the thin mahogany finish which is used on all Canadian Pacific passenger equipment. The exterior finish is varnish over the natural wood and the only ornamentation is narrow gold striping. The windows have double top and bottom sash, the outside top sash having three panels of beveled plate glass. Standard wide vestibules are used and the cars are mounted on 6-wheel trucks with 40-in. steel-tired wheels.

The main compartment of the car is divided into 14 sections in the same way as the standard sleeping cars. The seats, backs and head pads are upholstered with dark-colored leather. Each berth is supplied with a spring mattress, hair mattress, feather pillows, blankets and the necessary linen. At one end of the car a kitchen is provided, where passengers can prepare their own meals. It contains a steel range, sink with hot and cold water and ample cupboard room. Adjoining the kitchen is a smoking room furnished with leather and wicker upholstered furniture. Washing facilities for men are provided in this compartment and

Exterior of New Canadian Pacific Tourist Cars.



Interior of Tourist Sleeping Car.

the men's saloon leads off from it. At the opposite end of the car is the heater room, linen storage locker and two ladies' toilet rooms furnished with hot and cold water.

The car is lighted by acetylene gas made by the Toltz-Lipschutz system. The center lamps have opal globes and four branch burners and when all the burners are lighted give ample illumination.

We are indebted to Mr. W. E. Fowler, Master Car Builder of the Canadian Pacific, for the illustrations and details of the description.

## Train Registers and Their Bearing on the Collision Record.

BY H. W. FORMAN.

Rule No. 195. Both conductors and enginemen are responsible for the safety of their trains, and, under conditions not provided for by the rules, must take every precaution for their protection.

Rule No. 83.—A train must not leave its initial station on any division, or a junction, or pass from double to single track, until it has been ascertained whether all trains due, which are superior, or of the same class, have arrived or left.

Train registers play an important part in the safe movement of trains, yet they are not always rightly designed or properly located and used. They are too cramped; insufficient space is allowed for a conductor to write in the information required. Allowance of ¾ in. will be made for the names of conductors, and Conductor Schillinghauser will be expected to write his name within that space without encroaching upon and obscuring vital information in the adjoining column, which may be intended to show whether or not his train is displaying signals, simply because Conductor Hill can do so. It would have been well if the Train Rule Committee of the American Railway Association had suggested a train register form, as it no doubt would have been adopted by companies using Code rules. It will be necessary to somewhat qualify this remark, however, as there would be little relief or benefit derived from a standard train register if it possessed some of the objectionable features of certain standard code forms, the train order blanks, for example. The fact that a train order is often addressed to several trains moving in opposite directions seems to have been overlooked by this committee, as not enough space was allowed in the "19" and "31" forms to permit this to be done.

At points where both main line and branch trains are required to register one book is often used in common by all. At district terminals the book will be left lying on the counter where last used by the conductor who consulted it or registered. Often, in such cases, the register for east-bound trains may be found on that part of the counter which is intended for the use of trainmen of trains going in the opposite direction. A revolving train register holder can be made for about $3, which will keep each register in its proper place. Some train registers have pages long enough to accommodate trains for several days and are made up into books of several hundred pages. The entire page is filled up and long before the book is filled it becomes badly soiled. Its leaves are torn and it is almost a wreck. Again, a practice is followed of using the same page for trains arriving and leaving. First, No. 3 will be shown with green signals and perhaps 2d. No. 30, with no signals, will appear directly underneath to trap the unwary. Or No. 6, due to arrive at the end of its run on July 20th, may meet with delay and not reach its destination until after midnight and register on the page set apart for trains on the 21st. Later on, an inferior train may in checking the register assume that, as No. 6 of the day before is twelve hours overdue, it need not be checked for and that No. 6 of the 21st has arrived. Or No. 6 may be running in sections and part register on one page and part on another. Of course, if the time and other circumstances, such as running a train in advance of its schedule, were carefully considered there would not be accidents due to these irregularities; but registers are not always studied as carefully as they should be. Men generally come to the register when

they are ready to start on the trip and their orders are often such that they are in a hurry to leave as soon as possible.

If a regular train is due at a station on the 20th of July it should be registered on the page for that date, even though it does not pass such point until the 21st. Extra trains should be registered on the page for the actual date of their arrival or departure. There should be a train register of not over one hundred leaves permanently located for each district or branch, and its pages ought to be only long enough to accommodate an average day's business, using a page for each day of the month.

In drafting train registers three essential features should be given the most thought and be placed where they will at once attract the eye—the number of the train, signals displayed by it, and its engine number. Some registers first provide a column for the train number,then its section, and, nearly last of all, as if it were unimportant and a chance thought, a column to write in the signals displayed by it. Thus 1st No. 4 may be shown as "No. 4, 1st section." The section should be the first thing to arrest the attention, next the train number, and then its signals. Instead of allowing a column only half an inch wide for the section and train number, a full inch or more should be provided. The column for "green" or "no signals," if put between the train number and the engine number, will separate these groups of figures and thus may prevent those who must be governed by this form from mistaking an engine number for a train number.

Three of the most trustworthy and experienced conductors whom the writer has ever known have overlooked opposing superior trains at initial registering stations. One case came about through checking a branch train's engine number, which happened to correspond with the number of the main line train, which should have been waited for. This occurred where the same register was used for both main line and branch trains. The other two conductors actually overlooked trains, as they afterward privately confessed, but were prevented from colliding with them by the despatcher remarking when he cleared them, "You wait here for No. ——." I am prepared for the exception that may be taken to this seemingly unnecessary precaution; that it divides the responsibility and that what is everybody's business will eventually only be perfunctorily done, or that the conductors will depend too much upon the despatcher. But I know a number of despatchers of many years' experience who never fail to impart this information. No one can say how many accidents they may have thus averted, as no conductor cares to come right out and admit that had not the despatcher reminded him of a train he would have overlooked it; but there is evidence available that at least seven collisions have been prevented in this manner during the past quarter of a century. No doubt almost any despatcher of several years' experience can cite additional instances.

Run trainmen hard and call them out of bed about three o'clock in the morning, after having allowed them only five or six hours' sleep, and their minds are not so clear as that of the despatcher, who works regularly only eight hours of the twenty-four, and who has every train down on the sheet before him, with a good light to enable him to note their location. A few years ago an operator at a registering station at the end of double track delivered a clearance card to an early morning freight train, opened the switch and allowed it to proceed against a first class train which was due eight hours before, and which had been on time for months, but was late on this fatal morning. The train was overlooked by seven men. A suggestion to the operator by the despatcher that the freight train would wait at that station for the superior train would have reminded all of them of it and the great loss of life and property which resulted would never have been recorded. When a conductor or an engineman overlooks a train and moves against it he is considered unsafe and often is taken out of service permanently or for sixty days; but the despatcher and operator are seldom disciplined for failure to remind these men. I suppose this is a correct principle, as it is thought by many to be in the interest of good government to never look beyond the person who clearly is responsible for an accident. But my sympathy is with the man who is trapped. It seems to me, for instance, that the despatcher has not performed his full duty when he issues all the orders that a train needs, except the order to run extra, and then shifts the entire responsibility for the train going without this order upon the conductor and engineman.

There seems to be an impression that Code rules do not require enginemen to check registers. I will not here contend that they do, but it certainly cannot be claimed that they are forbidden to do so. If the conductor and engineman are both literally held responsible for the safety of the train, as provided in Rule 105, then it would seem that the enginemen, as well as conductors, should know, by examination of train registers, or by other means than verbal assurance of conductors, that at least superior trains have passed; to protect the company, the passengers, themselves and other employees.

I will not say that enginemen should always check registers at intermediate stations; but can they not get around five minutes earlier and check up the most vital one of them all—the one at their starting point? It is this register which is giving the most trouble and it is at the initial station where so many trains are overlooked.

### The White Star Steamship Baltic.

The accompanying illustration shows the Baltic, the newest addition to the White Star fleet, which leaves New York to-day on her first trip East. The Baltic is the largest steamship in the world, being of the same class as the Cedric and the Celtic of the same line, but 27 ft. longer (one plate), and is expected to make the ocean trip in 24 hours' faster time than these ships. The Baltic is 726 ft. long, comparing with 691 ft., the length of Brunel's Great Eastern. The tonnage of the Baltic is 24,000 gross. The gross tonnage of the Great Eastern was 22,500. The Baltic's cargo capacity is 28,000 tons, and she can carry this great bulk of freight at a speed of 17 knots on a coal consumption of about 250 tons a day. Low consumption is, of course, the noteworthy thing about the great, modern transatlantic freight and passenger carriers which have been built within the last few years to run at something less than express speed. The Teutonic, built in 1889, as an express

The Steamship Baltic.*

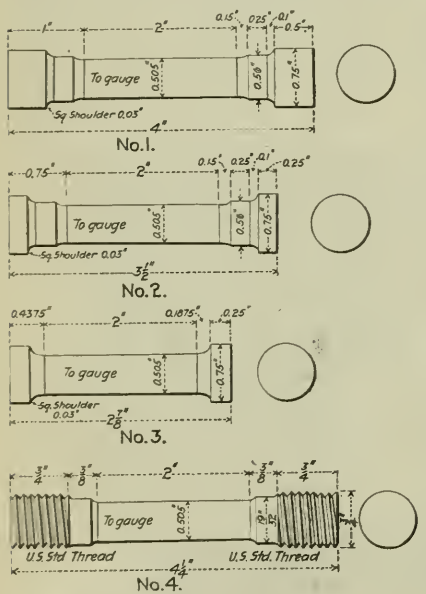
*Photo. courtesy Am. Syren & Shipping.

steamer, has a speed of 20 knots, but carries an insignificant dead weight tonnage. With each vessel running at its maximum speed, her coal consumption is not far from double that of the Baltic. The latter vessel represents the perfection of the modern type of carrier, which, by the sacrifice of a day in running time, compared with the express steamers, can carry a cargo enormously greater at half, or less than half the coal consumption. The new fast German steamers burn, in practice, approximately three times as much coal as the Baltic does, to pay for their speed.

The Baltic was built by Harland & Wolff, Belfast, the builders of the White Star fleet. She has quadruple expansion engines driving twin screws. The passenger accommodations provide for 3,000 and a crew of about 350 is carried.

## A Chuck for Holding Short Test Pieces.

At the Atlantic City meeting of the American Society for Testing Materials, T. D. Lynch, of Pittsburg, described a chuck designed to hold physical test pieces without the usual necessity of threading the ends. This chuck has been in use in the material and testing department of the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., for about two years; it is simple and easy to apply, gives

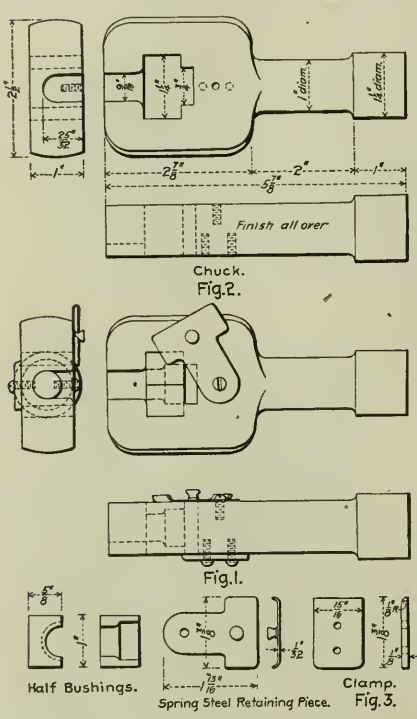



Different Forms of Holding-Heads for Test Pieces.

perfect alinement, saves threading and permits tests from minimum stock: Fig. 1 shows the assembled chuck; Figs. 2 and 3 show in detail the component parts. The head and neck are similar to the old chuck for the standard threaded-end test pieces. The body is 2⅞ in. x 2¾ in. x 1 in. with a chamber 1¼ in. x ¾ in. extending through it to receive the split bushings. Adjacent to this and over it is provided another chamber ¾ in. x ¼ in. to receive the end of the test piece that may extend above the bushing.

A slotted hole extends from the chamber to the bottom of the chuck to provide space for the test to assume proper alinement. The half bushings are of tool steel and so made that the shoulder of the test piece will fit snugly into them when put together. The outside of the half bushing is accurately made so that when put together in pairs they will slip easily into the chamber. A clamp is fitted to the back with two small screws and extends over the end of chamber to hold the bushings when they are pushed home. A retaining piece made of spring steel is attached to the front of the body by a screw, permitting a side motion. When drawn down it holds the bushings and test firmly in place, and when pushed to one side the bushings can be readily removed.

Fig. 4 illustrates three styles of holding-heads for specimens, used successfully in this chuck. No. 1 is 4 in. total length, and is recommended when there is plenty of stock. No. 2 is 3½ in. total length, and shows the proper proportion when the tests are but 3½ in. long. No. 3 is 2⅞ in. total length and is the minimum length so far




Chuck for Holding Short Test Pieces.

used in this chuck, maintaining a constant test section of 2 in. gage length and .505 in. diameter. There has been no noticeable difference in the results of tests due to the variations in total length. Even with the shortest piece, all tests so far conducted have broken near the middle, except for local flaws such as would affect any test regardless of holding devices. No. 4 is 4¼ in. total length, with threaded ends, and corresponds in every way to the standard adopted by the society, except the diameter is .505 in. instead of .5 in. This was used with the ordinary threaded chuck, until replaced two years ago by the one just described.

## Railroad Building in West Africa.

In April Mr. Frederick Shelford read a paper before the Royal Colonial Institute in London, on "The Development of West Africa by means of Railroads." In discussing the cost of building he asked that due allowance should be made for the fact that the lines had been built through dense tropical forest in the worst climate in the world. These conditions involved short tours of service, constant changes of staff in every grade, very heavy rainfall, scarcity and inferiority of unskilled labor and the complete absence of skilled labor, landing difficulties and the necessity of carrying on construction entirely from one base. Further allowance must be made for the native revolts and military operations which have occurred in each case. The cost of the different lines, including permanent bridges, headquarters, establishment and rolling stock, etc., complete, Mr. Shelford placed as follows:

| | Mileage. | Total Cost. | Cost Per Mile. |
|---|---|---|---|
| Sierra Leone Railroad.. | 222 | $4,656,638 | $20,976 |
| Gold Coast Railroad.... | 170 | 8,521,960 | 50,129 |
| Lagos Railroad* ..... | 125 | 4,291,190 | 34,328 |

*Cost of main line to June 30, 1903.

How the cost compared with that of other African railroads will be seen from the following figures:

| | Mileage. | Total Cost. | Cost Per Mile. |
|---|---|---|---|
| Uganda Railroad..... | 584 | $26,973,000 | $46,187 |
| Congo Railroad..... | 250 | 12,636,000 | 50,544 |
| Cape Gov't Railroad....2,089 | | 106,153,170 | 50,815 |

In considering these figures it must be remembered that the gage of the Sierra Leone and of the Congo Railroad is 2 ft. 6 ins., while that of the Gold Coast, Lagos and Cape Government railroads is 3 ft. 6 in. and, that of the Uganda Railroad is one meter. There was one important point, Mr. Shelford said, to be noticed with regard to railroads in West Africa—that the further they are built the greater is the speed of construction and the less the cost, provided they are authorized and organized as a whole, and not in sections. This is due to the better climate and the more open country found further inland, the greater facilities given to the staff to organize the machinery of construction, the increasing confidence and efficiency of the native laborers and the existence of an established base with quarters for the staff, workshops and improved landing facilities.

In summing up the present development of railroads in West Africa, Mr. Sheldon said that in Sierra Leone a railroad 222 miles long had been nearly completed, traversing the colony from west to east, forming probably the longest continuous length of railroad of 2 ft. 6 ins. gage in the world, and being the most cheaply built line on the western side of Africa. In Lagos a 3 ft. 6 in. gage line, 125 miles long, had connected up the three largest towns on the West Coast of Africa—Lagos, Abeokuta and Ibadan. On the Gold Coast a 3 ft. 6 in. line, 170 miles long, had placed Kumasi, the capital of Ashanti, within 16 days' journey of Great Britain. The French had connected St. Louis and Dakkar by rail, and were proceeding with meter gage railroads connecting Kayes and Koulikoro in Senegal, Konakry and Kouroussa in French Guinea, and Kotonou and Paouignan in Dahomey. The Belgians had connected Matadi and Leopoldville with a 2 ft. 6 in. gage line, and were proceeding with extensions. With regard to the future development of West Africa by railroad building, the field is a very large one. The immense area of Western Africa would not be adequately served by one hundred times the length of railroad at present built. All railroads, however, in West Africa, with few exceptions, must at present be developmental, and must be built without immediate prospect of a return upon the cost of construction, since it will take time to educate the natives and develop trade to such an extent as to return interest on the capital expended. Under these circumstances private enterprise cannot be expected to assist in building railroads.

The question is whether the Imperial Government should not assist the Colonies later on by grants of money to build railroads which are most urgently needed. It was mentioned that the French schemes for railroads in West Africa, now in process of carrying out, entirely dwarfed the British lines.

RAILROAD GAZETTE

## CONTROL OF INTERURBAN TRAFFIC

It was announced a few days ago that the New York Central had secured control of the Syracuse Rapid Transit and the Utica & Mohawk Valley companies, operating electric lines which compete for the short-haul passenger traffic in the territory served by the steam railroad in northern New York State. This is the most important step in meeting trolley competition which has been made since the New York, New Haven & Hartford took over the electric lines in New Haven, as a definite base from which ultimately to maintain an electric short-haul service of its own and to prevent further paralleling of the main and branch lines in this district. It has been frequently pointed out in the *Railroad Gazette* that this method of controlling trolley competition by setting a rogue to catch a rogue is undoubtedly the best way of taking care of the short-haul business in the vicinity of large cities, in view of the tremendous inroads which the electric lines have made in this territory within the last few years.

In the issue of August 21, 1903, a paper was printed discussing some of the operating features of the Utica & Mohawk Valley line, which constitutes part of the present purchase, running from Rome to Little Falls, 38 miles, through the city of Utica, with a branch to Clinton nine miles long. The company almost at the outset picked up an interurban business of some $30,000 a month, entirely independent of the heavy traffic in the city of Utica, and an efficient express service is maintained in connection with the passenger traffic. It seems quite evident that the steam road will be better served by having the Utica & Mohawk Valley as an ally instead of as a competitor, for these lines form the nucleus of what was likely soon to become a very serious competition indeed. At Syracuse the problem which the company has to face is the prevention of the establishment of a competitive paralleling electric line to Rochester. The country is well adapted for the interurban business, and it seems obvious that it would, in the near future, have been a troublesome locality if the steam road had not taken the trolley business into its own hands.

Control of the interurban lines in competitive territory is so reasonable and so easy a solution of the problem, that even at this time, when only the beginnings have been made, it seems remarkable that the chance has been so long neglected by the steam roads. A few years ago it would have been far easier and far cheaper than at present to secure either the properties as they then existed, or the franchises; a few years hence it will be far harder and far more expensive than it is now. The New Haven road and the New York Central are in the van of a movement which must shortly come in the many localities where the electric road is obviously the best agent for handling short-haul traffic. The steam roads now have a chance to build up an excellent collateral source of income and to establish at the same time an ally and a defense. If they neglect to do so they are sure to lose much, both of old business and of new profit. The interurban people in the last few years have been carrying on a most valuable object lesson in the development of suburban territory, and with that development goes also a suggestion of the way city tracks and terminals can be efficiently and economically cleared of the local passenger traffic, that is expensive to provide for and that blocks the way of the through traffic which is the natural function of the steam road.

## TRACK INSPECTION.

Elsewhere in this issue will be found the results of the annual inspection of track on one English and three American railroads, all of which have adopted the premium system of rewarding good work in that department. The four reports are presented together in a group, simply to show the slight differences in the working of the system, and not for the sake of comparison of results on one road with those on another, because comparisons would be obviously unfair, even if all of the markings of the inspectors were reduced to one common basis. In this, as in so many other details of railroad operation, the one important thing is the final result obtained, rather than the method of accomplishing it. Each of the four roads whose reports are shown are trying to improve the standard of track work by encouraging good work with rewards in the shape of money prizes or suitable emblems; other roads are doing the same thing in other ways, by careful superintendence and inspection, by disciplining slovenly employees and promoting conscientious men to positions of more responsibility. The value of the premium system depends largely on the caliber of the men who are putting up track, and it becomes beneficial or demoralizing as it encourages a spirit of healthy rivalry or a spirit of jealousy and discontent. The annual inspections on which rewards under this system are based, must of necessity be superficial in many ways. There is nothing about a railroad that is so deceptive as a piece of track and nothing is more affected by local conditions. As the inspectors go over the road they may find at one place a rough stretch, full of kinks and low joints, which needs, however, only a few days' work to be put in first class shape. Possibly just before the inspection the section foreman or the supervisor has been devoting all of his attention to holding a sliding bank or draining a wet cut and could not get his track in good surface until his other work was finished. Nevertheless, he gets a low mark. At another place the inspecting party may ride over what is apparently a fine piece of smooth and even track, but which, with a few hours of rain, can be reduced to worse condition than the average construction track. Give a section foreman or supervisor a few days' notice of an inspection, and he can straighten and lift a poor piece of track under his charge up to an almost perfect surface and alinement that will last until the first hard rain. Then all the loosely tamped ties and low joints will begin to show up as glaring evidence of the kind of work that was done. It is not that the inspectors mark unfairly or incompetently in making their inspection, but that they judge the condition of track while riding over it, and it is seldom that they have an opportunity of making a close examination of the quality and amount of work that has been done. It is obviously unfair to a man who is working conscientiously day and night, and perhaps with the greatest degree of skill on a hopelessly bad piece of track, when the announcement of prizes and rewards for the year gives the premium to another man who has no wet cuts, sliding banks, or ballast that is a mere excuse for such to worry about, but who spends his time tamping a little here and a little there and adorning the grounds about his "Prize Section" sign with flower beds and little piles of whitewashed stones. Perhaps this is putting the case too strongly, but it illustrates the truth of the statement made before, that in a large measure the value of the premium system depends on the men who are working under it. If they are the kind of men whose one aim is to make good track and to keep it good, then the premium system can do no harm, but will encourage them to keep on doing better every year. The average man likes to beat the other fellow at any game; but, unfortunately, every one is not endowed with that quality, sometimes called the "sporting spirit," which makes a man keep on going as hard as he knows how, even when he sees he is beaten. If a man is so heavily handicapped by local conditions that he stands no chance in the race to win a prize with some other man further along the line, he is quite apt to be discouraged and to feel that it is no use trying to make the track under his charge any better than it is. The annual inspection is a good thing for all the officers and men on the road, but the conditions found on inspection day should not be relied upon to indicate the conditions which hold for the other 364 days in a year. When the station agents and the track men and all of the other humble employees of the road know that the "G. M." and his party are due on a certain day, at a certain hour, they are very likely to have everything cleaned up and in the best of order. This has one great value in that it shows what can be done, but it seldom shows what is done when the "old man" is not around. The railroad officer who depends on a yearly trip of inspection to show him the condition of the property under his charge, is far from being acquainted with the true state of affairs. He has the right to demand, however, that if things can be done in a certain way when he is around, then they can be done in the same way when he is in his office a thousand miles away.

## THE RAILROAD LAWS OF MASSACHUSETTS.

A volume compiled by the Railroad Commission of Massachusetts, setting forth, to some extent, in condensed form, the statutes of that State relating to steam railroads and street railways, deserves somewhat specialized study for several reasons. The State is a commonwealth where railroad problems have received careful attention; the formative and plastic epoch of railroad lawmaking long ago was passed and, except as to certain phases of street railways, the body of laws in the State is crystalized and permanent; and no State of the Union has tried

harder, with more intelligence and with greater success, to reconcile on a basis of justice the conflicting claims of the corporation and the public. In a volume of 142 pages we can only select a few examples of railroad law, but they are suggestive and become more so when we contrast them with the statutes of neighboring States.

Men still in middle life will recall the reaction that set in soon after the panic of 1873—and the long drag that followed it—against the municipal aid for new railroad projects in which so many dollars of the taxpayers were lost. In Connecticut, for instance, the evil had to be checked sharply by a constitutional amendment adopted in 1877, which declares that "no county, city, town, borough or other municipality shall ever subscribe to the capital stock of any railroad corporation, or become the purchaser of the bonds or make donation to or loan its credit directly or indirectly in aid of any such corporation." But conservative Massachusetts allows municipal subscriptions to railroad enterprise, hedging them about, however, with close restrictions. The subscriptions, at most, cannot exceed 2 per cent. of the total valuation (tax list) of the city or town and in smaller municipalities they must not exceed 1 per cent.; two-thirds of the legal voters must authorize the subscription; no municipality shall let its "railroad" debt run up its total debt beyond 3 per cent. of valuation; and there are other modifying checks. That such statutes will stand suggest how much happier—or, any rate, less dismal—than in other States has been the experience of Massachusetts with the old "town aid" abuse.

In somewhat the same line may be noted the liberality of the State in contributing to the abolition of grade crossings. An official report, just made to the State Legislature, throws vivid light on the subject. Under a law passed 14 years ago there have been eliminated in the State 174 crossings at a total cost of $22,603,669, of which the State has contributed $6,019,406 and municipalities $2,927,769. Under the State law the railroad companies pay 65 per cent. of the cost of eliminating the crossing, the municipality not more than 10 per cent., and the State the remainder—in general practice 25 per cent. By way of contrast Connecticut lays one-half the cost of elimination on the municipality and one-half on the railroad company, the State contributing nothing.

The subject of taxation in Massachusetts is too large a one to treat fully here, but special reference may be made to the statute for local taxation of street railways imposing a sliding scale of tax on gross earnings, ranging from 1 per cent. on $4,000 a mile up to 3 per cent. on $28,000 a mile or more—the tax money to be used for improving public ways and for removal of snow. Contrast with this the Connecticut plan, by which taxes of street railways—1 per cent. on par of bonds and floating debt and 1 per cent. on stock at an official market valuation—all go to the State treasury, although the street railways are essentially localized properties. Or, again, contrast the Massachusetts plan with the astonishing statute of 1902 in Rhode Island, by which, in practice, a sliding scale of taxation to the State on gross earnings is made a formal contract with the commonwealth and then intrenched behind the Federal Constitution. Authorities will differ as to the theory of State, as contrasted with local taxation applied to steam railroads, especially since the latter have become consolidated into systems. But as to the justice of the municipal tax of the local trolley road there can hardly be more than one opinion.

Puritan-founded Massachusetts has enacted, in regard to Sunday trains, a brief statute allowing the running of such trains by consent of the railroad commission if public necessity and convenience require it, but "having regard to the due observance of the day." Puritan-founded Connecticut goes, in theory at least, a good way further in protecting Sunday. "Except from necessity and mercy" no Sunday trains can be run within the State between sunrise and sunset. But the State railroad commission can interpret the "necessity and mercy clause," and it does so with some liberality. The Massachusetts statute says nothing specifically about Sunday freight; but the Connecticut statute prohibits the handling of freight between sunrise and sunset on the day except from necessity or mercy—with a reservation that the commission may allow handling of freight up to 8 o'clock in the forenoon between railroads and steamboats for purposes of preservation. In practice, through freight trains run across the State pretty regularly on the Lord's Day and throughout southern New England. We should probably find less of Sunday statute-making for railroads if railroad competition had been more intense.

The distinctive feature of Massachusetts railroad law is the great authority given to her railroad commission. A noteworthy addition in that direction is a statute passed in 1903, giving that body the same power as to freights and fares, over steamship carriers between ports of the commonwealth as the commission has had over steam railroads and street railways. Those powers already were vast, including pretty sweeping authority as to persons and papers, operation, rates, capitalization—under the well known and now thoroughly tested "replacement value" statute for street railways—and, indeed, reaching almost through the whole limbo of railroad finance and administration under the statutes. In the more detailed and less generalized features of those statutes may be remarked briefly the purchase power which the State has reserved of buying out a railroad corporation for capital paid in, with 10 per cent. a year added since the payment; the privilege of a director or of an owner or owners of one fiftieth of the capital stock of a railroad or street railway company of calling for an examination of its financial condition; bonds not to exceed capital stock actually paid in; stock increase to be issued at not less than market value or sold at auction for not less than par; grade crossings of steam and electric roads—prohibited since 1895 in Connecticut—allowed only by consent of commissioners; free transportation of one bicycle per passenger; free passes to State officers forbidden; cheap morning and evening trains and trains for workingmen; personal liability of street railway directors until full payment of capital stock; special street railway rates for public school children; and finally, the opening to savings bank investment of certain classes of conservative street railway bonds of which the last report of the Massachusetts Bank Commissioners shows the savings banks and trust companies of the State had taken $3,769,594.

Other commonwealths have laws similar to some of the foregoing but in few of them have the statutes such amplitude, and in none are the law and its enforcement so closely bracketed together as in Massachusetts. She has not only had the statutes but she has tried them out to the point of survival of the fittest and her sister States, some fifteen of which have not even appointed railroad commissioners, can coin high profits from her experience and example.

## The Northern Securities Injunction.

Judge Bradford filed an opinion in the United States Circuit Court at Trenton, N. J., July 15, granting a preliminary injunction restraining the proposed plan for the distribution of the assets of the Northern Securities Company in the proceedings instituted by Edward H. Harriman, Winslow S. Pierce and the Oregon Short Line. It will be recalled that out of a total of $155,000,000 of Northern Pacific stock deposited at the time the Northern Securities Company was organized, $78,000,000 was deposited by the Harriman-Union Pacific interests; an amount which carries control. But the proposed pro rata distribution of Northern Pacific and Great Northern stock would have occasioned that the Union Pacific interests would have received a large share of the Great Northern stock which they did not previously possess, yet not enough to carry control; while they would have lost the control of the Northern Pacific, with which they went into the merger. As mentioned in the *Railroad Gazette*, April 8, it was claimed by the petitioners that the decision of the Circuit Court on June 7, 1903, directed that the stock be returned share for share, and that the plan proposed for a pro rata distribution would leave control in the hands of the same people who now control and would defeat the ruling of the Supreme Court. This suit, however, was terminated by the denial of the United States Circuit Court at St. Paul, April 19, of the application for leave to intervene in the case of the United States against the Northern Securities Company, and Judge Thayer in delivering the opinion held that the plan of the directors of the Northern Securities Company for the distribution of the stock of the Great Northern and Northern Pacific companies was not violative of the decree in the Northern Securities case; also, that no one but the United States could successfully appeal to the Court to enjoin the extension of that plan on the ground that it was in violation of the Sherman anti-trust act. The Judge further said in his opinion that the stock of the two railroad companies was not in the custody of the Court, but he added that an intervention was not necessary to enable the petitioners to protect any pecuniary interest or equity that they might have.

Without determining the merits of the more important questions raised by the complainants, Judge Bradford gives as the reason for the temporary restraint that the legitimate object of a preliminary injunction, preventive in its nature, being the preservation of the property or rights in controversy until final decision, the principal loss or inconvenience which can be brought about by the temporary injunction is the inability of the present stockholders to realize immediately upon their holdings; but this he considers as nothing, compared with the irreparable injury which the complainants would sustain by a refusal to restrain.

He holds that if the final decision should be adverse to the complainants, the interests of the defendants may in the meantime be protected by an order from the Court requiring a bond of sufficient size to indemnify them.

The effect of this temporary decision on the market was to cause a rally of several points in Union Pacific and Southern Pacific and a decline in Northern Securities. The latter company can either accept the injunction and await the main suit, or they can appeal from Judge Bradford's decision. It is not obvious that there will be very much to be gained by appealing this lesser point in the main contention which the company makes that it can distribute its assets pro rata in the process of dissolution, enforced by the original Northern Securities decision.

## Accounting Switching Charges.

Transportation and accounting officers have given much earnest attention to the consideration of means which will adequately provide for the protection of the revenue derived from switching freight cars, but as yet no simple and efficient method has been devised for surrounding this source of revenue with the proper safeguards and at the same time providing for convenient settlement as between the interested companies. The many industries along the line, calling for the movement of cars to and from convenient tracks within their grounds for loading and unloading by the road hauling the freight, or by another road whose geographical position requires it to intervene to perform this work, or to perform the service of conveying cars from one road to another, when that is necessary to continue a through movement of the car, necessitate countless car movements.

The general conditions and circumstances attending the handling of such cars present many difficulties to the auditing department, which has devoted much study to the subject. The true conditions surrounding the actual performance of the work do not appear at first sight, and there is much difference between specific cases that each industry is really a study by itself. The first difficulty seems to be to find a system providing for the proper and timely record of the cars to be switched and one that will be sufficiently simple in its detail to be readily understood by all the employees who handle the cars, and at the same time give to all interested, proper information of the work to be done, and to the accounting department, a complete history of all the performances, so that it may be placed in possession of the proper evidence to check the revenue and to settle the accounts.

The next difficulty is to originate some form or order or blank which will meet all these requirements and give full effect to any system which may be created without involving cumbersome detail or uncertainty of meaning. With these points settled, there would doubtless be little trouble in adjusting any other differences of opinion as to proper and safe methods for the protection of revenue from this source, and there is enough revenue in this feature of railroad transportation to engage serious attention. That it has been so engaged is very clearly evidenced by the fact that many methods have been tried out in the effort to reach the much hoped for solution of the whole question.

Three plans were reported to the Association of American Railway Accounting Officers at their Saratoga meeting in June last, but they all lacked the essential of simplicity, and were open to other objections, so that the difficulty of harmonizing all the interests, meeting all the demands of the situation and providing for satisfactory operation by the freight agents, yardmasters and switchmen, has not yet been overcome. It is very desirable that some comprehensive and efficient plan with the necessary blank forms needed to make it successful, should in the near future be brought out through the deliberations of the committee of accounting officers having the matter in charge.

## Cincinnati, Hamilton & Dayton.

The recent announcement of the merger of the Cincinnati, Hamilton & Dayton, Pere Marquette and Chicago, Cincinnati & Louisville railroads is one of great interest. Although it is doubtful if it will have any extensive effect on the traffic situation of the Middle West, it should prove of much importance to the three roads interested, as it will make them far stronger, so far as control and interchange of traffic is concerned, in a considerable territory. Including all leased and proprietary lines and those over which trackage rights are held, the new system will control about 3,450 miles of track. In addition, it will operate ferries on Lake Erie, running from Conneaut to Rond Eau and Port Stanley and also on Lake Michigan, running from Ludington to Kewaunee, Manitowac and Milwaukee. The chief terminal points on the new system will be Buffalo, Chicago and Cincinnati, and its branches will run through the largest commercial centers in the States of Indiana and Ohio. The total capitalization of the three properties merged is as follows: C., H. & D., $33,333,000; Pere Marquette, $76,173,622, and C., C. & L., $10,460,000. Taking the aggregate mileage worked by the three railroads as 3,200 the capitalization per mile of the new system will be about $37,000. The aggregate gross earnings of the three properties can only be approximated, as the Chicago, Cincinnati & Louisville has been in operation for such a short period that its earnings are not yet on a permanent basis. The figures from the last reports of the C., H. & D. and the Pere Marquette show total gross earnings on these two roads of $19,000,000, which, combined with those of the C., C. & L. (estimated at $5,000 per mile over 263 miles operated) will give the new system an earning power of over $20,000,000. Dividing this by 3,200, the mileage operated by the system, leaves an earning capacity of about $6,000 per mile. The strength of the consolidation seems to lie chiefly in the immense volume of local traffic which these railroads control. We give below the ton miles and passenger miles, together with the freight and passenger density of the C., H. & D. and the Pere Marquette, showing how the two roads compare and what they will contribute individually to the new consolidation.

| | C., H. & D. | Pere Marquette. | Total. |
|---|---|---|---|
| *Ton miles .... | 830,652 | 993,995 | 1,824,647 |
| *Pass. ton miles. | 109,506 | 129,643 | 239,149 |
| Freight density. | 818,376 | 459,120 | 584,074 |
| Pass. density... | 107,887 | 59,890 | 76,552 |

*Thousands.

As none of the railroads in the merger are dominant in the territory through which they pass, but are overshadowed by the Michigan Central, Lake Shore, Baltimore & Ohio and Big Four, they must rely on the future development of this local traffic. It is quite probable that in order to compete with the larger trunk lines in the east and west bound traffic a ferry will be established at Detroit connecting with the Pere Marquette at Walkerville, across the river from Detroit. In this way the through traffic can be handled via Toledo and Detroit, which will be a much shorter route than via Port Huron.

The third distressing passenger-train wreck of this month, the rear collision ot Glenwood, Ill., on the 13th, appears to have been due to the concurrent negligence of two, three or four men; and the explanation of what these men did or failed to do is so incomplete that little can be said until further information is forthcoming. A Chicago paper says that the passenger cars were of flimsy construction and that Engineman Hoxie had been on duty 15 hours. These points will, of course, demand attention in the final report, though it is to be borne in mind that a man is not necessarily worn out by 15 hours' service on a freight train and that the flimsiest cars in America are as strong as the great majority of the cars on many railroads in other countries. As to the specific cause of the collision, one obvious comment is already clearly indicated: that there is no such thing as a minor position on a train. The newest man, on the slowest train, has to be entrusted, now and then, with a duty as important as the duties devolving on the most experienced. This is such an elementary truth that we should hesitate to put it in writing, but for the fact that it is so often ignored in practice. The brakeman on the leading car ot the string of 30 being backed from Thornton to Glenwood had a duty as lookout, and probably as the responsible person to decide if it were safe to start from Thornton, as important as if he had been the conductor or the engineman. Engineman Hoxie is said to have a good "character," but it is also said that he has been on the road less than a year. Men long acquainted with their road have many times taken risks and come out all right; for newer men the trick is not so easy. A conductor going out with a flag can trust experienced subordinates to manage the train in his absence; while others, with less experience, cannot be thus trusted; and usually the conductor is left to decide for himself how far, or in what kind of work, he can trust a man whose acquaintance with the road or with train work is limited. Surely, the lowest conductor must be a man of the highest grade, if there is to be any elasticity whatever in our train rules.

## NEW PUBLICATIONS.

*Legal Decisions in Car Service Cases.* Published by the National Association of Car Service Managers, A. G. Thomason, Secretary, Scranton, Pa.

This is a pamphlet of 256 pages, giving in full all of the recorded judicial decisions in demurrage suits which Mr. Thomason has been able to find, the compilation having been made in pursuance of a resolution passed by his association last year. There are 44 decisions, including some made by minor courts, and one by the United States Treasury Department; but there are opinions by the Supreme Courts of Massachusetts, Georgia, Kentucky, Virginia, District of Columbia, Tennessee, Pennsylvania, Illinois and Mississippi.

## TRADE CATALOGUES.

*The London & North-Western* issues an illustrated pamphlet bearing the title, "Information for Visitors to the St. Louis Exposition, 1904." A brief history of the road is given, with illustrations of some of the first locomotives used, including the "Rocket," which was designed and built by George Stephenson, in 1829. The initial run of this famous engine was made on the

Liverpool and Manchester section of this road. Illustrations throughout the pamphlet picture the company's rolling stock, road bed, stations, etc. Views are also given of the company's exhibit at St. Louis, which includes a quarter size model of the Royal saloon cars, and a model of the company's steamer "Anglia," used on the Irish steamship service between London and Dublin. Other illustrations show Shakespeare's birthplace, Warwick Castle, etc. The pamphlet closes with a reproduction of a drawing made in 1839, which shows the unique method used in excavating the Tring cutting on the L. & N. W. Ry. in 1837.

The July number of *Something Pneumatic*, the magazine of the Chicago Pneumatic Tool Company, contains an article on "The Value of the Air Drill in Remote Shops," a large number of half-tone engravings of various pneumatic devices in service and descriptive information relative to the Duntley air-cooled electric drill, improved "Little Giant" flue expanders, lightning hose clamps and a new compression lever riveter.

# CONTRIBUTIONS

## Automatic versus Telegraph Block System.

New York, July 19, 1904.

To the Editor of the Railroad Gazette:

An editorial on the collision on the Erie Railroad at Midvale, N. J., which appeared in your issue of July 15, seems inaccurate, not in its main argument, but in the side issue. That "the first question . . . is not one of systems, but rather whether the system used was managed in the best possible way" is presumably unquestionable. But you further say, "whether the failures of the track circuit, plus the errors which enginemen have made in automatics but would not have made if watched by signalmen, have equaled or exceeded the errors of signalmen under a similar volume of traffic *no one knows*." In other words, no one knows whether the telegraphic block or the automatic block is the safer system.

This statement seems to be a distinct step backwards. Wire-connected manual signals —and the great majority of manual signals are wire-connected—are probably more liable to fail than the most thoroughly perfected type of automatic signal. When the signals are located over 2,000 ft. from the operating tower the manual signal is surely less reliable. Also with manual signals we have the chance of an error by the signalman, the operator at the tower in advance and the engineer. With the automatic signal the chance of human error is 1 to 3, as compared with the telegraphic block. The great safeguard of the track circuit in detecting back-up movements, open switches and other dangerous conditions makes the automatic system a more complete and more reliable protection than the telegraphic block system.

The *Railroad Gazette* was among the first to realize and approve of automatic block signaling, first as a protection theoretically more perfect, and, later, as an often proved fact. The writer particularly recalls an editorial in your January 1 issue of the present year on this subject. For this reason the suggestion in last week's editorial seems to require some notice. D. B.

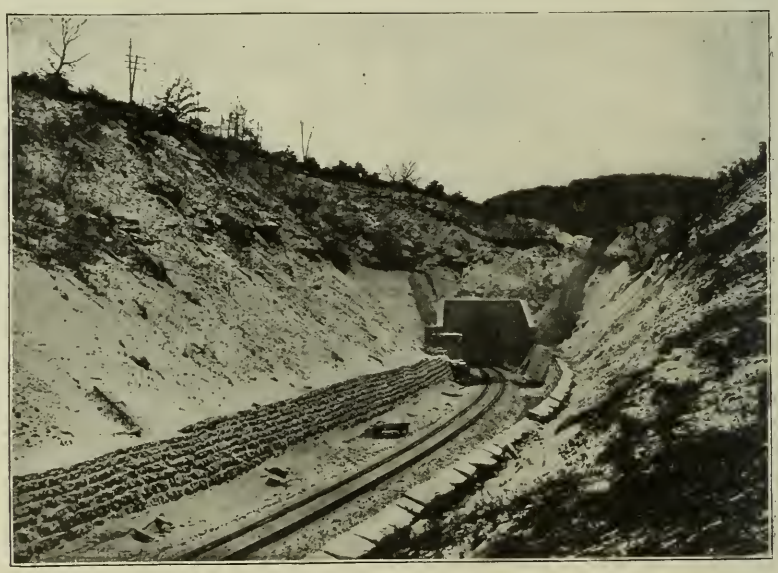
Our correspondent agrees with us as to what is the first question to be considered. Having gone that far he will admit that the question at issue is not one of correct principle in the construction or management of signals in the future, but of actual accomplishment in the past. The statement quoted was not equivalent to saying that no one knows which is the safer system. To paraphrase fairly he would have to include cases where enginemen have disregarded automatic stop signals and have not been detected. Admitting, for the sake of argument, that the chance of human error is as 1 to 3, we must add, in favor of the telegraph block, the likelihood of human perversity, which leads an engineman to take a risk with automatic signals which he would not take with the telegraph block, or which, if the telegraph block were in use, he would have no temptation or opportunity to take. In considering the mechanical efficiency of wires 2,000 ft. long and such dangers as back-up movements, "D. B." is broadening the discussion unwarrantably. The original statement looked toward the settlement of only one question, namely, has the telegraph block system been proved so inefficient in operation as to justify or demand its abandonment and the adoption of automatic signals in its place? No step has been taken backward, for nothing has been said that does not agree with what was said on January 1. "D. B." has fixed his mind on things said there which referred to the highest ideal. In the present case the discussion has to do, not with ideals, but with what has actually been accomplished. A court holds a railroad company up to the "state of the art" as the judges find it by looking at the actual accomplishments of reputable and exemplary railroads, not as it would be found by looking at inventors' prospectuses or even at the accomplishments of a few of the most advanced railroads. We have not forgotten the merits of the track circuit; neither can we forget the great record for safety which has been made by the block system worked by men.—Editor.

The Prussian State Railroads have ordered 278 additional locomotives, to be delivered in the months December, 1904, to March, 1905, inclusive. Among them are to be 58 four-cylinder compound express engines, ten-wheeled with four drivers, 4 smaller compound express engines, 16 passenger engines, 18 superheated steam passenger engines, 26 superheated steam tank passenger engines, etc.

## Relining Winston Tunnel on the Chicago Great Western.

The Winston tunnel on the Chicago Great Western, located near Rodden, Ill., about 12 miles southeast of Galena, penetrates a high ridge that shuts off the approach of the railroad to the Mississippi River. The tunnel, which is 2,440 ft. long, was built 18 years ago by Winston Brothers. The engineers who located it expected to encounter solid rock, there being a layer of limestone some distance above the line of the tunnel. After work was begun the material was found to be principally hard blue shale, which is quite hard when first exposed, but decomposes rapidly in the presence of air and water. The tunnel was lined with wood, the original arches being made of 12-in. x 12-in. timbers, spaced 4 ft. apart. As these showed signs of decay other timber arches were placed beneath them until finally there was a complete double lining of 12-in. x 12-in. timber arches, spaced from 1 to 4 ft. apart in different parts of the tunnel.

The tunnel required constant attention,



East Portal of Winston Tunnel, Chicago Great Western.

and it and the banks of the approach cut on the east were a constant source of danger and annoyance. In order to do away with any further trouble it was decided to re-line the tunnel with brick and concrete and build retaining walls in the cut.

The plan called for the lowering of the track sufficiently to allow leaving in the roof timbers. The original intention was to remove the front and back rows of plumb posts entirely, but this proved impracticable owing to the treacherous nature of the material back of the posts. It was therefore decided to remove the front row only, leaving in the back row. By so doing it was possible to get a wall 3 ft. thick, which was quite sufficient. The wall was built of Portland cement concrete, faced with vitrified brick. To remove the plumb posts an 8-in. x 12-in. sill or straining beam was first notched in on the No. 1 pieces of the timber arches and drift-bolted there. Posts 10 in. x 10 in. were then placed about 4 ft. apart on a batter so as to clear the foundation excavation and also clear the passing trains. There was just room for these posts. The plumb posts were then removed and the foundation for the wall was dug. It was necessary to undermine the back posts in getting the foun-

Partially Finished Section of Tunnel Showing Arch Centering.

Sides Bricked and Original Timber Lining in Crown.

dation to the required grade and in several instances slides occurred which delayed the work somewhat, but not seriously.

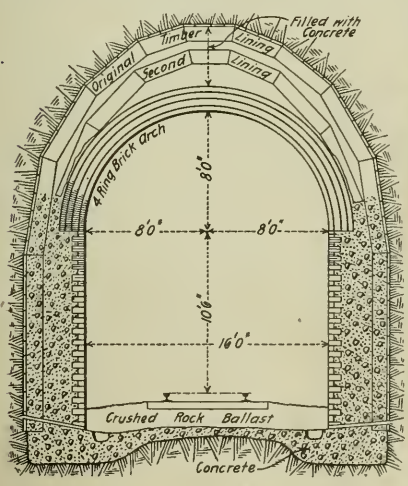
Both walls being finished to the springing line, the track was lowered from 1 to 3 ft. over a distance of 4,000 ft. through the tunnel and approaches. Owing to the heavy traffic this work proved very tedious and expensive. Stretches of 150 ft. were gradually worked down to subgrade, a run-off being put in at the end of the work for the passage of trains. In the tunnel a 6-in. layer of concrete was placed from wall to wall under the ballast in order to seal out all water and mud. Outside of the tunnel 12 in. of crushed rock was placed under the ties.

After the track had been lowered and brought to final grade with ballast, the arching was begun. A four-ring brick arch was built underneath the roof timbers and the space between the timbers and the arch was packed solidly with concrete. This work was all done from the top of platform cars built especially for the purpose, the platform coming about 18 in. above the springing line of the arch. The mortar mixing was done on the floor of the car and the mortar passed through a trap door. The brick were tossed directly from the cars to the working platform as they were needed.

The arch is a complete semi-circle of 8 ft. radius. The centering was made of 4-in. x 4-in. x ½-in. T iron bent to a radius of 7 ft. 9½ in., so as to allow for 2½ in. of lagging. These ribs were spaced 5 ft. apart and supported on posts, wedges being used to bring them to exact position. Forty of these ribs were used, which allowed 200 lin. ft. of arch to be under construction at a time. It was necessary to have a considerable length of working face so that bricking-up and backfilling with concrete could be carried on without interference. The arch was carried up about 2 ft. at a time in benches of 40 to 50 ft. length. When a section was completed and sufficient time had elapsed for setting, the centers were taken down and moved forward.

The outside work was also carried on in connection with the tunnel work. Heavy dry masonry retaining walls were built on each side of the east approach cut for a distance of 1,000 ft. A 24-in. tile drain was laid in concrete, extending from the east portal to the east end of the cut, which was designed to carry off the drainage of a considerable area of country which drains into the cut at this point.

The entire work required almost two years for completion, the greatest hindrances being the heavy traffic and the smoke. An average of 12 to 15 trains during working hours was common in the busy season. Their operation through the tunnel was controlled by a specially installed staff system. The work was carried to completion without serious accident and practically without delaying or impeding traffic. About 15,000 barrels of Medusa and Lehigh cement, 2,500,000 brick and 11,000 cu. yds. of gravel for concrete were used. The Lorimer, Gallagher & Walsh Construction Company, Chicago, had the contract for the entire work. It was planned and executed under the direction of Mr. F. R. Coates, formerly Chief Engineer of the road, assisted by Mr. A. Munster, Bridge Engineer, and Mr. C. H. Potter, Resident Engineer. Mr. W. T. Keating was Superintendent of the work for the contractors.

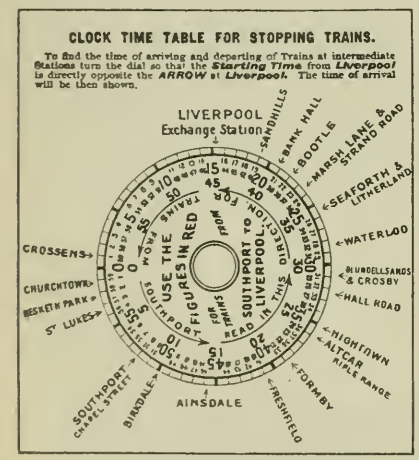



Section of Winston Tunnel.

Mason Gang Laying Crown Sheeting.

## Traffic Features of the Lancashire & Yorkshire Electric Service.

The electrification of the branch of the Lancashire & Yorkshire between Liverpool, Southport and Crossens, for the purpose of most advantageously and economically taking care of a heavy suburban passenger traffic, has been fully described in previous issues of the *Railroad Gazette*, so far as the engineering features are concerned. Certain of the traffic features, particularly the methods of handling the crowds at stations and on trains, are of considerable interest. The company has printed a number of circulars which are designed in part to advertise the service and in part to give instructions to passengers, and these instructions cover a number of points which will be at once recognized from their similarity to American conditions by travelers out of New York, Chicago, or any one of twenty other large cities in this country. A circular at hand calls attention to the fact that a frequent and quick suburban service cannot be secured without the stopping time at stations being cut down to a minimum. In order to obtain this there are notice boards at all station platforms, except Liverpool (Exchange) and Southport, indicating the position on the platform where passengers will be required to stand when waiting for trains. A diagram accompanies this paragraph, showing a train from Liverpool to Southport in its relation to the two notice boards on the platform. Between the Liverpool end of the train and the first notice board is the compartment for third class smokers. Be-


CLOCK TIME TABLE FOR STOPPING TRAINS.
To find the time of arriving and departing of Trains at intermediate Stations turn the dial so that the Starting Time from Liverpool is directly opposite the ARROW at Liverpool. The time of arrival will be then shown.
LIVERPOOL Exchange Station
SANDHILLS
BANK HALL
BOOTLE
MARSH LANE & STRAND ROAD
SEAFORTH & LITHERLAND
WATERLOO
BLUNDELLSANDS & CROSBY
HALL ROAD
HIGHTOWN
ALTCAR RIFLE RANGE
FORMBY
FRESHFIELD
AINSDALE
SOUTHPORT CHAPEL STREET
BIRKDALE
ST LUKES
HESKETH PARK
CHURCHTOWN
CROSSENS
USE THE FIGURES IN RED FOR TRAINS FROM SOUTHPORT TO LIVERPOOL
READ IN BLACK FOR TRAINS FROM LIVERPOOL TO SOUTHPORT

Clock Time Table.

tween the two notice boards is the compartment for first-class passengers and between the second notice board and the Southport end of the train, the compartment for third class non-smokers. In the reverse direction, Southport to Liverpool, the position for passengers is the same. That is to say, the compartments for smokers of both classes will always be at the Liverpool end of the train. This is a very simple matter to arrange, and it is a great advantage that the passengers can always classify themselves in the same places on the platform, thus avoiding much confusion at the rush hours.

The disk, or clock, time-table, illustrated herewith, is also a unique device for timing the arrival of one's train at any station on the line. All that is necessary is that the number of minutes past the hour at which the train leaves a certain station be placed against that station by rotating the disk, and the exact time at which the train arrives at each of the other stations will be shown by the figures opposite them on the disk. In the original, as can be judged from the cut, the lower range of figures is red, and is intended for use in reading the running time of trains moving in the opposite direction. To have such a time-table effective it is, of course, necessary that the running time of all trains, or at least the running time of all trains which the time-table is intended to provide for, should be the same; but, where such conditions are found, as, for example, on the regular trains of the elevated roads in New York City, such a time-table would prove quite a convenience to passengers. The novelty of it has doubtless proved a little puzzling at the outset to patrons of the Lancashire & Yorkshire, but the trick once learned—and it is a very simple one—no handier time card could be imagined.

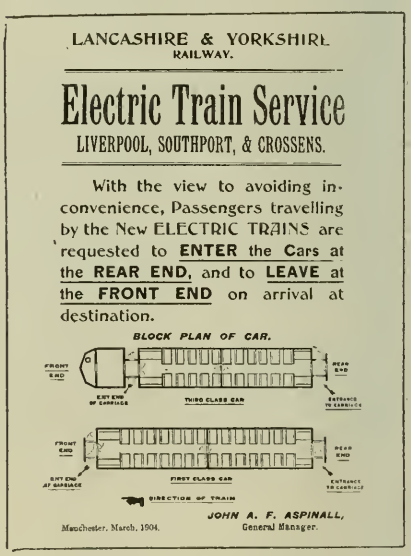
The rule that no article must be taken into the cars which cannot be put in the

Map of L. & Y. Electric Service.

racks, or disposed of without inconvenience to other passengers, or which would interfere with entering or leaving the cars, relates to a difficulty which is more characteristic of English practice than it is American, although the fact that racks are provided, and racks sufficient in capacity to really carry bundles, might well be noted by nearly every railroad in the United States. The New York, New Haven & Hartford has shown especial care in this matter for years, but on most roads it is a convenience much needed but seldom found.

Another paragraph in the Lancashire & Yorkshire announcement states that, in accordance with the notice posted inside the cars, passengers will enter at the rear end and alight at the front end of each vehicle in the direction in which the train is traveling. The obvious purpose of this regulation is to avoid confusion and to lead to the quick despatch of the trains from the stations, and passengers are provided with a special circular telling them just how to enter and leave the cars. This rule is most excellent, and it seems rather surprising that so little effort has been made to carry it out in America. In some cases signs are posted requesting passengers to observe this procedure, but no really systematic effort seems to have been made to keep the current of traffic moving in one direction. The blockading of the path of the outgoing passengers by the rush of passengers attempting to board the car is a continual source of delay on rapid transit lines everywhere in this country, and if the English managers, by starting in at the very outset with this sensible rule, can get it grafted into tenacious British custom, they will have accomplished a great deal toward facilitating suburban traffic.

A special baggage car service is provided to avoid carrying heavy baggage on the regular trains, and in connection with this service a system of checking almost precisely like that in use in America, but a decided novelty in the United Kingdom, has been introduced. It was obviously necessary to have some such arrangement if the luggage was not to be carried at the same time with the passenger—and, indeed it always rather surprises the American traveler to get his own baggage at all, when its delivery seems to depend entirely on claim of ownership and the services of the porter. The circular says that whenever the baggage of passengers is in large quantities or of a heavy or bulky character, it will have to be delivered at the station in sufficient time to be despatched by the baggage car service in advance of the train by which the passenger intends to travel, so that it may be at his disposal when he arrives at his destination; but, in case it is not received in time to be sent out ahead of the passenger it follows on the next baggage car train and


LANCASHIRE & YORKSHIRE RAILWAY.

Electric Train Service

LIVERPOOL, SOUTHPORT, & CROSSENS.

With the view to avoiding inconvenience, Passengers travelling by the New ELECTRIC TRAINS are requested to **ENTER** the Cars at the **REAR END**, and to **LEAVE** at the **FRONT END** on arrival at destination.

BLOCK PLAN OF CAR.



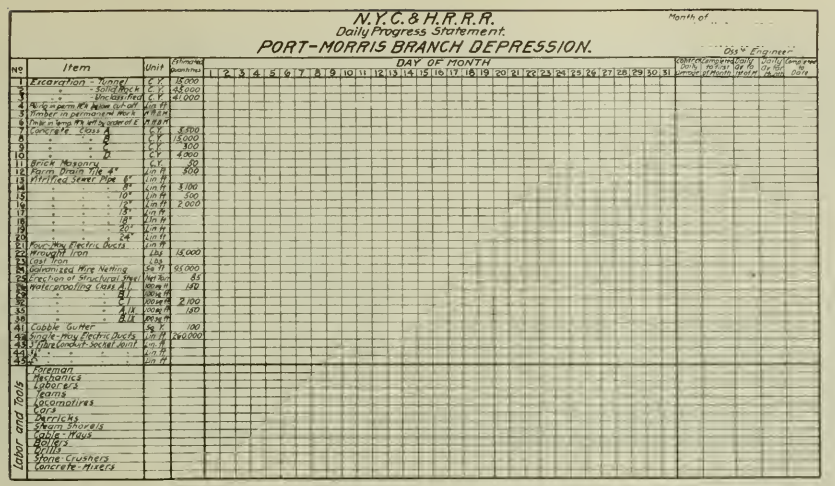
JOHN A. F. ASPINALL, General Manager.

Manchester, March, 1904.

To Save Time at Stations.

can be claimed by check, quite as in American practice. Arrangements have also been made at all stations between Liverpool and Southport to collect and deliver passengers' baggage at low, fixed rate. Moreover, at each of the stations there is a certain area at which luggage consigned under the "Luggage in Advance" system will be collected and delivered free, thus putting a premium on sending one's baggage ahead instead of carrying it in the car. This service seems very liberal and must afford a great accommodation to passengers, since no charge whatever is made for transportation, unless the weight exceeds 150 lbs., first class, and 100 lbs. for third class passengers. The company conducts a special parcel business also, at low rates, performing a service quite similar to that found on some of our interurban electric lines.

Until April 1 second class carriages were run on this branch of the Lancashire & Yorkshire, but since that time, to simplify the service, they have been discontinued.




Daily Progress Statement.

Passengers buying tickets through from other places on the Lancashire & Yorkshire system to places on the Liverpool and Southport line, will still be able to obtain second class tickets, entitling them to travel in carriages of that class as far as the point where they join the electrified branch, but these tickets will be only available for third class on the electric trains. Special arrangements were made for holders of existing second class season tickets to enable them to exchange them for tickets available in first class or in third class carriages on the electric lines after April 1.

In connection with this circular of directions the company prints a schedule to show what the rates and taxes might be expected to amount to at each of the stations on the line for a house renting at $150 a year. The estimate includes the charge for taxes, water and gas, and is given with a view to promoting the country through which the line passes as a residence district. Indeed, the possession of full information is quite an important inducement in the choice of a home. The company points out that the rates and taxes on its line compare favorably with those paid for houses of a similar rental on the Chelsea side of the Mersey, and are in some instances considerably lower.

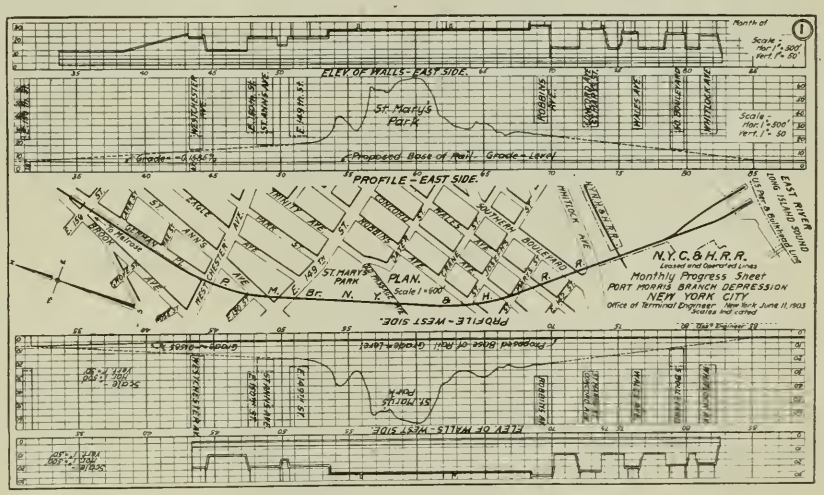
The care with which all these little traffic details have been worked out, and the enterprise with which they are presented in attractive form to perspective travelers, should be important assets in the welfare of the line. Conditions have been met with a rapidity and ingeniousness which seems quite unlike the conservatism of the old established steam railroad lines in England, and is far more suggestive of the opening up of suburban country by electric lines in the United States. It is just this kind of enterprise which has made the American interurban lines successful in short-haul traffic at the expense of their steam competitors, and the results of this attempt by an old established railroad in England to protect itself against this kind of competition by maintaining and increasing the attractiveness of the service offered will be watched with considerable interest.

## Progress Reports—Contract Work.

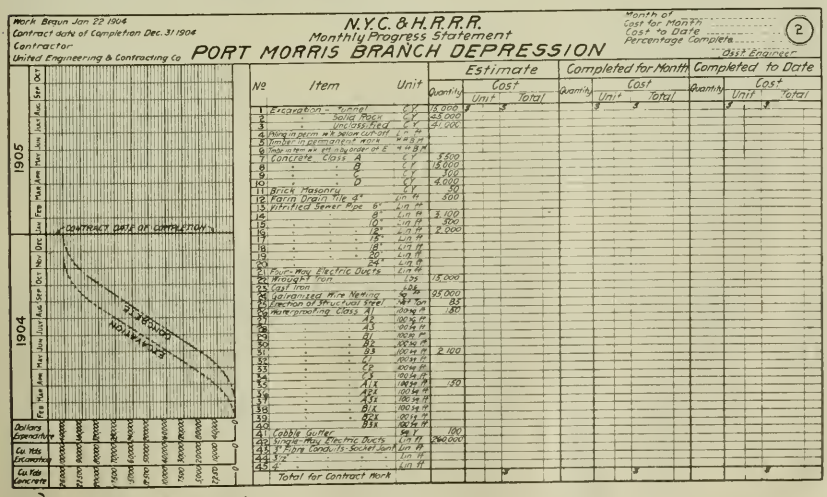
BY G. R. WADSWORTH.*

Record of progress on contract work is usually kept more or less in detail for an office record and for the information of engineers and officers in charge who have little opportunity to visit the work. Reports of a tabular and graphical nature, together with photographs, best illustrate the situation. The accompanying sheets prepared for progress records of the depression of the Port Morris branch of the New York Central, now in progress under contract with the United Engineering & Contracting Co., of New York, give a fairly comprehensive and accurate view of the situation each month.

The sheets are white prints of a uniform size, 7 in. x 12 in. inside margins, and are bound with copies of the voucher, estimate and distribution sheets for the corresponding month. The daily progress statement, compiled from the inspector's daily reports,




Graphic Record of Monthly Progress in Contract Work.




Monthly Progress Statement for Contract Work.

gives a record of the plant and labor, together with the output. The daily averages illustrate the increase or decrease in the rate of work, and may be compared with the contract daily average, which is figured on the basis of completing on contract time. The monthly progress statement is compiled from quantities derived from actual sections and is used for the basis of the monthly estimate. The more important quantities, excavation, concrete and total expenditure are illustrated graphically. The unit prices, estimated cost, and expenditure curve are omitted in the illustrations for obvious reasons. The curves are plotted to finish within contract time, and the actual progress is plotted from month to month. It is also of interest to plot a curve showing the estimated cost to the contractor, when data is obtainable. The monthly progress sheet illustrates the scope of the work within a small compass and the excavation and concrete work done during the month and to date is shown by crayon shading on the white print.

*Asst. Terminal Engineer New York Central.

## Tests for Detecting Brittle Steel.*

Most of the steel now made will more than meet the requirements of the specifications in general use. This has given a false sense of security, and too many chances are being taken. In some cases the cold bending tests have been omitted on boiler steel and the material accepted on the results of tension tests alone. Hundreds of boilers are made every year under these conditions. Every now and then a plate fails in shop work and samples taken from such plates generally will not bend flat cold. We have no means of learning how many other brittle plates, which do not fail in shop work, are put in boilers. The failures generally occur in thick material, and in most cases the ordinary cold bending test, as called for in the specifications, would have detected the brittleness.

There are other cases where axles, rails, etc., are put in service without any physical tests being made. This is directly contrary to the specifications adopted by this society and the opinions expressed in the discussions at our meetings.

Some think that heat always has a softening effect on steel, as in annealing, and that the hotter the steel is finished in rolling or forging, the softer it will be. On the contrary, under such conditions, heat has a hardening effect and is one cause of brittleness. The laboratory experiments on the effect of heat have been confirmed by the results obtained from large masses of steel. Steel finished too hot in rolling or forging will have a coarse grain and will fail under the ordinary cold bending and drop tests. The engineer cannot ignore this any more than he could ignore the effect of chemical composition. Under these conditions is it not proper and just that he demand of the maker some assurance that his steel is finished at the proper temperature? It is, of course, preferable to prevent, if possible, steel being made brittle than to take the chances of its being detected after it has been made brittle.

The society did well to specify that cold bends shall be made on each heat of steel in the condition it leaves the rolls. This has been more clearly defined by the committee on iron and steel structures of the American Railway Engineering and Maintenance of Way Association, in their specifications, as follows: "Full-sized material for eye-bars and other material 1 in. thick and over, tested as rolled, shall bend cold 180 deg. around a pin the diameter of which is equal to twice the thickness of the bar without fracture on outside of bend." This requirement has been put in general use and necessitates the bars being finished in rolling at a lower temperature, and large eye-bars are now made which meet the requirements of the full-size test very much better than formerly.

All specifications make concessions in the requirements for the heavy material, and it is a question if we have not gone too far in that direction, as it assumes that such heavy material will, of necessity, be finished at a much higher temperature than the lighter material. It also does not induce the maker to improve his methods. The necessary improvement in the present methods which would be required to finish the heavy material at the proper temperature would decrease output and increase cost of such heavy material. Is the consumer willing to pay more for a better material? If so, the maker would, no doubt, meet him half way.

It will not be necessary to adopt any of the more elaborate tests which have been suggested to detect brittle steel, if the finishing temperature is properly controlled and wide cold bends made of full thickness of material rolled. But in the case of forgings, castings, and other very heavy material, annealing will have to be more generally introduced.

*Extract of a paper presented by Wm. R. Webster at the Atlantic City meeting of The American Society for Testing Materials, June, 1904.

## Steel Car Design.

### IV.

BY A. STUCKI.

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*Flat Cars with Center Sills Carrying the Load.*—Flat cars are often loaded with heavy concentrated loads and for that reason it is not safe to design for a uniformly distributed maximum load. It is best to design the car to carry two-thirds of the maximum permissible load concentrated at the center. This is:

44,000 lbs. for 60,000-lb. cars.
58,700 lbs. for 80,000-lb. cars.
73,300 lbs. for 100,000-lb. cars.

The moment in the center of the car due to this load, p, is

$$M = \frac{p}{2}\left(\frac{l}{2} - c\right)$$

Assuming the weight of the car body as $p_1$

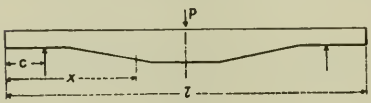



Fig. 13.

uniformly distributed throughout the whole length, then the moment for any section between the bolster and the center of the car, at a distance x from the end is

$$M_x = \frac{p_1 x}{2}\left(\frac{l}{x} - 1 + \frac{c}{x}\right)$$

To find the value of the moment in the center substitute for x, the value $\frac{l}{2}$ from which $M_1 = \frac{p_1}{2} \times \frac{l}{2}\left(\frac{2c}{l} - \frac{1}{2}\right)$

Instead of assuming two-thirds of the nominal capacity of the car as concentrated in the center, it can be assumed that three-quarters of the nominal capacity is concentrated at one side of the center at a distance from the bolster equal to one-third the distance between truck centers. Or, one-half of the nominal capacity of the car can be assumed as concentrated on each side of the center at a distance from the bolsters equal to one-third the distance between truck centers. In all three cases the moments at the center are equal. The following table gives the moment at the center of the car for different lengths of the three capacity cars. In the table the moments M and $M_1$ due to the load and the weight of the car, are combined.

*Combined Moments in Center of Car Due to Load and Dead Weight.*

| Length Over End Sills. | Distance. c. to c. Trucks. | 60,000-Lb. Cars. in. Lbs. | 80,000-Lb. Cars. in. Lbs. | 100,000-Lb. Cars. In. Lbs. |
|---|---|---|---|---|
| 34 ft. | 24 ft. | 3,510,720 | 4,611,960 | 5,706,000 |
| 36 ft. | 26 ft. | 3,829,440 | 5,025,720 | 6,214,200 |
| 38 ft. | 28 ft. | 4,133,760 | 5,423,280 | 6,704,400 |
| 40 ft. | 28 ft. | 4,080,000 | 5,362,800 | 6,637,200 |
| 42 ft. | 30 ft. | 4,403,520 | 5,781,960 | 7,151,400 |
| 44 ft. | 32 ft. | 4,709,760 | 6,181,680 | 7,644,000 |
| 46 ft. | 34 ft. | 5,017,920 | 6,583,560 | 8,139,000 |
| 48 ft. | 36 ft. | 5,328,000 | 6,987,600 | 8,636,400 |

In the above table, the weights of the three capacity flat car bodies were assumed as 16,000 lbs., 18,000 lbs. and 20,000 lbs., respectively.

In designing cars in which the center sills are to carry all of the load, the following tables will be found useful in determining the proper sections. Where the tables do not show the section modulus or moment of inertia for the exact section wanted, combinations can be made from the figures shown for similar sections, which will prove accurate enough for all practical purposes. For example, in Table I., if a $^5/_{16}$ in. sill with the reinforcement as per column 5 is the required section, the section modulus can be obtained by subtracting from the figure in column 5 the difference between the figures in columns 3 and 4. The result is a close approximation.

Allowance has been made for rivet holes in the tension member. The table is not carried beyond a depth of 24 in. because in deep sills, with the web and flanges of the same thickness throughout, much of the material is wasted so far as strength is concerned. Proper deductions have been made in the above table to compensate for the large fillets which are formed in pressed steel sills. The section modulii given for reinforced sills are for the bottom portion of the section and are a minimum.

In all the tables, where structural shapes for the sills have been shown, the rivet holes in the tension side have been considered, but in the compression side they have not been taken out, since well-driven rivets will fill the holes and no loss of strength in compression results.

To find the distance of the neutral axis from the extreme fiber, $e_1$, divide the mo-

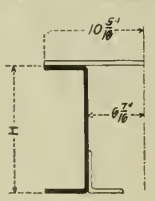



TABLE I.

MOMENT OF INERTIA AND SECTION MODULUS PER SILL FOR PRESSED STEEL CHANNEL SILLS.

| 1. | 2. | 3. Pressed Steel Sill Alone. | | | | 4. | | 5. ⅜-in. Sill Reinforced With | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ¼-in. Material. | | 5/16-in. Material. | | ⅜-in. Material. | | 3½ x 3½ x ⅜ Angle. 10¼ x ¼ Plate. | | 4 x 4 x ½ Angle. 10¼ x ⅜ Plate. | |
| H. Ins. | | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. |
| 10 | | 56.5 | 11.3 | 68.8 | 13.7 | 81.2 | 16.2 | 184.7 | 33.6 | 236.8 | 42.3 |
| 11 | | 71.0 | 12.9 | 86.7 | 15.7 | 102.5 | 18.6 | 228.1 | 37.9 | 292.1 | 47.8 |
| 12 | | 87.8 | 14.6 | 107.3 | 17.8 | 126.9 | 21.1 | 276.9 | 42.4 | 353.8 | 53.4 |
| 13 | | 106.7 | 16.4 | 130.6 | 20.1 | 154.6 | 23.8 | 331.1 | 47.0 | 422.2 | 59.1 |
| 14 | | 128.0 | 18.3 | 156.9 | 22.4 | 185.8 | 26.5 | 391.2 | 51.7 | 497.7 | 65.0 |
| 15 | | 151.9 | 20.2 | 186.3 | 24.8 | 220.8 | 29.4 | 457.3 | 56.6 | 580.3 | 71.1 |
| 16 | | 178.3 | 22.3 | 218.9 | 27.3 | 259.6 | 32.4 | 529.3 | 61.7 | 670.1 | 77.2 |
| 17 | | 207.5 | 24.4 | 255.0 | 30.0 | 302.5 | 35.6 | 607.6 | 66.8 | 767.4 | 83.5 |
| 18 | | 239.6 | 26.6 | 294.6 | 82.7 | 349.7 | 38.8 | 692.8 | 72.2 | 872.5 | 89.9 |
| 19 | | 274.7 | 28.9 | 338.0 | 35.5 | 401.3 | 42.2 | 784.3 | 77.6 | 985.4 | 96.5 |
| 20 | | 312.9 | 31.3 | 385.2 | 38.5 | 457.6 | 45.7 | 882.8 | 83.2 | 1106.4 | 103.2 |
| 21 | | 354.4 | 33.7 | 436.5 | 41.5 | 518.7 | 49.4 | 988.3 | 88.8 | 1235.7 | 110.0 |
| 22 | | 399.2 | 36.3 | 492.0 | 44.7 | 584.9 | 53.2 | 1101.1 | 94.6 | 1373.4 | 116.9 |
| 23 | | 447.5 | 38.9 | 551.8 | 47.9 | 656.2 | 57.0 | 1221.3 | 100.6 | 1519.8 | 124.0 |
| 24 | | 499.5 | 41.5 | 616.2 | 51.2 | 732.9 | 61.1 | 1349.1 | 106.7 | 1674.8 | 131.2 |

ment of inertia for any given section, as shown in the table, by the corresponding section modulus. The distance $e_o$ can be obtained by subtracting $e_t$ from the extreme height of the sill. The section modulus for compression, $Z_c$, is found by dividing the moment of inertia I by $e_c$. Many combinations can be made in the use of the tables so that the section modulus Z of almost any variation in the web and cover plates and in the angles can be obtained. Heavy members are hard to punch, and for this reason the thickness of the material in any section should never be greater than the diameter of the punch. In practice this limit is seldom approached.

To obtain the same fiber stress in the top and bottom flanges of the sills under a maximum load and a maximum end shock F, the respective distances from the neutral axis must bear the following relation to each other:

$$e_t : e_c :: \left(s + \frac{F}{A}\right) : \left(s - \frac{F}{A}\right)$$

A is the total cross-sectional area of the section and s is the allowable fiber stress.

The use of the above ratio gives an excessive stress in the bottom flange when the effect of the end shock ceases. The bottom of the section should, therefore, be designed for the tensile stress induced by the load alone and the top portion of the section for the stress due to load and end shock combined.

In the sill shown in Fig. 14, the line of application of the end shock F is a distance a above the neutral axis. The maximum compression per sq. in. in the top portion is

$$s_c = \frac{M}{Z_c} + \frac{F}{A} + \frac{Fa}{Z_c}$$

The maximum tension per sq. in. in the bottom portion is

$$s_t = \frac{M}{Z_t}$$

and in order to make the two stresses equal the relation between $e_c$ and $e_t$ must be varied

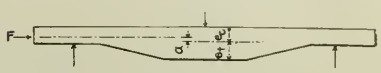



Fig. 14.

to suit the conditions imposed. The stress usually allowed is 12,500 lbs. per sq. in.

Example: Design a 36-ft. flat car of 60,000 lbs. capacity with plate girder center sills to carry the whole load and side sills to carry a uniformly distributed load between the deep cross-bearers and body bolster to the next point of support. To find the sec-

TABLE II.

MOMENT OF INERTIA I AND SECTION MODULUS Z ARE CALCULATED FOR BOTTOM PORTION. 13/16-IN. RIVET HOLES HAVE BEEN SUBTRACTED FROM EFFECTIVE AREA FOR TENSION SIDE.

WIDTH OF WEB = H − ½ in. $e_t = \frac{I}{Z}$ $e_c = H - \frac{I}{Z}$.

| | H = 18 in. | | H = 20 in. | | H = 22 in. | | H = 24 in. | | H = 26 in. | | H = 28 in. | | H = 30 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angles. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. |
| 3½ x 3½ x 5/16 | 721.6 | 76.8 | 940.0 | 90.2 | 1183.0 | 103.2 | 1473.2 | 118.0 | 1789.6 | 132.4 | 2151.0 | 148.0 | 2559.8 | 166.0 |
| ⅜ | 814.8 | 86.6 | 1052.8 | 100.8 | 1328.0 | 115.8 | 1648.2 | 132.0 | 1998.4 | 147.8 | 2397.6 | 164.8 | 2842.0 | 182.6 |
| 7/16 | 904.4 | 96.2 | 1167.4 | 111.8 | 1469.6 | 128.0 | 1814.2 | 145.0 | 2202.8 | 162.8 | 2641.6 | 181.4 | 3120.8 | 200.2 |
| ½ | 993.4 | 105.6 | 1279.2 | 122.4 | 1607.8 | 139.8 | 1981.6 | 158.2 | 2402.4 | 177.2 | 2872.0 | 197.0 | 3392.8 | 217.4 |
| 9/16 | 1078.2 | 114.6 | 1386.6 | 132.6 | 1741.0 | 151.4 | 2142.8 | 171.0 | 2596.8 | 191.6 | 3098.0 | 212.2 | 3655.4 | 234.0 |
| ⅝ | 1159.4 | 123.2 | 1491.2 | 142.8 | 1868.8 | 162.4 | 2298.0 | 183.2 | 2780.0 | 204.8 | 3315.8 | 227.0 | 3911.4 | 250.2 |
| 4 x 3 x 5/16 | 749.6 | 79.8 | 967.0 | 92.6 | 1218.6 | 106.4 | 1506.8 | 120.6 | 1833.0 | 135.6 | 2218.4 | 152.8 | 2611.0 | 168.0 |
| ⅜ | 848.0 | 90.2 | 1090.6 | 104.4 | 1370.4 | 119.4 | 1695.0 | 135.6 | 2050.0 | 151.6 | 2453.8 | 168.6 | 2902.4 | 186.6 |
| 7/16 | 925.2 | 98.4 | 1213.0 | 116.2 | 1520.8 | 132.4 | 1871.0 | 149.6 | 2264.8 | 167.4 | 2709.4 | 186.0 | 3194.0 | 205.0 |
| ½ | 1046.8 | 111.4 | 1308.4 | 125.2 | 1663.2 | 144.8 | 2042.8 | 163.2 | 2489.6 | 183.6 | 2945.2 | 202.2 | 3472.0 | 222.6 |
| 9/16 | 1126.4 | 119.8 | 1441.6 | 137.8 | 1802.4 | 156.6 | 2211.0 | 176.4 | 2671.6 | 197.0 | 3179.6 | 217.8 | 3743.4 | 239.6 |
| ⅝ | 1212.2 | 129.0 | 1550.0 | 148.0 | 1936.0 | 168.2 | 2372.8 | 189.2 | 2861.8 | 210.8 | 3405.2 | 233.2 | 4008.2 | 256.4 |
| 4 x 4 x 5/16 | 786.6 | 83.8 | 1018.6 | 97.8 | 1287.6 | 112.8 | 1595.4 | 128.0 | 1944.0 | 144.4 | 2335.2 | 161.2 | 2769.6 | 178.6 |
| ⅜ | 914.2 | 95.2 | 1155.6 | 111.0 | 1456.6 | 127.4 | 1800.0 | 144.4 | 2189.0 | 162.4 | 2622.0 | 180.6 | 3106.6 | 200.0 |
| 7/16 | 998.6 | 106.6 | 1288.0 | 123.6 | 1620.0 | 141.6 | 1998.2 | 160.2 | 2424.0 | 179.6 | 2900.6 | 199.6 | 3427.0 | 220.4 |
| ½ | 1099.2 | 117.2 | 1415.2 | 135.8 | 1776.6 | 155.2 | 2190.0 | 175.4 | 2653.0 | 196.4 | 3169.0 | 218.0 | 3741.0 | 240.4 |
| 9/16 | 1193.4 | 127.2 | 1535.4 | 147.2 | 1927.6 | 168.2 | 2377.4 | 190.4 | 2870.6 | 212.2 | 3425.4 | 235.6 | 4013.4 | 257.6 |
| ⅝ | 1288.8 | 137.2 | 1657.0 | 158.8 | 2078.6 | 181.4 | 2561.0 | 206.6 | 3089.8 | 228.4 | 3683.8 | 253.2 | 4339.2 | 278.4 |

TABLE III.

MOMENT OF INERTIA I AND SECTION MODULUS Z ARE CALCULATED FOR BOTTOM PORTION; 13/16-IN. RIVET HOLES HAVE BEEN SUBTRACTED FROM EFFECTIVE AREA FOR TENSION SIDE.

WIDTH OF WEB = H − ½ in. $e_t = \frac{I}{Z}$ $e_c = H - \frac{I}{Z}$.

| | H = 18 in. | | H = 20 in. | | H = 22 in. | | H = 24 in. | | H = 26 in. | | H = 28 in. | | H = 30 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angles. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. |
| 3½ x 3½ x 5/16 | 824.8 | 87.8 | 1075.8 | 103.2 | 1372.8 | 120.0 | 1716.4 | 137.8 | 2115.6 | 157.2 | 2554 | 176.4 | 3056 | 197.4 |
| ⅜ | 916.0 | 97.6 | 1193.6 | 114.4 | 1518.0 | 132.6 | 1891.8 | 151.8 | 2318.4 | 172.0 | 2798 | 193.0 | 3340 | 215.4 |
| 7/16 | 1022.2 | 108.6 | 1308.2 | 125.4 | 1659.6 | 145.0 | 2063.4 | 165.2 | 2522.8 | 186.8 | 3042 | 209.6 | 3620 | 233.2 |
| ½ | 1083.4 | 115.2 | 1420.0 | 136.0 | 1797.8 | 156.8 | 2231.4 | 178.6 | 2722.4 | 201.4 | 3274 | 225.4 | 3888 | 250.0 |
| 9/16 | 1177.2 | 125.0 | 1527.2 | 146.2 | 1930.8 | 168.2 | 2391.6 | 191.2 | 2934.6 | 217.0 | 3500 | 260.8 | 4150 | 266.6 |
| ⅝ | 1260.6 | 134.0 | 1629.4 | 156.0 | 2058.6 | 179.2 | 2547.4 | 203.6 | 3099.8 | 229.0 | 3718 | 255.4 | 4408 | 282.8 |
| 4 x 3 x 5/16 | 850.8 | 90.6 | 1112.4 | 106.8 | 1408.6 | 123.2 | 1756.0 | 141.0 | 2159.0 | 160.2 | 2602 | 179.8 | 3108 | 200.6 |
| ⅜ | 950.2 | 101.2 | 1231.4 | 118.2 | 1560.6 | 136.4 | 1938.8 | 155.6 | 2369.8 | 176.4 | 2856 | 197.0 | 3418 | 220.4 |
| 7/16 | 1046.4 | 111.2 | 1353.8 | 129.8 | 1714.0 | 149.6 | 2120.0 | 169.8 | 2585.0 | 191.4 | 3108 | 214.2 | 3694 | 237.8 |
| ½ | 1137.8 | 121.0 | 1469.4 | 140.8 | 1853.0 | 161.6 | 2292.2 | 183.4 | 2789.6 | 206.4 | 3348 | 230.4 | 3968 | 255.2 |
| 9/16 | 1225.4 | 130.2 | 1568.6 | 150.2 | 1990.2 | 173.4 | 2459.8 | 196.8 | 2989.4 | 221.0 | 3582 | 246.4 | 4242 | 272.4 |
| ⅝ | 1316.0 | 139.8 | 1691.0 | 161.8 | 2126.2 | 185.2 | 2622.0 | 209.6 | 3181.8 | 235.2 | 3810 | 261.8 | 4504 | 289.0 |
| 4 x 4 x 5/16 | 887.6 | 94.8 | 1159.4 | 111.6 | 1475.2 | 129.2 | 1844.6 | 148.4 | 2264.0 | 168.2 | 2738 | 189.4 | 3270 | 211.4 |
| ⅜ | 995.6 | 106.4 | 1296.2 | 124.8 | 1646.2 | 145.0 | 2049.2 | 164.6 | 2507.8 | 186.2 | 3034 | 209.6 | 3584 | 231.4 |
| 7/16 | 1099.8 | 117.4 | 1428.2 | 137.4 | 1811.2 | 158.6 | 2245.2 | 180.2 | 2751.2 | 205.6 | 3302 | 228.0 | 3924 | 253.2 |
| ½ | 1200.2 | 128.0 | 1561.2 | 150.0 | 1967.8 | 172.2 | 2472.8 | 198.6 | 2971.6 | 220.4 | 3570 | 246.2 | 4238 | 273.2 |
| 9/16 | 1294.4 | 138.0 | 1679.0 | 161.2 | 2117.4 | 185.0 | 2654.8 | 213.0 | 3190.4 | 236.8 | 3828 | 263.8 | 4538 | 292.2 |
| ⅝ | 1392.0 | 148.4 | 1800.8 | 172.8 | 2268.4 | 198.2 | 2804.8 | 224.8 | 3407.8 | 252.6 | 4086 | 281.4 | 4836 | 311.2 |

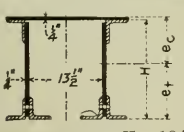



TABLE IV.

MOMENT OF INERTIA I AND SECTION MODULUS Z ARE CALCULATED FOR BOTTOM PORTION. 13/16-IN. RIVET HOLES HAVE BEEN SUBTRACTED FROM THE EFFECTIVE AREA FOR TENSION SIDE.

WIDTH OF WEB = H − ½ in. $e_t = \frac{I}{Z}$, $e_c$ = H + ½ in. $- \frac{I}{Z}$.

| | H = 18 in. | | H = 20 in. | | H = 22 in. | | H = 24 in. | | H = 26 in. | | H = 28 in. | | H = 30 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angles. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. | I. | Z. |
| 3½ x 3½ x 5/16 | 1386.4 | 139.0 | 1761.2 | 159.6 | 2190.2 | 181.2 | 2669.2 | 203.2 | 3206.4 | 226.0 | 3801.6 | 249.8 | 4457.0 | 274.0 |
| ⅜ | 1534.8 | 157.8 | 1964.4 | 182.6 | 2415.6 | 204.6 | 2943.2 | 229.0 | 3531.4 | 254.6 | 4181.6 | 280.4 | 4916.4 | 308.4 |
| 7/16 | 1673.6 | 175.8 | 2123.2 | 201.6 | 2633.4 | 227.8 | 3206.6 | 254.6 | 3844.0 | 282.6 | 4548.6 | 310.8 | 5326.4 | 340.2 |
| ½ | 1808.2 | 193.8 | 2295.0 | 221.4 | 2843.4 | 250.2 | 3460.4 | 279.6 | 4146.0 | 309.8 | 4902.8 | 340.6 | 5732.4 | 372.2 |
| 9/16 | 1935.8 | 210.8 | 2453.2 | 241.0 | 3044.8 | 272.0 | 3681.8 | 302.0 | 4433.6 | 337.4 | 5240.2 | 369.2 | 6140.0 | 404.2 |
| ⅝ | 2057.2 | 227.0 | 2608.8 | 259.6 | 3232.6 | 292.8 | 3932.0 | 326.8 | 4708.0 | 361.6 | 5582.8 | 398.2 | 6498.6 | 432.8 |
| 4 x 3 x 5/16 | 1441.2 | 143.8 | 1825.2 | 164.6 | 2261.8 | 186.0 | 2752.8 | 213.0 | 3300.6 | 231.6 | 3906.8 | 255.2 | 4573.6 | 279.6 |
| ⅜ | 1596.4 | 163.4 | 2021.2 | 186.8 | 2497.2 | 210.4 | 3036.4 | 235.2 | 3637.8 | 260.8 | 4300.4 | 286.8 | 5048.0 | 315.0 |
| 7/16 | 1751.4 | 183.4 | 2208.2 | 208.2 | 2730.8 | 235.2 | 3316.6 | 262.2 | 3967.4 | 290.2 | 4685.8 | 318.6 | 5469.2 | 347.8 |
| ½ | 1886.0 | 201.2 | 2383.8 | 229.4 | 2946.6 | 258.2 | 3577.0 | 287.8 | 4276.4 | 317.8 | 5068.2 | 350.4 | 5892.6 | 380.6 |
| 9/16 | 2021.2 | 219.2 | 2580.6 | 252.2 | 3155.2 | 280.8 | 3828.6 | 312.8 | 4575.4 | 345.2 | 5364.8 | 376.4 | 6297.6 | 412.6 |
| ⅝ | 2148.6 | 236.2 | 2702.8 | 268.0 | 3353.6 | 302.6 | 4068.6 | 336.8 | 4860.4 | 371.6 | 5732.0 | 407.4 | 6684.8 | 443.6 |
| 4 x 4 x 5/16 | 1520.4 | 155.2 | 1930.6 | 178.0 | 2397.2 | 201.8 | 2922.0 | 226.2 | 3507.4 | 251.8 | 4155.0 | 277.0 | 4867.0 | 303.6 |
| ⅜ | 1688.4 | 177.2 | 2144.8 | 203.0 | 2660.8 | 229.4 | 3240.4 | 257.0 | 3885.4 | 285.0 | 4598.0 | 313.6 | 5380.0 | 343.0 |
| 7/16 | 1851.2 | 198.8 | 2348.0 | 227.2 | 2911.4 | 256.6 | 3543.4 | 286.8 | 4245.8 | 317.8 | 5021.4 | 341.0 | 5870.6 | 381.6 |
| ½ | 2004.0 | 219.2 | 2541.4 | 250.8 | 3139.8 | 282.0 | 3833.0 | 316.0 | 4590.6 | 349.6 | 5428.0 | 384.2 | 6340.6 | 419.2 |
| 9/16 | 2145.4 | *238.6 | 2721.4 | *273.0 | 3373.6 | *308.0 | 4104.0 | *343.6 | 4914.6 | *380.4 | 5807.4 | *417.4 | 6784.2 | *455.2 |
| ⅝ | 2287.2 | *258.4 | 2900.0 | *295.0 | 3597.2 | *333.0 | 4375.6 | *371.4 | 5238.8 | *410.8 | 6188.8 | *450.6 | 7227.8 | *491.2 |

Figures marked * are not a minimum, and the moduili for the top portion should be considered.

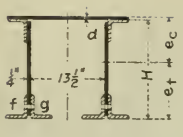



TABLE V.

MOMENT OF INERTIA I AND SECTION MODULUS Z ARE CALCULATED FOR BOTTOM PORTION. 13 16-IN. RIVET HOLES HAVE BEEN SUBTRACTED FROM EFFECTIVE AREA FOR TENSION SIDE.

WIDTH OF WEB = H − ½ in. $e_t = \frac{I}{Z}$, $e_c = H + d - \frac{I}{Z}$.

| Angles f. | Angles g. | d. | H = 24 in. I. | H = 24 in. Z. | H = 26 in. I. | H = 26 in. Z. | H = 28 in. I. | H = 28 in. Z. | H = 30 in. I. | H = 30 in. Z. |
|---|---|---|---|---|---|---|---|---|---|---|
| 3½ x 3½ x ⅜ | 3½ x 3½ x 7/16 | 5/16 | 3183.6 | 243.7 | 3817.6 | 270.7 | 4511.4 | 297.9 | 5286.8 | 326.5 |
| | ½ | ⅜ | 3427.4 | 258.4 | 4113.9 | 287.4 | 4866.6 | 316.8 | 5688.6 | 346.4 |
| | 9/16 | 7/16 | 3712.3 | 276.0 | 4441.2 | 306.0 | 5244.0 | 336.8 | 6123.0 | 367.9 |
| | ⅝ | ½ | 3955.9 | 290.2 | 4728.2 | 321.6 | 5578.1 | 353.7 | 6508.0 | 386.2 |
| 4 x 3 x ⅜ | 4 x 3 x 7/16 | 5/16 | 3302.7 | 251.3 | 3943.5 | 277.9 | 4657.9 | 305.6 | 5439.5 | 334.1 |
| | ½ | ⅜ | 3558.6 | 266.5 | 4252.8 | 295.1 | 5017.9 | 324.3 | 5855.6 | 354.4 |
| | 9/16 | 7/16 | 3844.2 | 283.7 | 4589.1 | 313.9 | 5408.9 | 344.7 | 6306.1 | 376.2 |
| | ⅝ | ½ | 4093.6 | 297.9 | 4886.8 | 329.8 | 5755.3 | 362.0 | 6704.4 | 394.8 |
| 4 x 4 x ⅜ | 4 x 4 x 7/16 | 5/16 | 3489.6 | 272.2 | 4184.7 | 302.1 | 4951.5 | 332.7 | 5792.2 | 364.0 |
| | ½ | ⅜ | 3771.3 | 290.1 | 4514.2 | 321.5 | 5338.6 | 354.0 | 6238.2 | 387.0 |
| | 9/16 | 7/16 | 4070.6 | 308.8 | 4869.9 | 342.2 | 5749.6 | 376.3 | 6702.9 | 410.7 |
| | ⅝ | ½ | 4343.6 | 325.6 | 5191.7 | 360.7 | 6124.4 | 396.6 | 7137.0 | 432.5 |

tion of the center sills in the center of the car.

The moment per car is 3,829,440 in. lbs. (See table with Fig. 13.) The stress allowed per square inch is 12,500 lbs. and the necessary section modulus is therefore $\frac{3,829,440}{12,500}$ = 306.3. In Table IV. a 30-in. girder with 3½ x 3½ x ⅜ in. angles, ¼-in. cover plate and ¼-in. web, has a section modulus of 308.4 for the bottom portion and the tension side is therefore safe. For the top portion or compression side

$$e_c = (30 + ¼) - \frac{4916.4}{308.4} = 14.35$$

$$Z_c = \frac{4916.4}{14.35} = 342.$$

$$s_c = \frac{3,829,440}{342}$$

or 11,200 lbs. per sq. in. compression. The available compressive strength per sq. in. in the top portion is 12,500 — 11,200 = 1,300 lbs., which corresponds with the expression (Fig. 14):

$$\frac{F}{A} + \frac{Fa}{Z_c} \text{ or } F\left(\frac{1}{A} + \frac{a}{Z_c}\right)$$

The cross-sectional area of the center sills is 33.3 sq. in. and the center line of draft is assumed to be 6¼ in. below the top of the sill cover plate. Therefore, a = 14.35 — 6.25 = 8.1 in.

Since $F\left(\frac{1}{A} + \frac{a}{Z_c}\right) = 1,300$ lbs., then $F\left(\frac{1}{33.3} + \frac{8.1}{342}\right) = 1,300$, or F = 24,250 lbs. In other words, the end shock can be 24,250 lbs. without exceeding the allowable fiber stress of 12,500 lbs. assumed in the beginning. To provide for heavier shocks than this it would be better to use a somewhat heavier section in order to obtain a greater available compressive strength in the top portion.

The center sills should be analyzed at intermediate points in the same way as just described. Especially at the body bolster, care should be taken that the combined compressive stresses in the *bottom* portion do not exceed the safe working stress. The deep cross bearers, usually two per car, should be made strong enough to transmit any load on the side sills to the center sills. It is frequently assumed for the purposes of calculation that one-fourth of the nominal capacity is concentrated at each end of each cross-bearer.

In designing box and gondola cars with wooden body framing and with center sills designed to carry all of the load, the above method should also be used.

*Deflection of Sills.* The deflection of a tapered sill is, of course, greater than that of a sill of maximum and uniform depth throughout its length. A sill 24 in. deep for 10 ft. of its length at the center and tapered to 10 in. at the bolsters, 30 ft. apart, has 50 per cent. greater deflection than a sill 24 in. deep throughout its length. So long as the deflection is kept within reasonable limits, however, it is not objectionable in flat cars.

*(To be continued.)*

## The Morrison Automatic Air-Brake Safety Valve.

The Morrison automatic air-brake safety valve is designed to control the setting of brakes if the air hose parts or bursts, preventing an emergency application. It is arranged to be added to the angle cock of the present air-brake equipment. The operation is by air pressure and by gravity, and it is claimed that it in no way interferes with the usual service and emergency applications.

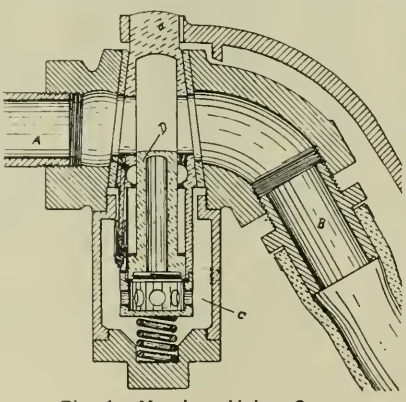



Fig. 1—Morrison Valve, Open.

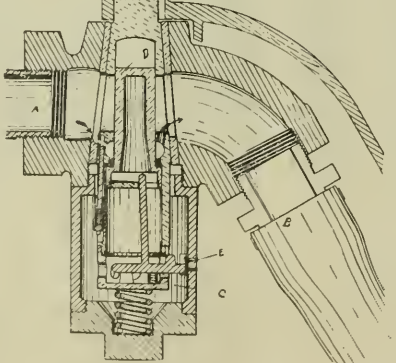



Fig. 2—Valve Closed (Showing Locking Device, E).

Illustrations are shown from which the operation of the device may be understood. When the air line is coupled up the pressure is equalized and valve D drops open and is not affected by service of emergency applications. The auxiliary reservoir "C" below the plunger "D" has the same pressure as the air line "A." Air is supplied to "C" through a feed groove alongside the cut-off plug. Should the air-hose break, the pressure of air in the auxiliary reservoir "C" instantly closes "D" as in Fig. 2. A slow leak around "D" from the air-line sets the brake gradually on the broken section, while on the section next to the locomotive the brakes are under the control of the engineman, the air pump being able to supply the air faster than the valve allows it to escape. One condition under which it is claimed the valve would prove advantageous would be in the case of a heavy freight train when it is desired to stop for water. The engineman would merely have to cut loose from the moving train and run to the tank, the valve at the front end of the train making a service application. When the locomotive couples on again the valve opens automatically. No change in present standard angle cocks is required, the mechanism being placed in an extension applied to the lower side of the cock. Where no angle cocks are supplied the cost of equipping a car is about $10. Applied to old cocks, the cost is less.

A test of some of the valves was made in the Hocking Valley yards at Columbus, Ohio, on July 13, in the presence of a number of railroad officers and of representatives of the Westinghouse Air-Brake Company. A train of ten empty coal cars were used, three of which were equipped with the valve. After a series of standing tests, the cars were put in motion and the train cut while running. The valves are reported to have worked satisfactorily in every case. Additional tests were made with a train of 28 cars—20 with and eight without air. They were cut off at from eight to 12 cars back of the engine, with results equally as satisfactory as in the first case.

The valve is the invention of Mr. F. B. Morrison, formerly a locomotive engineman. The Morrison Automatic Safety Valve Company, Toledo, Ohio, C. W. Munson, President, has been organized to make and sell the device.

## Premium Track Inspection.

A number of railroads in this country have put into operation in connection with the annual trips of inspection by the general officers a premium system for rewarding efficient work in the maintenance-of-way department and at least one road in England has recently adopted a similar plan. In a general way the system now in use on all of these roads is the same and has for its object raising the standard of track work by promoting a spirit of rivalry between the men in charge of different sections of the line. Minor differences in the nature and amount of the premiums offered and the basis of marking are, however, of interest.

The London & South-Western put the new system into operation for the first time last March, when the annual inspection was made. The entire line was gone over by the Chief Engineer and his party and two judges, drawn from the engineering staff of the road, but stationed on some other division than the one under inspection, judged each section of the track, the mark given to a section being an average of the markings of the two men. The inspectors considered the condition of a section under four different heads—alinement, condition of surface and joints, condition of ballast, general appearance and efficiency. Each of these elements was marked on a basis of 100 per cent. and the final mark for a section was, therefore, on a basis of 400.

Cash prizes were awarded to the inspec-

tor or supervisor in charge of the best track on each superintendent's division and also to the foreman and men under him in charge of the best section on each inspector's district. The inspectors received two pounds, the section foremen one pound and the plate layers ten shillings each. In addition to these prizes, two challenge cups were put up, one for the inspector having the highest mark and one for the section foreman having the highest mark. Silver medals to become the property of the winner of the cups each year were given with the cups, and bronze medals to the platelayers under the foreman winning the cup.

The best mark for an inspector's district was 364.4 for a section of track 19.8 miles long. Of the section foremen, the best mark was 382 for a section two miles long. The general average for the system was 340.09, and lowest mark for section foreman was 245. The report of the chief engineer giving the results of the inspection, comments on the high average found and on the value of the inspection in increasing the interest taken in their work by the officers and men in the maintenance-of-way department.

On the New York Central the annual track inspection is made during the latter part of October, by which time the track has been put in good shape for the winter season, after the summer's work. The inspection is carried on under the direction of the engineer of maintenance-of-way. The road is divided into six divisions, in charge of division engineers, and each of these is further divided into sub-divisions in charge of supervisors. Each subdivision includes from 10 to 37 sections, and premiums are awarded to the section foreman having the best section on any one sub-division. Premiums are also awarded to supervisors of the sub-divisions showing the best average mark for the division. Supervisors making the best showing on their respective divisions receive a premium of $10 additional pay per month for the year following the inspection, and the supervisor of the sub-division showing the highest mark for the system, receives an additional premium of $5 per month, so that it is possible for the man making the best showing on the whole system to receive a total of $180 per year extra pay. Each section foreman who receives the highest mark on his respective sub-division is awarded a premium of $3 a month extra pay, and the foreman having the best section on each division receives an additional premium of $2 a month. Yard sections are kept separate from the main track sections, and the foreman in charge of the best yard section on each division receives a premium of $3 a month for the year. The accompanying reproduction of the table of detail percentages for the fifth annual inspection, shows the markings for each section on the entire system, and the averages for the system and for each division and sub-division.

On account of the differences in local conditions on sub-divisions and the difficulty of awarding sub-division premiums on a fair basis, the New York Central has decided to discontinue the premiums awarded to supervisors, but premiums for section foremen will be retained and some additional premiums will hereafter be awarded to foremen on side lines. The local conditions on each section of a sub-division do not vary so greatly, and a fairer basis of award can be used. In awarding the premiums, the company states that the object of the system is to reward foremen for their individual efforts during the year, rather than for the appearance of their section on the day of inspection, and this is as it should be.

The Southern Pacific is another road which has adopted the premium system on the lines west of El Paso, but the conditions of track and permanent way are very different from either of the two roads previously mentioned. Only two prizes are given, one to the roadmaster having the highest average mark for his district and one to the section foreman having the highest mark of any section on the system. The result of the inspection is given in detail in a printed pamphlet which is distributed among the men, so that while there are not so many premiums to be tried for, each man has a chance to compare his work with that of the other men, and in this way a spirit of competition is fostered. The inspecting party, which consists of the general manager of the system or the assistant general managers of the groups of lines into which the system as a whole is divided, the engineer of maintenance-of-way and the superintendent, resident engineer and roadmaster of the division over which the party is traveling. In marking, the condition of alinement and surface is rated on a basis of 25; spiking ties, lining and spacing ties, switches and frogs, 25; drainage and ballast, 20; material, grass and weeds, right-of-way, 10; houses and grounds, 10; sidings. 5; road crossings, run-offs and fencing, 5; total, 100. Besides these, the inspectors also mark the condition of all depots, shops, round houses, pump houses, fuel oil plants and miscellaneous structures on a basis of 10, and these markings are included as part of the report for each division. Each member of the party keeps an independent record of his markings, and these are averaged up at the conclusion of the trip.

For the annual inspection of 1903 the best mark for a roadmaster's district was 93.2, on the Tucson division of the main line. This division also received the highest mark for a whole division, 90.9. The best section was section 18, on the Los Angeles division, which received the excellent mark of 98. The average for the system was 87.2.

The Pennsylvania has a premium system which differs in many respects from that on the other railroads previously mentioned. The money prizes awarded are fewer in number, but each is quite a large sum in itself. Two special inspections of the main lines between Philadelphia and Washington and Jersey City and Pittsburg are used as a basis for making the awards. One of these is a periodical inspection once in every six weeks throughout the year by a special committee, consisting of the chief engineer of maintenance of way, engineer of maintenance of way and four division superintendents, none of whom are in charge of main line divisions. This committee makes a test of the condition of the track with the aid of instruments designed for the purpose and mounted in a car attached to one of the first class passenger trains in each direction. This car and the method of making tests with it was described in the *Railroad Gazette*, January 9, 1903. The markings for each division for each inspection are averaged at the end of

## N. Y. C. & H. R. R. R.

Prize Sections in Square thus ☐

*Inspection of Tracks, October 22d to October 31st, 1903*

**DETAIL PERCENTAGES**

| DIVISION | SUB DIVISION | SECTIONS 1 | 2 | 2½ | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 9A | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | Average for Sub-Division | Average for Division | Average for Division Last Year | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EASTERN F. S. Hunt Div. Eng. | 1 | | | | | | | | 87.8 | 87.2 | 87.8 | 89.2 | 87.3 | 86.7 | 87.2 | 87.8 | 89.2 | 87.3 | 86 | 86 | 79.5 | 79.0 | 74.5 | 77.2 | 78.7 | 77.2 | 81.6 | 78.8 | 79.5 | 80.7 | 82.5 | 78.0 | 79.3 | 79.0 | 77.5 | 79.2 | | 98.2 | 96.5 | | | 81.6 | | | |
| | 2 | 88.8 | 70.7 | | 70.3 | 89.1 | 71.1 | 74.8 | 77.7 | 70.2 | 88.1 | | 89.2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 77.1 | | | |
| | 2 A | 76.1 | 81.6 | | 70.9 | 77.9 | 78.4 | 78.6 | 75.0 | 80.1 | 76.9 | | 76.4 | 81.7 | 78.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | 78.2 | 81.2 | 79.6 | 2.6 |
| | 3 | 87.4 | 83.7 | | 85.8 | 84.4 | 85.8 | 84.4 | 83.7 | 80.6 | 85.8 | | 85.5 | 84.6 | 83.4 | 84.4 | 86.8 | 84.7 | 84.2 | 83.4 | 81.1 | 85.1 | 83.6 | 80.8 | | | | | | | | | | | | | | | | 84.6 | | | |
| | 4 | 80.4 | 79.0 | | 77.8 | 81.1 | 82.5 | 82.8 | 83.4 | 82.6 | 81.9 | | 82.9 | 80.8 | 84.1 | 79.4 | 83.4 | 84.9 | 83.0 | 79.8 | 83.4 | 79.6 | 80.1 | | | | | | | | | | | | | | | | | | 81.6 | | | |
| MOHAWK C. E. Lindsay Div. Eng. | 5 | 85.8 | 83.8 | | 80.0 | 85.4 | 80.0 | 86.8 | 87.2 | 80.8 | 81.4 | | 81.8 | 71.0 | 71.0 | 72.5 | 76.8 | 72.0 | 68.0 | 67.6 | 82.2 | 80.8 | 66.4 | 84.0 | 61.4 | 84.4 | 83.2 | 79.0 | 60.0 | | | | | | | | | | | | 78.6 | | | |
| | 6 | 86.0 | 84.9 | | 85.3 | 83.9 | 83.8 | 81.6 | 82.5 | 81.0 | 81.0 | | 82.1 | 83.1 | 83.8 | 84.3 | 82.1 | 81.4 | 83.6 | 81.8 | 83.8 | 81.8 | 82.5 | 83.6 | 83.6 | 85.0 | 83.5 | | | | | | | | | | | | | | 83.7 | | | |
| | 7 | 81.5 | 84.4 | | 79.6 | 77.6 | 79.3 | 77.1 | 81.5 | 80.6 | 76.8 | | 81.6 | 79.8 | 78.8 | 80.8 | 76.6 | 81.1 | 81.3 | 83.0 | 82.5 | 82.6 | 79.6 | 81.8 | 85.2 | 84.3 | | | | | | | | | | | | | | | | 80.9 | | | |
| | 8 | 72.0 | 73.6 | | 76.6 | 73.5 | 75.6 | 75 | 80.4 | 79.8 | 75.2 | | 72.6 | 73.6 | 75.8 | 77.8 | 74 | 72.4 | 73.8 | 70.6 | 69.8 | 69.8 | 70.2 | 69.6 | 69.6 | | | | | | | | | | | | | | | | 75.3 | | | |
| | 9 | 72.0 | 76.6 | | 76.8 | 75.6 | 76.8 | 74.2 | 79.0 | 78.8 | 79.6 | | 77.0 | 76.2 | 78.2 | 81.8 | | | | | | | | | | | | | | | | | | | | | | | | | | | 77.1 | 79.3 | 77.4 | 1.9 |
| | 9 A | 85.6 | 85.8 | | 80.2 | 83.6 | 83.8 | 84.8 | 84.4 | 82.8 | 81.4 | | 82.8 | 81.4 | 83.0 | 84.0 | 85.2 | | | | | | | | | | | | | | | | | | | | | | | | | | 84.4 | | | |
| | 22 | 79.4 | 78.8 | | 81.6 | 81.8 | 81.4 | | 79.0 | | 76.4 | | 78.0 | 77.4 | 77.0 | 73.2 | 78.6 | | | | | | | | | | | | | | | | | | | | | | | | | | 78.4 | | | |
| | 22 A | 77.6 | 76.6 | | 74.8 | 74.4 | 79.0 | 75.6 | 78.2 | 79.0 | 75.0 | | 74.6 | 75.2 | 71.6 | 75.0 | 74.2 | 75.0 | 74.6 | 77.4 | 82.4 | 80.8 | | | | | | | | | | | | | | | | | | | | 76.2 | | | |
| WESTERN G. W. Vaughan Div. Eng. | 10 | 86.1 | | | 79.3 | 83.6 | 83.5 | 84.8 | 82.8 | 83.6 | 82.0 | | 83.6 | 85.8 | 82.3 | 81.6 | 84.5 | 82.8 | 84.0 | 83.6 | 82.9 | 71.1 | 72.1 | 77.4 | 75.5 | 71.1 | 72.5 | 75.9 | 73.0 | 69.3 | 70.1 | 68.6 | 70.6 | 69.3 | 76.3 | 79.7 | 78.6 | 77.4 | 79.6 | 81.4 | 77.6 | 78.4 | | | |
| | 11 | 76.5 | 86.9 | | 85.5 | 84.7 | 84.0 | 84.1 | 84.7 | 86.0 | 85.3 | | 81.4 | 81.9 | 84.7 | 81.0 | 81.7 | 81.4 | 82.9 | 72.7 | 78.1 | 76.1 | 77.7 | 79.8 | 75.6 | 76.7 | 76.4 | 76.4 | 75.4 | 74.4 | | | | | | | | | | | 80.8 | | | |
| | 12 | 83.3 | 83.1 | | 83.1 | 81.4 | 81.4 | 81.7 | 79.3 | 80.3 | 80.1 | 85.4 | 79.1 | 82.8 | 81.1 | 85.6 | 80.6 | 78.3 | 78.6 | 79.1 | 80.3 | 77.4 | 78.1 | 78.7 | 77.1 | 74.6 | 78.1 | 77.9 | 79.0 | 78.6 | 76.0 | 73.8 | 77.7 | | | | | | | | 79.6 | 79.3 | 78.8 | 0.5 |
| | 13 | 82.9 | 83.9 | | 85.6 | 85.1 | 84.0 | 84.6 | 85.9 | 83.8 | 82.6 | | 82.6 | 83.6 | 79.8 | | 79.8 | 78.1 | 75.7 | 79.8 | 77.6 | 76.9 | 73.3 | 75.1 | 71.0 | 75.1 | 67.9 | 70.6 | 75.0 | 70.0 | 78.9 | | | | | | | | | | | 79.1 | | | |
| | 14 | 77.3 | 77.8 | | 78.0 | 70.7 | 78.3 | 78.0 | 80.4 | 79.0 | 79.9 | | 70.7 | 80.0 | 80.8 | 83.4 | 80.8 | 79.9 | 70.4 | 70.0 | 68.9 | 75.4 | 79.3 | 80.0 | 77.3 | 71.0 | 77.1 | 78.5 | 78.0 | | | | | | | | | | | | 77.6 | | | |
| | 23 | 85.0 | 83.7 | 83.1 | 81.4 | 83.8 | 86.5 | 84.5 | 84.3 | 83.0 | 83.5 | | 81.1 | 84.1 | 79.3 | 76.8 | 78.6 | 79.7 | 76.0 | 76.1 | 77.6 | 79.7 | 83.0 | 80.0 | 78.1 | 79.6 | 77.4 | 77.4 | 78.5 | | | | | | | | | | | | 80.2 | | | |
| R. W. & O. G. L. Semmerville Div. Eng. | 15 | 78.6 | 78.7 | | 73.0 | 72.5 | 72.0 | 72.2 | 73.7 | 75.6 | 73.5 | | 74.8 | 74.2 | 75.5 | 83.0 | 76.2 | 73.0 | 74.0 | 76.8 | 72.6 | 74.0 | 73.3 | 71.0 | 74.0 | 74.1 | 73.8 | 74.8 | 75.9 | 80.8 | | | | | | | | | | | 74.8 | | | |
| | 16 | 76.2 | 76.8 | | 77.3 | 72.7 | 76.5 | 80.5 | 80.7 | 77.5 | 78.5 | | 78.2 | 79.6 | 80.6 | 81.8 | 82.3 | 84.2 | 82.7 | 76.6 | 78.2 | 77.5 | 77.2 | 77.7 | 81.0 | 79.9 | 79.5 | 80.4 | 82.4 | 76.0 | 81.4 | 80.0 | | | | | | | | | 79.0 | | | |
| | 17 | 81.2 | 83.2 | | 80.3 | 83.2 | 80.5 | 71.7 | 73.8 | | 72.3 | | 74.0 | 76.2 | 76.3 | 77.5 | 76.3 | 74.2 | 80.0 | 79.6 | 67.8 | 66.2 | 69.2 | 72.2 | 71.7 | | | | | | | | | | | | | | | | 74.6 | 76.4 | 74.5 | 2.8 |
| | 18 | 83.3 | 79.7 | | 80.8 | 78.6 | 77.0 | 80.2 | 78.8 | 79.6 | 80.3 | | 80.0 | 78.7 | 75.8 | 70.2 | 67.5 | 82.5 | 82.8 | 83.8 | 74.2 | 73.8 | | | | | | | | | | | | | | | | | | | | 76.1 | | | |
| | 19 | 80.4 | 78.8 | | 79.6 | 81.6 | 77.6 | 76.4 | 76.8 | 74.2 | 76.2 | | 74.8 | 75.0 | 74.0 | 77.4 | 61.0 | 81.7 | 81.8 | 77.6 | 75.8 | 74.0 | 73.0 | 80.0 | 67.6 | 74.2 | 78.0 | | | | | | | | | | | | | | | | 76.4 | | | |
| RIVER C. E. Buchholz Div. Eng. | 20 | 76.5 | 75.0 | | | 88.7 | 82.7 | 84.7 | 86.7 | 85.0 | 84.0 | | 82.5 | 83.8 | 83.3 | 84.0 | 84.0 | 83.8 | 76.5 | 75.0 | 71.8 | 71.6 | | | | | | | | | | | | | | | | | | | | 79.6 | | | |
| | 21 | 75.5 | 80.5 | | 84.5 | 85.6 | 83.2 | 82.0 | 81.8 | 74.0 | 71.7 | | 75.0 | 78.5 | 75.6 | 80.3 | 87.8 | 78.2 | 77.3 | 77.0 | 77.8 | 79.7 | 79.8 | 78.7 | 74.6 | 77.0 | 76.0 | 74.8 | | | | | | | | | | | | | | 78.3 | 79.0 | 76.1 | 2.9 |
| PENNA. A. W. Carpenter Div. Eng. | 24 | 79.0 | 81.6 | | 77.3 | 79.9 | 76.4 | 76.1 | 74.6 | 76.1 | 73.0 | | 76.4 | | | | 72.4 | 79.3 | 78.8 | | 78.4 | 77.1 | 76.0 | 75.3 | 79.0 | 71.7 | 65.7 | 74.7 | 75.8 | 77.1 | 83.7 | 84.1 | 64.7 | 65.9 | 68.8 | 66.0 | 70.8 | | | | | | 73.2 | | | |
| | 25 | 78.4 | 78.6 | | 77.1 | 78.9 | 78.6 | 72.0 | 72.6 | 77.6 | 76.3 | | 76.1 | 74.7 | 77.6 | 75.1 | 76.8 | 75.6 | 82.6 | 81.4 | 80.6 | 79.7 | 79.1 | 79.9 | 79.6 | 77.4 | 82.8 | 85.4 | 87.5 | 90.9 | | | | | | | | | | | 78.4 | | | |
| | 26 | 74.7 | 80.5 | | 79.6 | 77.6 | 77.6 | 74.0 | 68.7 | 68.4 | 66.0 | | 67.9 | 79.6 | 76.9 | 74.0 | 79.0 | 74.7 | 74.9 | 75.1 | 79.9 | 75.0 | 75.7 | 75.2 | | | | | | | | | | | | | | | | | | 74.0 | 75.1 | 73.8 | 1.3 |
| | 27 | 78.3 | 77.6 | | 77.0 | 77.5 | 77.1 | 78.0 | 78.9 | 80.3 | 82.8 | | 80.8 | 74.6 | 78.9 | 79.6 | 78.6 | 77.0 | 71.3 | 70.8 | 74.9 | 65.0 | 66.6 | 65.4 | | 75.0 | 71.0 | 71.7 | 67.6 | | | | | | | | | | | | 74.9 | | | |
| Average for System | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 79.5 | 76.9 | 1.6 | |

Fifth Annual Track Inspection on the New York Central.

the year and prizes are awarded as follows:

First premium, $1,200—$800 to the supervisor and $400 to the assistant supervisor having the best line and surface for the year between Jersey City and Pittsburg and between Philadelphia and Washington.

Second premium, consisting of four prizes of $800 each—$600 to the supervisor and $200 to the assistant supervisor having the best line and surface for the year on each of the main line superintendent's divisions between Jersey City and Pittsburg and Philadelphia and Washington. The winner of the first premium is not considered in the award of any of the second premiums.

Third or improvement premium, $1,000—$700 to the supervisor and $300 to the assistant supervisor of the Main Line division showing the greatest improvement during the year. The division taking the "improvement premium" is not, however, eligible for the second premium of $800.

The annual inspection of the whole system, known as the general manager's inspection, is usually made in October and the party consists of the general manager, chief engineer of maintenance of way, engineer of maintenance of way, all general superintendents, all principal assistant engineers and assistants to the principal assistant engineers, all division superintendents, all assistant engineers and all supervisors. This inspection covers not only the condition of track, but also all the structures and property of the company. One prize of $100 is given for the Main Line yard having the best surface, alinement and general appearance at the time of the inspection. A number of the divisions other than the Main Line divisions have premiums of their own which are awarded after the annual inspection.

The real value of these detailed inspections is in affording a fairly accurate basis for comparison of one year's work with another on the same section of the road, rather than a means of comparison of widely separated sections for any one year. Even in this ,however, allowances must be made at times for wide differences in climatic conditions from year to year, improvements made with special appropriations for rail, ties or ballast, increase or decrease in density of traffic, natural depreciation and many other factors which affect the fairness of marking. It is entirely out of the question to compare the results on one road with those on another.

## Railroad Shop Tools.

(*Continued.*)

BORING MILLS.

The 30-in. boring and turning mill shown in Fig. 1 will take work 32 in. in diameter and 15½ in. high under the cross-rail. The chuck or face plate has eight changes of speed, ranging from 73 r.p.m. to 18 r.p.m. without back gears and from 9.3 r.p.m. to 2.28 r.p.m. with back gears. This machine is furnished with a three-jaw independent and universal chuck combined, or it can be fitted with a plain table, with or without

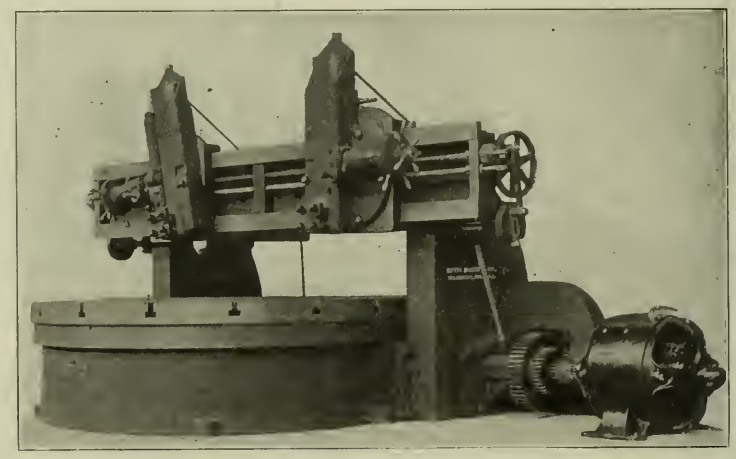


Fig. 2—The Betts 100-in. Boring Mill.

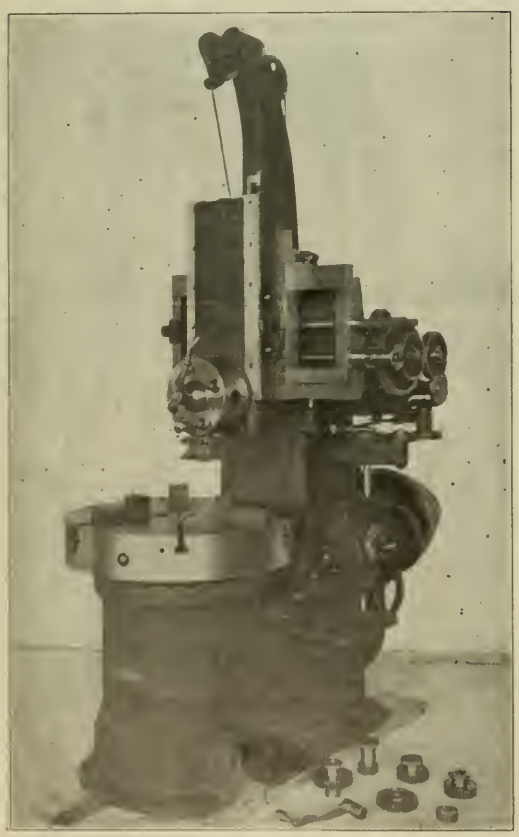


Fig. 1—The Baush 30-in. Boring Mill.

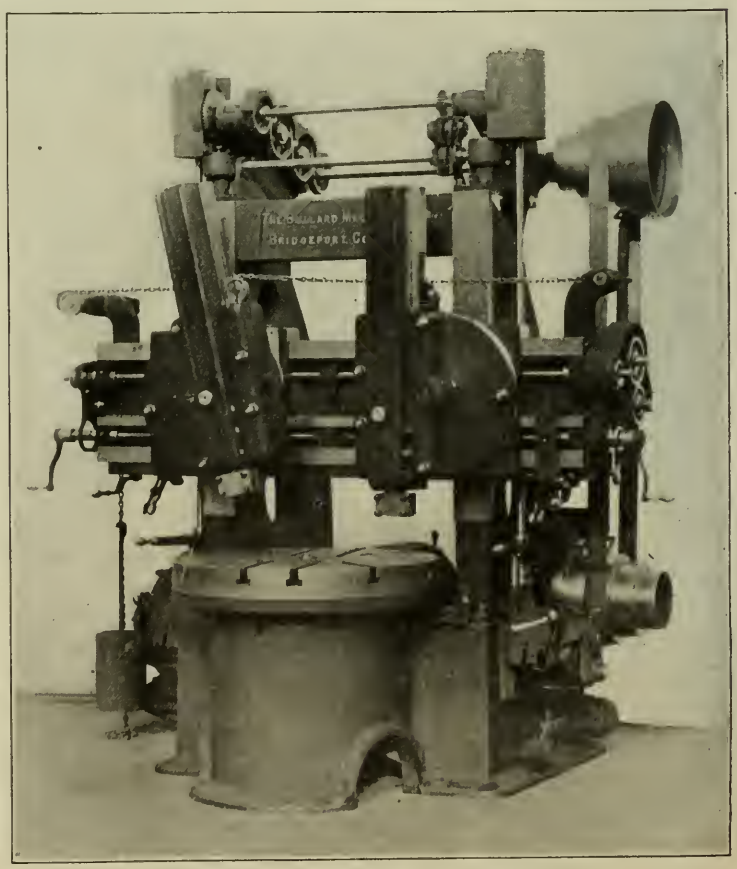


Fig. 3—The Bullard 42-In. Boring Mill.

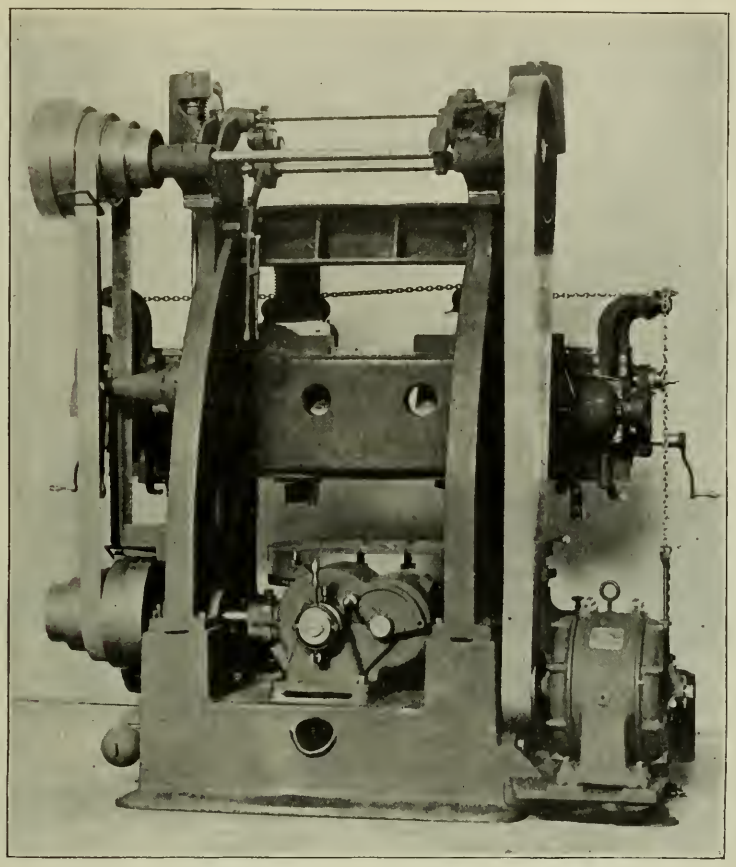


Fig. 4—The Bullard Mill with Motor Mounted on Side Bracket.

jaws. The diameter of the chuck is 30 in. The distance from the floor to the top of the table is 2 ft. 9¾ in. The table has an outer bearing which has an automatic oiling device. The turret slide is attached to a swivel head and has a traverse of 16 in. and can be set to any angle up to 30 deg. By using the Hendy-Norton change gear device attached to the upright the mill will cut the following threads: 6, 7, 8, 9, 10, 12, 14, 16, 18 and 20 threads per inch.

The vertical feed has 20 changes. The horizontal feed has 20 changes, ranging from 0.015 in. to 0.211 in. The mill is driven by a cone, having a 3-in. belt, and it is arranged so that a motor drive may be attached at any time. The back gears are changed by a lever, without the use of a nut lock. The turret has five sides, each of which is 10 in. wide. The holes in the turret head are $2\frac{5}{16}$ in. in diameter. The countershaft has a four-step cone, with a tight and a loose pulley, and should run at 200 r.p.m. The Baush Machine Tool Company make this machine. Its weight is 5,500 lbs.

The 100-in. tire turning and boring mill shown in Fig. 2 is made by the Betts Machine Company. This mill is specially designed for rough turning and finishing steel tires, and swings work 104 in. in diameter and 18 in. high under the cross-rail. The table is 100 in. in diameter and has 15 changes of speed. This machine can be driven by a cone and gearing or it may be driven by a motor connected, as shown. The table is mounted on a spindle, the bearings of which have adjustment for wear. There is also an annular bearing on the bed, which is automatically lubricated. The cross-rail has two saddles, made right and left for close work, and either saddle will move to the center for boring. The tool spindles have a traverse of 18 in. They have rapid hand movement and are counterbalanced. The

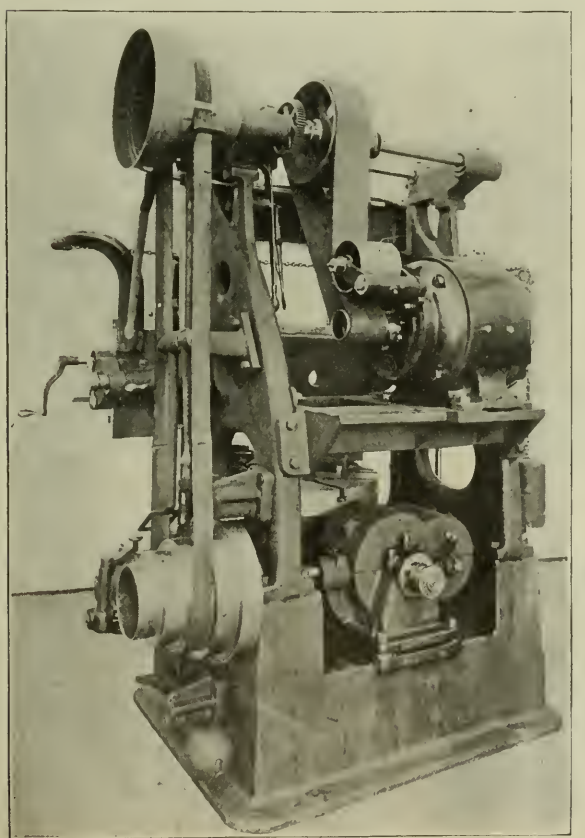


Fig. 5—The Bullard Mill with Motor Mounted between Uprights.

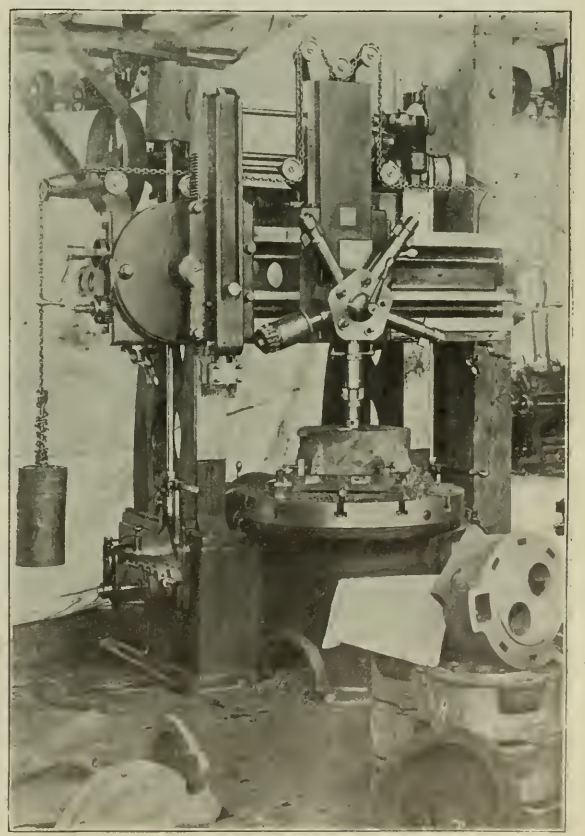


Fig. 6—The Bullard Mill with Turret Head.

swivels are moved by a worm and ratchet for angular adjustment. The feeds are positive and operate at any angle and are entirely independent of each other in all movements. Separate feed mechanism is provided on each side of machine. The changes in feed are made at the ends of the cross-rail by means of slotted feed plates. This mill is self-contained and requires no expensive foundation. The weight is about 39,400 lbs.

The boring and turning mill shown in Fig. 3 is made by the Bullard Machine Tool Company. This machine has a capacity for machining a piece 42 in. in diameter and 33½ in. in height. The table is 37½ in. in diameter and has ten changes of speed. The table spindle is self-centering and the journals are immersed in oil. Each head has a separate feed mechanism, thus making the heads independent in their movements, both as to direction and amount of feed. Either head can be brought to the center for boring. A quick power traverse operates the heads in all directions. The machine is constructed so that it is impossible for the quick power device to be thrown in at the same time with the feed. The left-hand head can be set at any angle and has a downward movement of 30 in. The right-hand head is arranged for cutting all standard threads from 2½ to 12 per inch, including 11½ threads per inch. The screw-cutting gears on the head are independent of the feed gears. The illustration shows the machine with two swivel heads, but the machine can be provided with one swivel head and one turret head if desired. The turret has five sides, each of which is 10 in. wide. The holes in the turret head are 2½ in. in diameter. The slide has a vertical movement of 24 in. Each feed is positive and has ten changes, ranging from $\frac{1}{32}$ to ¾ of an in. horizontally, and from $\frac{1}{30}$ to ½ in. in angular and vertical directions. The cross-rail is raised and lowered by power. The cone has five steps for a 3-in. belt, the largest diameter being 19 in. The table may be stopped at any point by means of a brake attached to the right-hand side of the machine. All the high-speed journals are bronze bushed and self-oiling. Two methods of motor drive are shown. Fig. 4 shows the method of applying a motor on a bracket at the side of the mill, while Fig. 5 shows a constant speed motor mounted on a bracket placed between the uprights. In this case a clutch is introduced into the line shaft to enable the starting and the stopping of the machine without affecting the motor. Fig. 6 shows the application of the turret head.

The 42-in. car wheel boring machine, Fig. 7, is made by the Niles-Bement-Pond Company. This machine will bore wheels up to 42 in. in diameter on the thread. The table is 48 in. in diameter and is fitted with a self-centering chuck, which can be operated by a single motion of a cam lever. The chuck jaws are prevented from slipping by engaging with corrugations in the chuck slides. The slides are graduated in inches, and the jaws can be set at any point on the slide, thus enabling the quick chucking of all diameters of wheels. The boring spindle has power down-feeds and quick hand movement. Two fine feeds are provided for roughing out and one coarse feed for finishing cuts. A quick-acting power crane is mounted on the side of the mill for handling the wheels. The power hub-facing-bar passes through the column. It carries an adjustable tool-slide at its end, and is supplied with power feeds and hand movements. A 15-h.-p. motor operates the driving and feed mechanism and a 2½-h.-p. motor is supplied for operating the crane.

*(To be continued.)*

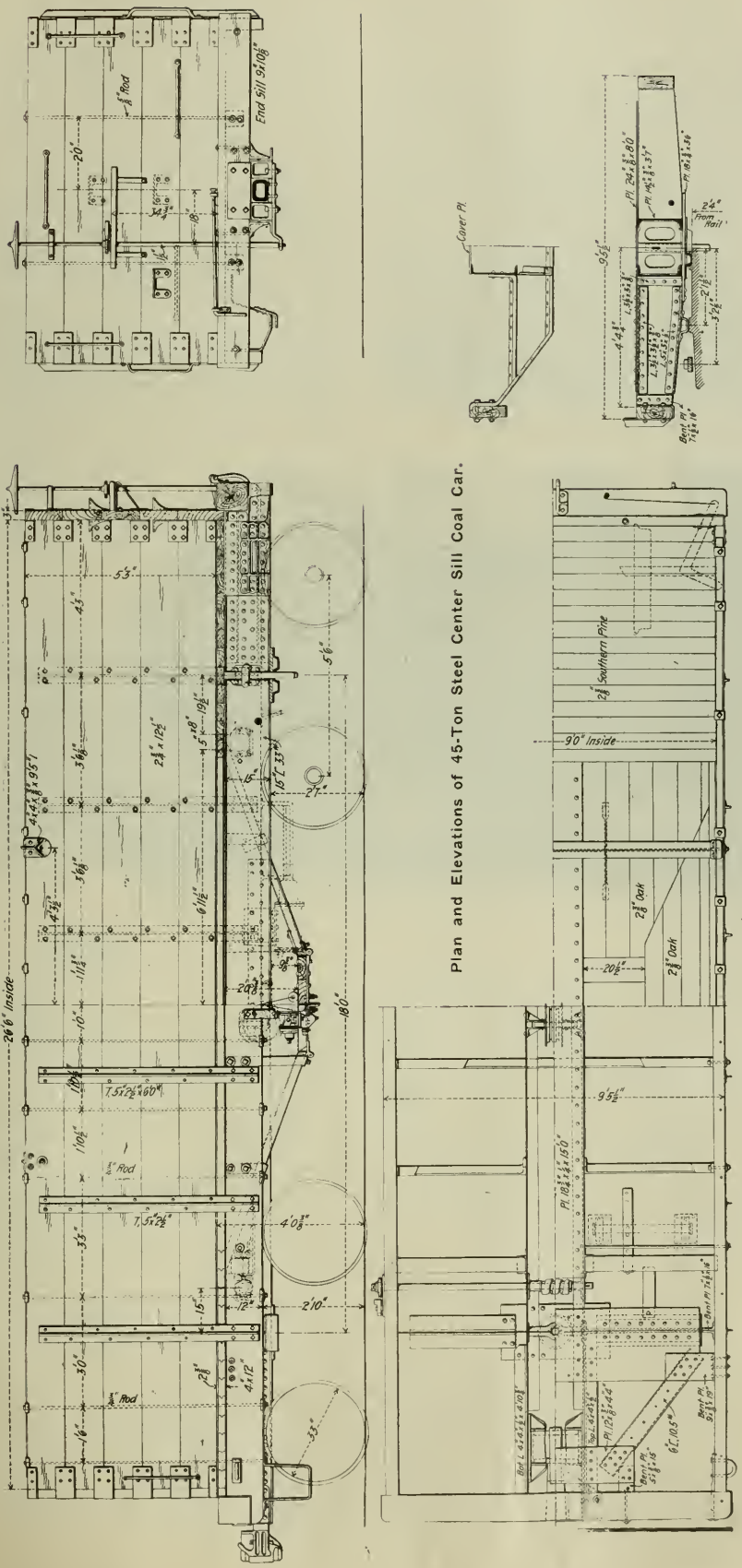
Fig. 7—The Niles-Bement-Pond 42-in. Car Wheel Boring Machine.

## Composite Steel Underframe Coal Car.

The accompanying illustrations show a design of steel center sill coal car of 45 tons capacity, 25 of which have recently been built for the Bulah Coal Company by the Middletown Car Works, Middletown, Pa. It is a car similar in every way to the Pennsylvania type G. N. car with the exception that steel channels have been substituted for wood in the center sills and 4-in. x 12-in. side sills have been used instead of 4-in. x 10-in. timbers, as in the Pennsylvania car. This gives a much stronger underframe and at the same time the weight, 37,500 lbs., has been kept within reasonable limits. The cars are mounted on P. R. R. standard 50-ton trucks and the only reason for giving them a load limit of 90,000 lbs. is because the box will scarcely hold more coal than that.

Steel Center Sill Coal Car.

The design has a number of interesting features, particularly in the construction between the end sills and the bolsters. Two 15-in. channels with the flanges turned in are used for center sills and between the bolsters a ¼-in. top cover plate 15 ft. long is riveted on them. The bolsters are built up around the sills with a cast filling piece in between the webs and to provide extra stiffness in a horizontal direction, a 24-in. x ⅜-in. top cover plate is riveted over the bolster and center sills. The center sills are cut off square, 26 in. outside the bolsters and a ⅜-in. x 14½-in. plate, 3 ft. 7 in. long, is butt-spliced on with 4-in. x 4-in. x ½-in. top and bottom flange angles and a 6-in. x ½-in. plate laid along the middle of the web. There are 25 rivets back of the splice and 34 in front of the joint and the whole forms a strong and rigid connection. The splice pieces extend out to the end sill and are cut away at the top to fit around the back and bottom faces of it. Two heavy steel castings are riveted on the ends of each of the longitudinal sills, inside and outside, and these give a bearing 11 in. wide and 7 in. deep against the back of the wooden end sill. These castings also form the coupler chafing irons and the carry iron which is carried out to form the bottom brake shaft step, is bolted on below them. End sill diagonal braces made of 6-in. channels are carried back to the outer ends of the bolsters and all of the connections are made with wide,




heavy gusset plates. The heavy end shocks which exceed the capacity of the twin draft springs are taken through the shoulder on the back of the head of the coupler through the end sills to the center sills, almost in line with the neutral axis of the sills, so that no serious bending or buckling strains are induced.

The bottom of the car forms a shallow pyramidal hopper with double drop doors operated with a double chain running back between the center sills to the operating shaft, which is placed just back of the bolster at one end of the car. On the plan of the car will be noticed a bell crank attached under the floor for transforming the motion of the hand-brake chain from a lateral to a longitudinal direction. A noticeable feature of the design of the steel underframe is the absence of any pockets or depressions in which acidulated water might collect and cause corrosion.

We are indebted to Mr. George I. King, Vice-President and General Manager of the Middletown Car Works, for the illustrations.

## Seventeen Passengers Killed at Glenwood, Ill.

In a rear collision on the Chicago & Eastern Illinois, at Glenwood, Ill., 23 miles south of Chicago, on the evening of July 13, about 8 o'clock, 17 or more passengers were killed and about 60 were injured, all members of a Sunday school excursion returning to Chicago. The excursion train of 12 cars was running on the southbound track, having been put upon that track to get it around a delayed northbound freight. This freight had broken in two, and the forward portion, consisting of the engine and 30 cars, had been set upon the southbound track to be rejoined to the rear portion, and while moving slowly *northward* was struck by the passenger train at full speed on a curve. The baggage car and first two passenger cars were completely crushed. The stations, going north, are: Chicago Heights, Glenwood, 3.2 miles, and Thornton, 1.7 miles farther. The freight, northbound, broke in two before reaching Chicago Heights. The engine and 30 cars were run to Thornton, backed across to the southbound track and run back to Glenwood, and the rear end of this 30-car section had been pushed about 1,000 ft. south of Glenwood station when the collision occurred, the passenger train having been sent north from Chicago Heights on the west or southbound track, the rear part of the freight having been stopped at or near Chicago Heights. It would seem that Engineman Hoxie of the freight set back from Thornton by reason of some misunderstanding with the conductor, he (the conductor) having gone north to flag the southbound track. An order had been given to set the 30 cars on the siding at Thornton, there being considerable upgrade southward and the southbound track had to be crossed to do this. Why the cars were not set off has not yet been explained. Neither is it clear how Hoxie could start southward when the despatcher had, presumably, put out an order at Thornton to hold all southbound trains for the northbound excursion train. There was no operator on duty at Glenwood. For a satisfactory statement of the cause, therefore, it will be necessary to await further information.

About 20,000 men engaged in railroad construction partly in Gallcia (Austrian Poland) and partly in Hungary, agreed to strike April 30. Those working in Hungary were arrested while trying to cross over the border. The Galicians were not willing to strike alone, and the movement then ended.

### Water Filters for Railroad Use.

There are many waters which are comparatively soft and would be classed as good waters as far as hardness is concerned. Such waters, however, often contain 300 gr. of solid matter per gallon, especially during freshets. About 200 lbs. of sediment may be deposited in the boiler in an ordinary day's work. This suspended matter is a mineral consisting of clay, which is an impure silicate of alumina, or silt, which is a combination of silica oxide, iron, lime, etc. These foreign substances are accompanied by mud, and a carbonaceous, organic mixture, more or less soluble. The minerals are deposited in the boiler with the scale, and gives it a heterogeneous composition, often stratified and tough. A pure mineral scale is generally brittle. The mud, however, is lighter and remains mostly in suspension, except where the circulation is poor, such as the water leg, where it deposits and becomes baked, causing the sheets to bag and burn out. The mud, which remains in suspension, often produces foaming, especially if much saline matter is present.

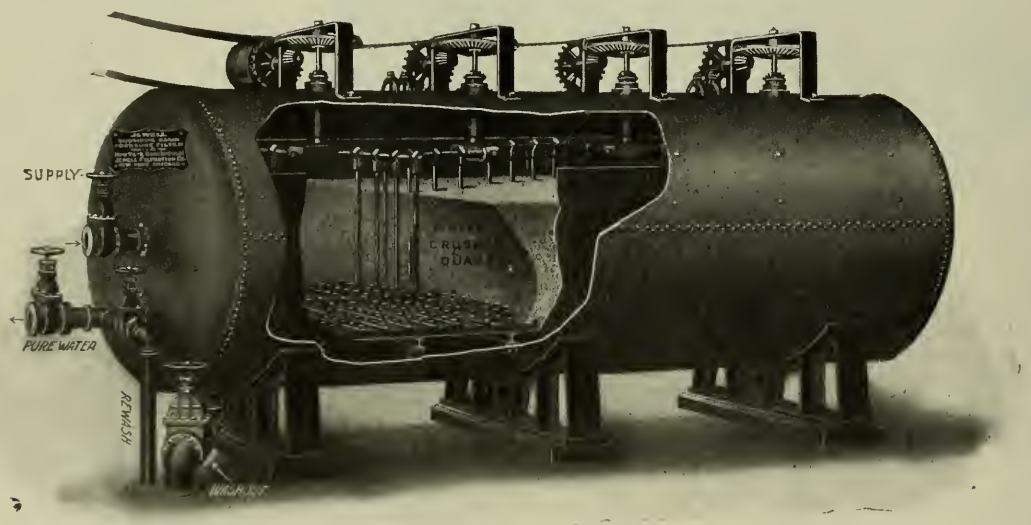
It is with such waters that filtration proves most advantageous, although it may be said that no water should contain more than 350 parts per million (20 gr. per gallon) of suspended matter. Such a water would be quite milky or opalescent, but never "roily" or brown. Filtration, with the use of a coagulant such as sulphate of alumina, removes all suspended matters, color and stain, and a large portion of the dissolved organic matter, delivering the water perfectly clear without materially affecting the dissolved mineral constituents.

The Chicago & Eastern Illinois is about to install at Villa Grove, Ill., on the Embarras River, a filtration plant having a capacity of from 400,000 to 500,000 gals. of water per day of 24 hours. An illustration of the filter, which is made by the New York Continental Jewell Filtration Company, is shown. It is 8 ft. in diameter and 24 ft. outside. The inner tank, which is rectangular, is 6 ft. 4 in. wide x 25 ft. 4 in. long, giving an effective filtration surface of 153 sq. ft. The filter bed, which is contained in the inner tank, is ground flint rock, carefully sifted to a uniform size. The depth of this bed is 3 ft. At the bottom of the filter bed is a system of manifolds and branch pipes, the former extending the entire length of the tank and the latter to either side from the center. Into these pipes are screwed several hundred strainers of a special design, adapted to draw off freely the water which comes down through the bed, and prevent the escape of the quartz particles. The muddy water enters at the central connection in front and is deflected so as to pass below the inner tank. It then rises in the space around the tank, or between the two tanks, and descends through the quartz bed. When the water reaches the strainers it is perfectly clear and runs along the manifold to the lower opening in front, whence it is delivered to the storage tank.

It is necessary to clean the filter on an average once a day, depending, of course, on the turbidity of the water, which varies. This operation requires from 10 to 15 minutes and is very thorough, leaving the bed clean and white. A 4-h.-p. vertical steam engine is used to operate the "agitators" during washing and serves to revolve the perpendicular bars, or rakes, through the bed. This thoroughly agitates the bed, so that the grains are rubbed together and the sediment washed off. In order to make these bars revolve easily and carry away the heavy sediment, which is then, of course, very concentrated, a reverse current of water is applied to the strainer system. This water comes back by gravity from the storage tank and being filtered, does not clog up or wear out the strainers as the river water would do if applied for washing. The upward current thus established is sufficiently strong to expand the bed about 4 in. in height. This expansion of the bed separates the minute grains of quartz by a layer of water and keeps them dancing up and down, so that the agitator bars pass through the bed almost as easily as if no quartz was there.

Much of the heavy matters carried by the river water, such as the silt, clay, etc., settles in the "subsidence basin" (the space between the two tanks). The rest is carried over on the bed and lodges principally on the surface, only the very lightest and finest penetrating it to any appreciable extent; therefore, when the wash-out valve is opened the first to leave is the matter deposited by the settling, and also the first water to leave the quartz carries the top layer of sediment off the filter bed, so that very little water—approximately 2 to 3 per cent. of the amount filtered—is required for washing. As the wash water overflows the inner tank it serves also to wash out the subsidence basin in one operation.

The filter shell is built of heavy steel plate, double riveted, to stand 100 lbs. per sq. in. The pipe connections on this size filter are 6 in. for the supply and discharge connections and 8 in. for the washout. The rewash, or draining, pipe, which is seldom used, is 4 in. During filtering the quartz particles settle down very compactly, leaving a perfectly level and solid filtering surface. The initial resistance of the filter bed during filtering is just about equal to 1 lb. pressure per square inch. During filtering as the sediment accumulates, this gradually increases and may run up to 10 or 15 lbs., although it is generally most economical to wash the filter before it reaches 5 to 6 lbs. This resistance and condition of the bed is readily observed by two ordinary pressure gages, one on the supply pipe and the other on the discharge of the filter. The gage on the discharge pipe also serves to show when sufficient water is turned on for washing and enables the operator to set the valve at the proper opening. Too much back pressure during washing would cause a gradual waste of the quartz and would not be economical in the relative percentage of wash to filtered water. Only enough water is turned back to liquefy the bed and relieve the engine of any heavy load. The engine and agitators are not moved during filtering, and are, therefore, used only a few minutes each day.




Filter for Chicago & Eastern Illinois at Villa Grove.

The apparatus is practically indestructible, as it is subject to very little wear. The only vulnerable parts are the strainers and the quartz filter bed. Strainers have been in use now over 12 years on a filter installed for this road at Brazil, Ind., and strainers removed from filters in operation over six years, for purposes of examination, were found only slightly worn. The loss of the quartz should not exceed 3 per cent. of its volume per year (ordinary wear), but if care is not exercised in the matter of wash water pressure and speed of agitators during washing, the loss may be as high as 10 per cent. These conditions have been safeguarded as far as practicable by proportioning the size of the pipe connections, openings in the strainers and automatic governing of the engine.

The filters are easily erected and may be moved from one station to another without

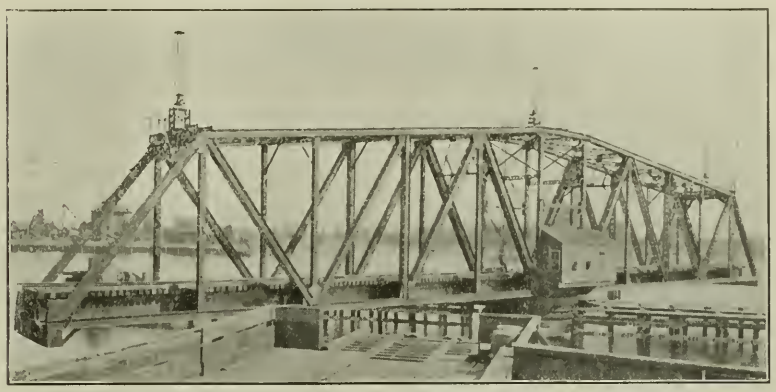
being taken apart. For large equipments, exceeding 500,000 gals. per day, a battery of two or more smaller sizes is used.

Among the railroads using these filters are the Chicago & Eastern Illinois, Chicago, Milwaukee & St. Paul; Michigan Central, Illinois Central, Southern Pacific, Reading Terminal (Philadelphia) and the Missouri Pacific.

### The St. Joseph Drawbridge of the Pere Marquette.

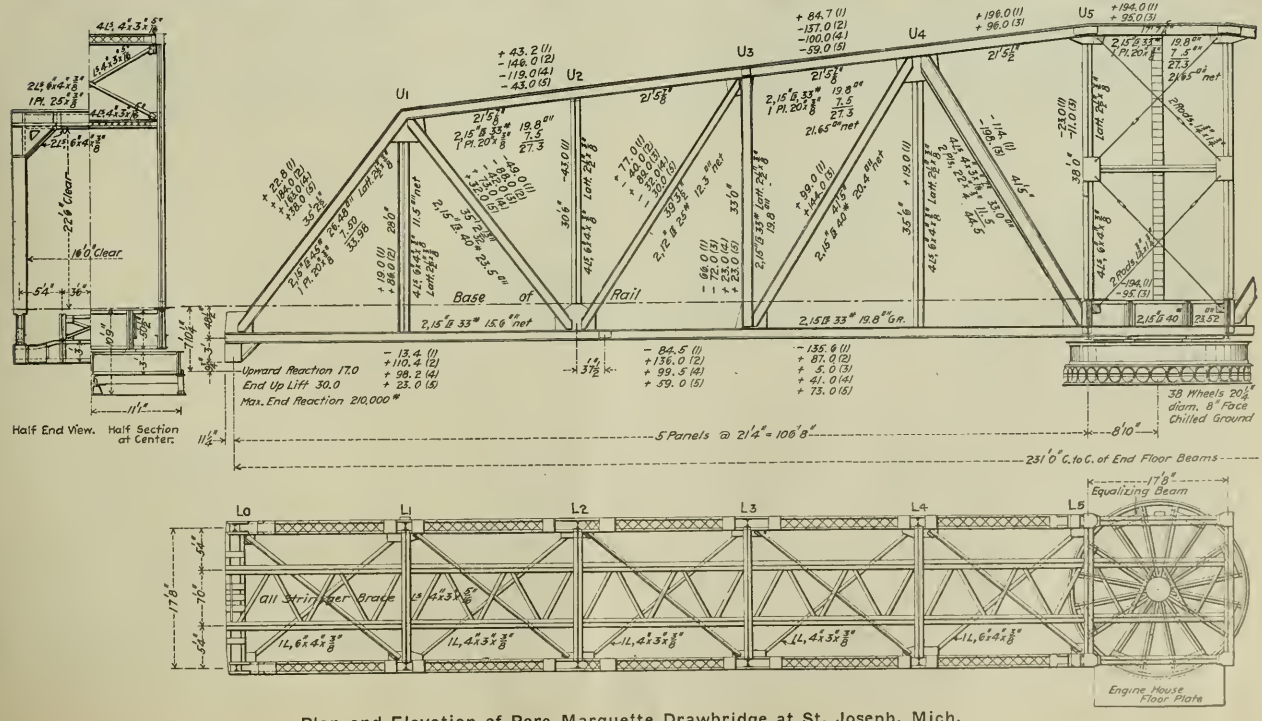
The Pere Marquette has recently completed and put in service a new drawbridge across the St. Joseph River at St. Joseph, Mich., replacing an older span which had become too light for modern locomotives. The latter was built in 1887 by the Detroit Bridge & Iron Works and was 231 ft. 4 in. center to center of end piers, giving two 100-ft. clear openings. Quick work was done in putting up the new structure, the old bridge having been withdrawn from service on February 28 and the new one swung into place on March 27. It was necessary to have the new bridge ready for the passage of boats when navigation opened, and the first large boat passed through the draw on the evening of March 28. The contract for the bridge was let December 20, 1903.

To provide for railroad traffic during the progress of the work, piles were driven for a temporary trestle in the north opening and a temporary draw span, to permit the passage of small boats, was put in the south opening. This span was made of two old 45-ft.



New Drawbridge of the Pere Marquette at St. Joseph, Mich.

Erection View of Pere Marquette Drawbridge at St. Joseph, Showing Temporary Draw Span.


Base of Rail
Half End View.
Half Section at Center.
5 Panels @ 21'4" = 106'8"
231'0" C. to C. of End Floor Beams
Equalizing Beam
All Stringer Brace
Engine House Floor Plate

Plan and Elevation of Pere Marquette Drawbridge at St. Joseph, Mich.

plate girder spans riveted together end to end with cover plates, and was placed on a turntable center resting on a pile pier. It was opened and closed by means of ropes leading to winches on the protection pier. Four or five movements a day were all that were required during the three weeks or so that this span was in use. The old bridge having been swung around on the protection piers and the diagonals of the center panel taken out to permit the passage of trains, the steel work was taken down and the new structure erected on this pier.

The new bridge is 231 ft. center to center of end floor beams, 17 ft. 8 in. center to center of trusses and 38 ft. center to center of chords at the middle panel. The clearance is 22 ft. 6 in. It was designed for Cooper's Class E loading. The longitudinal and transverse girders are 5 ft. ½ in. back to back of angles, and the intermediate floor beams are 4 ft. 6½ in., the end floor beams 3 ft., the stringers 3 ft. 2½ in. and the equalizing beams 3 ft. in this same dimension. The weight of the new bridge is 300 tons, that of the old one having been 140 tons. The new bridge is operated by a 30-horsepower, gasoline engine, which opens or closes it in one minute. The bridge was built at the Detroit plant of the American Bridge Company.

The foregoing information and photographs were furnished by Mr. J. Tuthill, Bridge Engineer of the Pere Marquette.

## A Novel Flue-Rattler.

The accompanying illustration shows a flue-rattler used at the Elizabethport shops of the Central Railroad of New Jersey. It consists of a semi-circular trough 5 ft. in diameter and 21 ft. 8 in. long, made up of $^{5}/_{16}$-in. boiler plates. It rests on a concrete support, as shown. In this trough is suspended the flue rumbler, which is 3 ft. 3⅜ in. in diameter and is supported at each end by 9 in. x 5 in. bearings. The power for driving is obtained from the main shaft in the boiler shop by a belt. The belt drives a 36 in. pulley, which is on the same shaft with a small gear. This gear meshes with a larger gear keyed to the driving shaft of the rumbler. The machine is operated as follows: Water flows into the trough from the pipe shown in the illustration. When the trough is partially filled the water is shut off. The water is then heated by turning steam into the trough from a steam pipe provided for the purpose. The water is heated in order to shorten the time required for cleaning the tubes and to prevent the water from freezing in winter, as the rattler is outdoors. The water is let out of the trough before the tubes are removed. It took about 8 hours to clean 125 tubes using the old-style dry rattler, but with the above design 125 flues are thoroughly cleaned in 2½ hours. Enough heat is retained in the tubes from the hot water to dry them quickly after being taken out of the rumbler and stood on end. In addition to saving time, the advantages of the water flue rattler are: Little noise; the flues do not have to be dried out before rattling as in a dry rattler, and the tubes are thoroughly cleaned.

## Locomotive Testing Plant of the Pennsylvania at St. Louis.*

*Methods Used in Tests.*

A list of items, comprising the observed and calculated results, which have been approved by the Advisory Committee is given below: It is divided into seven general headings: (1) Description, Dimensions and Proportions, (2) Constants, (3) Observed Data, (4) Summary of Average Results—Boiler, (5) Summary of Average Results—Engine, (6) Summary of Average Results—Locomotive, (7) Summarized Statement of Average Results.

All of the items given under heading "Summarized Statement of Average Results" are contained in earlier statements, but are here grouped together, thus giving in a condensed form the most important facts.

DESCRIPTION, DIMENSIONS AND PROPORTIONS.

*Driving Wheels.*

1. Number of pairs.
2. Approximate diameter, inches.
3. Measured circumference, feet, Right No. 1...
4. " " " " " 2...
5. " " " " " 3...
6. " " " " " 4...
7. " " " " " 5...
8. " " " Left " 1...
9. " " " " " 2...
10. " " " " " 3...
11. " " " " " 4...
12. " " " " " 5...
13. Average " " .....

*Engine Truck Wheels.*

14. Number
15. Diameter, inches.

*Trailing Wheels.*

16. Diameter, inches.

*Wheel Base.*

17. Driving wheel base, in feet.
18. Total wheel base in feet.
19. Gage of wheels, in inches.

*Weight of Engine, Pounds.*

(With water at second gage cock and normal fire.)

20. On truck.
21. On first drivers.
22. On second drivers.
23. On third drivers.
24. On fourth drivers.
25. On fifth drivers.
26. On trailers.
27. Total.
28. Total on drivers.

*Cylinders.*

29. High pressure, number.
30. Low pressure, number.
31. Arrangement.
32. Diameter, inches, high pressure, right.
33. Diameter, inches, high pressure, left.
34. Diameter, inches, low pressure, right.
35. Diameter, inches, low pressure, left.

*Stroke of Piston, Feet.*

36. High pressure, right.
37. High pressure, left.
38. Low pressure, right.
39. Low pressure, left.

*Clearance, Per Cent. of Piston Displacement.*

40. High pressure, right, head end.
41. High pressure, right, crank end.
42. High pressure, left, head end.
43. High pressure, left, crank end.
44. Low pressure, right, head end.
45. Low pressure, right, crank end.
46. Low pressure, left, head end.
47. Low pressure, left, crank end.

*Receiver, Cubic Feet.*

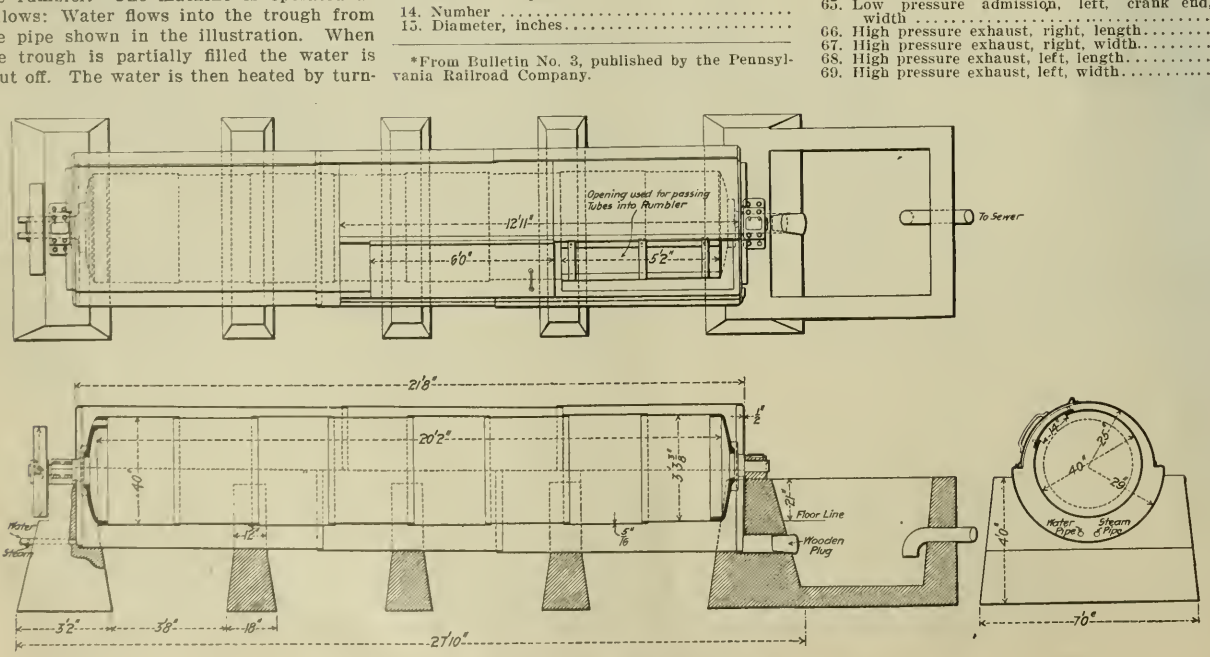
48. Volume, right side.
49. Volume, left side.

*Steam Ports, Inches.*

(For piston valves, the length equals the circumference of inside of bushing, minus the sum of the widths of bridges.)

50. High pressure admission, right, head end, length.
51. High pressure admission, right, head end, width.
52. High pressure admission, right, crank end, length.
53. High pressure admission, right, crank end, width.
54. High pressure admission, left, head end, length.
55. High pressure admission, left, head end, width.
56. High pressure admission, left, crank end, length.
57. High pressure admission, left, crank end, width.
58. Low pressure admission, right, head end, length.
59. Low pressure admission, right, head end, width.
60. Low pressure admission, right, crank end, length.
61. Low pressure admission, right, crank end, width.
62. Low pressure admission, left, head end, length.
63. Low pressure admission, left, head end, width.
64. Low pressure admission, left, crank end, length.
65. Low pressure admission, left, crank end, width.
66. High pressure exhaust, right, length.
67. High pressure exhaust, right, width.
68. High pressure exhaust, left, length.
69. High pressure exhaust, left, width.

*From Bulletin No. 3, published by the Pennsylvania Railroad Company.




Flue-Rattler—Elizabethport Shops, C. R. R. of N. J.

70. Low pressure exhaust, right, length.....
71. Low pressure exhaust, right, width.....
72. Low pressure exhaust, left, length.....
73. Low pressure exhaust, left, width.....

*Piston Rods, Diameter, Inches.*

74. High pressure, right.....
75. High pressure, left.....
76. Low pressure, right.....
77. Low pressure, left.....

*Tail Rods, Diameter, Inches.*

78. High pressure, right.....
79. High pressure, left.....
80. Low pressure, right.....
81. Low pressure, left.....

*Valves.*

82. Type .....
83. Design .....
84. Balanced area in per cent. of total.....
85. Type of link motion.....

*Greatest Valve Travel, Inches.*

86. High pressure, right.....
87. High pressure, left.....
88. Low pressure, right.....
89. Low pressure, left.....

*Outside Lap of Valve, Inches.*

90. High pressure, right, head end.....
91. High pressure, right, crank end.....
92. High pressure, left, head end.....
93. High pressure, left, crank end.....
94. Low pressure, right, head end.....
95. Low pressure, right, crank end.....
96. Low pressure, left, head end.....
97. Low pressure, left, crank end.....

*Inside Lap of Valve, Inches.*

98. High pressure, right, head end.....
99. High pressure, right, crank end.....
100. High pressure, left, head end.....
101. High pressure, left, crank end.....
102. Low pressure, right, head end.....
103. Low pressure, right, crank end.....
104. Low pressure, left, head end.....
105. Low pressure, left, crank end.....

*Miscellaneous.*

106. Cylinder lagging, material.....
107. Cylinder jacket material.....
108. .....
109. .....
110. .....
111. .....
112. .....

*Boiler.*

113. Type .....
114. Outside diameter, first ring, inches.....

*Tubes.*

115. Number .....
116. Outside diameter, inches.....
117. Thickness, inches .....
118. Length between tube sheets, inches.....
119. Total fire area, square feet.....
120. Serve tubes, number of ribs.....
121. Serve tubes, square inches of inside surface in one inch of length.....
122. .....
123. .....
124. .....

*Superheater.*

125. Number of tubes.....
126. Outside diameter, inches.....
127. Thickness, inches.....
128. Length of tubes, inches.....
129. .....
130. .....
131. .....

*Fire-box, Inside.*

132. Length .....inches.....
133. Width .....inches.....
134. Depth, front end.....inches.....
135. Depth, back end.....inches.....
136. Volume .....cubic feet.....
137. .....
138. .....
139. .....
140. .....

*Fire Doors.*

141. Number .....
142. Area, square feet.....
143. .....

*Grates.*

144. Style .....
145. Total area, square feet.....
146. Total area, dead grates, square feet.....
147. Width of air spaces, inches.....

*Air Inlets.*

148. Through fire-box sides.....Square feet
149. Through grates.....Square feet
150. Through fire doors.....Square feet
151. Total air inlets, No. 148, No. 149 and No. 150.....Square feet
152. Ratio air inlets (No. 149) to grate area (No. 145) .....
153. Ratio air inlets (No. 151) to grate area (No. 145) .....

*Heating Surface, Square Feet.*

154. Of the tubes, water side.....
155. Of the tubes, fire side.....
156. Of the fire-box, fire side.....
157. Of the superheater, fire side.....
158. Total, based on inside of fire-box and inside of tubes.....
159. Total, based on inside of fire-box and outside of tubes .....

*Boiler Volumes.*

(With water surface at level of second gage cock).

160. Water space, cubic feet.....
161. Steam space, cubic feet.....

*Exhaust Nozzle.*

162. Double or single.....
163. Dimensions of right side, inches.....
164. Dimensions of left side, inches.....
165. Area of right side, square inches.....
166. Area of left side, square inches.....
167. Total area, left side.....

*Reverse Lever.*

168. High pressure cylinder, notches forward of center .....
169. Low pressure cylinder, notches forward of center .....
170. .....

*Ratios.*

171. Heating surface (No. 158) to grate area (No. 145) .....
172. Fire area through tubes (No. 119) to grate area (No. 145).....
173. Fire-box heating surface (No. 156) to grate area (No. 145).....
174. Tube surface (No. 155) to fire-box heating surface (No. 156).....
175. Fire-box volume (No. 136) to grate area (No. 145) .....
176. .....
177. .....
178. .....

CONSTANTS.

179. For dynamometer horse-power (power developed when the sped is one r. p. m. and the pull is one pound).....
For indicated horse-power (power developed at one r. p. m. and one pound m. e. p.).
180. High pressure cylinder, right, head end.....
181. High pressure cylinder, right, crank end.....
182. High pressure cylinder, left, head end.....
183. High pressure cylinder, left, crank end.....
184. Low pressure cylinder, right, head end.....
185. Low pressure cylinder, right, crank end.....
186. Low pressure cylinder, left, head end.....
187. Low pressure cylinder, left, crank end.....

*For Piston Displacement, Cubic Feet.*

188. High pressure cylinder, right, head end.....
189. High pressure cylinder, right, crank end.....
190. High pressure cylinder, left, head end.....
191. High pressure cylinder, left, crank end.....
192. Low pressure cylinder, right, head end.....
193. Low pressure cylinder, right, crank end.....
194. Low pressure cylinder, left, head end.....
195. Low pressure cylinder, left, crank end.....

The numbered blank spaces are provided so that information concerning unusual features of the locomotive under test may be inserted. The dimensions and constants will be given for each locomotive tested, the observed data and calculated results for each test. There will be from fourteen to twenty tests on each locomotive.

The method for obtaining the dimensions and data given is in most cases self-evident; but that these may be clearly understood, and also to show the precautions taken to insure accuracy, the following are deemed sufficiently important to require special mention:

DESCRIPTION, DIMENSIONS AND PROPORTIONS.

Items Nos. 3 to 13. The circumference of the driving wheels will be measured with a flexible steel tape, divided in feet, and hundredths of a foot. The circumference will be taken at the point where the driver would rest on the rail. The gage of track being 4 ft. 8½ in. and the width of the rail head being 2¼ in., the distance between the circumferences to be measured is 4 ft. 10¾ in.

Items Nos. 20 to 28. As there is no scale at St. Louis with sufficient capacity to weigh many of the locomotives which are to be tested, the locomotive will be weighed at the most convenient point by a member of the testing force, although in some cases it may be necessary to take the builders' weights of the engine in working order.

Items Nos. 32 to 35. The diameters of cylinders will be taken with an inside micrometer caliper, at the head end, crank end and middle of the bore of the cylinder. These three locations in the cylinder will be measured with the calipers in a vertical position, and also in a horizontal position; the diameter given being an average of the six measurements obtained in this manner.

Items Nos. 36 to 39. The locomotive being set on one of its dead centers, the distance from some convenient point on the guides or cylinder to some point horizontally in line on the cross-head or piston rod will be measured. A similar measurement will then be taken between the same two points with the locomotive on the other dead center. The difference between these two measurements in feet will give the stroke.

Items Nos. 40 to 47. The volume of clearance will be obtained by placing the locomotive on the dead center and filling the clearance space with water from a vessel holding a known weight of water. The water remaining in the vessel will be weighed and the rate of leakage from the clearance space observed. From these data the volume of the clearance space can be readily calculated, and 100 times this volume, divided by the volume of piston displacement, will be the result desired. As a check, the clearances will be calculated from measured dimensions and working drawings, but preference will be given to the results obtained by the use of water.

With piston valve engines it will be necessary to place the valve so that it will block the steam port; a tell-tale hole being provided to allow the escape of air and to show the height of the water. By removing a cylinder cock, and using a hand pump, the water may be forced in from below, and the amount ascertained.

Items Nos. 48 to 49. The receiver volumes will be ascertained if practicable in the same manner as the volume of clearances.

Items Nos. 50 to 73. The length of the steam and exhaust ports given will not be the actual length, but will be such a dimension that, multiplied by the actual width, will give the actual area of the port. The measurements are given in this way to allow for the rounded corners usually found in cylinder ports.

Items Nos. 74 to 81. The piston rods and tail rods will be measured at several points by a micrometer caliper. The diameter given for each rod will be the average of all measurements.

Item No. 84. The balanced area of the valve will be the product of the dimensions to inside edges of balance strips or rings; the total area that of the entire face of valve.

Items Nos. 86 to 89. The greatest valve travel will be obtained with the reverse lever in full gear forward, by scribing the valve rod and measuring with a tram.

Items Nos. 90 to 105. The outside and inside laps will be calculated from measurements of valve and valve seat taken while hot, and their relative positions at center of valve travel.

As a set of working drawings will be furnished, the chief purpose of these measurements will be to check the drawings.

Item No. 114. The outside diameter of the first or smallest ring of the boiler will be calculated from the circumference as measured with a flexible steel tape.

Items Nos. 116 and 117. As the thickness and outside diameter of tubes vary considerably after they have been in service, the nominal diameter and specified thickness will be taken.

Item No. 118. The length of tubes, between tube sheets, will be obtained by measuring the length over beads of a number of tubes well distributed and deducting the thickness of tube sheets and beads.

Item No. 119. The total fire area of tubes will be obtained by multiplying the area of cross section of inside of tube by the number of tubes.

Item No. 121. As a factor in obtaining the surface contour of the Serve tubes, a strip of adhesive tape will be pressed into the form of the ribs of the tube or a cast of the same. The length of this tape in inches will equal the square inches of surface in one inch of length.

Items Nos. 126 and 127. The dimensions of superheater tubes will be found in the same way as already described for boiler tubes.

Items Nos. 132 and 133. The length of the fire-box will be measured at the level of the bottom of fire door, and parallel to line of rail, the width being the horizontal distance between side sheets at mid-length.

Items Nos. 134 and 135. The depth of fire-box will be the measured distance (perpendicular to the rail) from grate surface to

crown sheet at front and at back of fire-box.

Item No. 136. The volume of fire-box will be calculated from dimensions of the fire-box above the surface of the grates, and checked from the drawings.

Item No. 147. The width of the air spaces in grates will be, with bar grates, the actual width of the openings; with finger grates, the maximum opening.

Item No.. 149. The area of the air inlets through the grates will be calculated from drawings known to correctly show the grates.

Item No. 150. The air inlet area through fire doors will be the area of dampers or holes in fire door, when dampers are open as far as possible.

Item No. 154. The heating surface of the water side of the tubes will be obtained by multiplying the circumference of the outside of tube, in feet, by the length between tube sheets, in feet, and by the number of tubes.

Item No. 155. The heating surface of the fire side of the tube is to be obtained in a similar manner to Item No. 154, except that the internal diameter of the tube will be used. In the case of Serve tubes the length over the ribs (No. 121) divided by 12 is the circumference in feet.

Item No. 156. The heating surface of the fire-box is the area calculated from measurements of the fire-box sheets, above the level of the grates, less the total fire area of the tubes (No. 119), the area of fire doors (No. 142), and the area of air inlets through sides of fire-box (No. 148).

Item No. 157. In the heating surface of superheater will be included any headers, etc., which may form a part of the true superheating surface.

Items Nos. 158 and 159. The heating surface of the superheater, for a locomotive so equipped, is included in these items; using the fire sides of tubes and headers. The heating surface, based on the fire side, will be used in all calculations in these tests.

Items Nos. 160 and 161. To obtain the volume of water and steam space in the boiler, the locomotive frame will be leveled, and the boiler completely filled with water. The water will be weighed out, down to level of second or middle gage cock; from the weight of water corrected for temperature, the volume of steam space can be calculated. By weighing out the remaining water in the same way the volume of water space will be found.

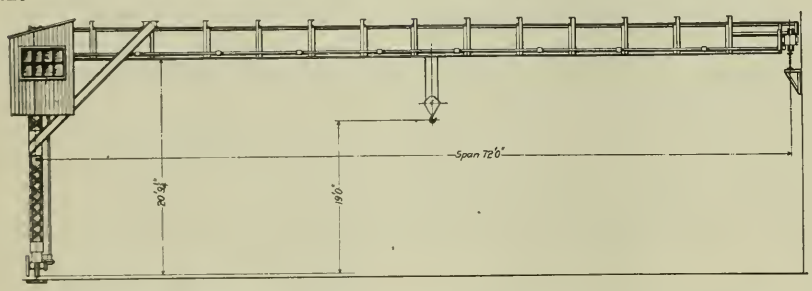
CONSTANTS.

Items Nos. 188 to 195. The piston displacement is the length of stroke multiplied by the difference between the area of the cylinder and the area of the piston rod or tail rod, as the case may be.

*(To be continued.)*

## A Six-Ton Gantry Crane.

The accompanying illustrations show a 6-ton one-leg gantry crane used at the Elizabethport shops of the Central Railroad of New Jersey. The crane is 20 ft. 9¼ in. in the clear and has a span of 74 ft. The present travel of the crane is 112 ft., as it now only serves the machine shops, but it is intended to extend its travel so as to make it serve the blacksmith shop also. This will add 144 ft. of track, thus making it available for use over an area of 74 ft. x 256 ft. The end of the crane farthest from the shop wall and adjoining the transfer table pit rests on two legs having a spread of 16 ft. The other end of the crane is carried on brackets secured to the shop wall. The trolley runs on a track which is secured to the lower flanges of the girders. The two girders are stiffened by latticing and the saddle as shown. The truck wheels are chilled iron and are fitted with bronze bushings. The bridge motor is placed on the long leg next to the cab. This is geared to the vertical shafting, so as to bring an equal distribution of the gearing on each side of the motor, which gives an even travel to both ends. The three motions, hoist, trolley travel and bridge travel, are operated by three independent motors. The hoist motor is a 7-h.-p. 240-volt machine, running at 640 r.p.m. and lifting at the rate of 24 ft. p.m. The load is carried on wire rope instead of a chain. The trolley drive motor is a 3-h.-p. 240-volt machine, running at 640 r.p.m. The crane travels at 100 ft. p.m. The crane motor is a 16-h.p. 240-volt machine and runs at 750 r.p.m. The motors are the enclosed type and are made especially for crane service. They are designed so that they will stand a heavy overload without injury. The crane is controlled by three levers in the cab, and in addition there is a foot brake for controlling the travel of the bridge. The hoist is fitted with automatic mechanical and electrical brakes. The trolley is protected from the weather by a roof. Before the crane was installed the transfer table was used for shifting driving wheels and other material for the machine shop. This took up a great deal of time and practically monopolized the use of the transfer table and in consequence the car shop was hampered by constant delays at the transfer table. Since this crane has been installed the car shop has practically the exclusive use of the transfer table, as this crane now handles all of the material for the machine shops rapidly and economically. The shop power house furnishes the current for operating the motors. The builders of this crane are Maris Brothers, Philadelphia, to whom we are indebted for the illustrations.



A Six-Ton Gantry Crane.

## Pig Iron Production for June.

The *Iron Age* in its report for the month of June shows that the pig iron production during this month was only 1,292,030 tons, as compared with 1,533,350 tons in May, 1,555,267 tons in April, and 1,447,065 tons in March. The total decrease over May was about 240,000 tons, of which 184,000 tons was due to the steel companies and 57,000 tons to the merchant furnaces. On July 1 the number of stacks in blast was 188, as against 213 on June 1. The weekly capacity on July 1 was only 272,301 tons, compared with 336,197 tons on June 1, 368,244 tons on May 1, and 337,357 tons on April 1. The largest falling off in production was in the Mahoning, Shenango and Schuylkill valleys and in the Wheeling, Central and Northern, and Pittsburg districts. Returns from the various plants of the United States Steel Corporation show a total production of 788,822 tons during June, as compared with 927,534 tons in May, 974,006 tons in April, 913,412 tons in March, 756,230 tons in February, and 502,994 tons in January. Merchant stocks, which were declining steadily during the first quarter of the year, continue to show the gains which were first noticeable in the last monthly report. The total number of merchant stocks on hand on July 1 was 620,844 tons, as against 545,892 tons on June 1, and 576,402 tons on January 1. The greater part of this accumulation during the month of June was in the Central Western and Northwestern districts.

The summer time-table of the Siberian railroad shows a regular passenger service only as far east as Irkutsk (3,386 miles from Moscow, from which the express trains start). So far there are four express trains weekly and one daily passenger train. East of Lake Baikal the road is devoted to military traffic. Between St. Petersburg and Moscow a sleeping car was to run once daily (the line has a very heavy passenger traffic, but mostly by day trains) till June 29, then three times a week till August 12; then daily again.

RAILROAD GAZETTE

## MISLEADING STATISTICS.

Probably no one will question the statement that the purpose which Congress intended to serve in authorizing the collection, compilation and publication of railroad statistics by the Intersate Commerce Commission was the enlightenment of the people and their legislative representatives concerning the nature, conditions and methods of the great railroad industry. This being the case, it is worth while to consider what effect upon the public comprehension of railroad problems is likely to result from the widespread dissemination of the official synopsis of the forthcoming report of its statistician which has just been issued by the Interstate Commerce Commission. This abstract issued "for the press" contains about all that the average citizen will ever see of the work of the statistician. It goes to nearly every newspaper in the country and is liberally accorded space in the columns of the daily and weekly press. When, six or seven months later, the annual report for the fiscal year which ended with June 30, 1903, of which the document under discussion is an abstract, is published, the edition will consist of but a few thousand copies, and most of these will speedily be hidden on library shelves. The publication of the formal volume will receive no attention in the press, for its news value will have been forestalled by the abstract just issued. It is important, therefore, that the abstract should fairly epitomize the data which will finally appear; but on certain matters of great importance it fails to do so. The capitalization of railroad property should be an aggregate easily ascertained, since all that is necessary in order to determine it with accuracy is to add the capitalization of the separate corporations and to deduct from the sum the total par value of railroad shares and bonds owned by railroad corporations and thus duplicated in the first result. The facts necessary for this simple calculation will appear in the final report, but the present synopsis states the capitalization as $12,599,990,258 in the aggregate, and as averaging $63,186 per mile of line. The press synopsis does not show the amount of securities held by railroad companies, and consequently constituting a part of their assets. But even if these holdings were not increased between June 30, 1902, and the same date of last year, the real capitalization on the latter date was less by $2,208,518,793, or 17.53 per cent., than the amount shown, and the actual average capitalization per mile of line was $52,109 instead of $63,186. When public opinion regards railroad capitalization as excessive, as it is prone to do; when a widely prevalent prejudice conceives that this supposed over-capitalization is the cause of extortionate rates that are alleged to exist, and when not a few of those citizens who have been misled honestly believe that the aggregate par value of railroad securities has been increased with the deliberate purpose of defrauding the shipping and traveling public and deceiving legislative bodies, the promulgation by a Federal statistical agency of figures which exaggerate the capitalization of the American railroad system by over seventeen per cent. is quite unfortunate.

This, however, is far from being the sole instance of the presentation of data, or the omission of qualifying and significant facts, in such a way as to give to the synopsis the appearance of having been prepared without proper regard to fairness. The taxes exacted from the railroads by the various State and municipal governmets within whose jurisdiction their property is found, constitute an important and steadily increasing expenditure. In 1901 this item was $50,944,372, and in 1902 it was 6.91 per cent. more, or $54,465,437. The increase from 1902 to 1903 was substantially the same, or 6.21 per cent., to a total of $57,849,569; yet the item of taxes, which is thus equal to one-third of the income received by the holders of railroad shares, does not appear in the synopsis as a separate deduction from gross receipts, but is obscurely introduced as an element in the item of so-called "deductions from net increase," which also includes interest on funded debt and current liabilities, payments to lessors, and the cost of permanent improvements. In 1902 no less than 15.20 per cent. of the dividends paid on the capital stock of American railroad corporations was paid to other railroads which were the owners of the dividend-paying shares, and thus furnished the payees with resources from which to meet their own payments of interest and dividends. The dividends paid during 1902 on all railroad shares aggregated $185,391,655, but as $28,176,275 of this amount went to railroad corporations themselves, it is apparent that private investors received but $157,215,380, and that the latter amount is all that the railroads of the country, considered as a system, actually paid to their shareholders. The present synopsis repeats the higher figure and gives the corresponding amount for the year 1903, which was $197,148,576. It affords no reliable clue to the deduction necessary in order to arrive at the real payment to private investors for this purpose, but it is doubtful if this sum exceeded $160,000,000.

It is a thankless task to point out the deficiencies of an official report, and there can be little pleasure in noting the failure of any American public officer to realize the obligation of impartiality which goes with high public position. Yet it cannot be wholly useless to expose the misleading character of such a widely distributed and generally quoted document as that under discussion, and it should not be regarded as presumptuous to suggest to the statistician the desirability of including in it some of the facts which make the railroad side appear in a more favorable light, as well as all of those which are useful to the partisan "advocate of the small shipper."

## THE TRAIN STAFF.

A correspondent asks us to describe the merits of the electric train staff and tell him what he can save, or what improvement he can make, by using it. He says, among other things:

> Wherein is the electric train staff superior to the controlled manual block system? Or to automatic block signals? The several accounts which have been printed in your paper describing the train staff have represented that the officers of the railroads where it is in use found great satisfaction in the improvement; yet they give very few particulars concerning its actual operation, and . . . one is left with the impression that there must be some feature of the subject which has not been fully dealt with. Is the field for this device as limited as would appear from the very brief list of American railroads using it?

The train staff is designed and used for single track, and should be first compared, not with the controlled manual or with the automatic, or even with the telegraph block system, but with the "American despatching system"—time-table rules for regular trains, when on time, and despatchers' orders for trains behind time and for extras. For either the automatic or the manual, controlled or uncontrolled, is prima facie in the same class with the electric train staff, and an intelligent comparison of these involves a close study of details; while in practice the staff (like the block system) has been used chiefly or wholly to cure the difficulties which are experienced with the American despatching system. In this system there are two principal faults—the danger of making a mistake in sending, receiving, delivering or executing orders, causing a collision; and the constant delays involved in writing, telegraphing, repeating and delivering written orders.

The electric train staff has a good reputation for curing both of these faults. The difference, in convenience or celerity, between the usual system and the staff may be roughly compared to that between the telegraph and the telephone. In telegraphing from New York to Boston or Philadelphia one may send a single message and get its answer in from 10 minutes to an hour or more. By the telephone a message may be started in five minutes or less, and the answer received at once; and from two to a dozen messages and their answers may follow within half that number of minutes. On the Cincinnati, New Orleans & Texas Pacific, at the Cincinnati end, where yard engines and other irregular trains are numerous, a half minute often serves to despatch an extra train on single track. The engineman draws up to the cabin and tells the staff operator his wish to go; and if the staff is not locked in the pillar (the fact that it is not locked indicates that the block is clear), the operator takes it out at once, uses it to clear the signal, hands it to the man on the train and the train proceeds. This Cincinnati installation, now of several years' standing, is in a situation to test any instrumentality for single-track working, as each single-track block-section lies between two double-track sections. The staff must survive on its merits; no blame for delays can be shifted to adjoining block-sections.*

The only definite statements that we have concerning the saving in time effected by the use of the staff are those from the Reading and the Atchison, published in the *Railroad*

*The electric train staff sections on the C., N. O. & T. P. are as follows: Cincinnati to Ludlow, across the Ohio River, about 1 mile; then double track through Ludlow yard; then another staff section 4.5 miles to Kenton Heights; then 2 miles of double track to Erlanger; then a staff block section 4 miles long to Dixon. The operators communicate with each other by telephones, and each one keeps posted so as to give precedence to the most important trains. These operators understand the power of the engines and the grades of the lines, so that they carry out the scheme very successfully, and they rarely have to call on the despatcher for an order to move a train. In the normal movement of trains the despatcher has no control whatever on this 13-mile section. For all ordinary trains the staff is delivered by means of a rubber hoop, which is practicable up to a speed of 35 miles an hour; while the faster trains have engines equipped with catchers.

*Gazette* Dec. 6, 1901, and Dec. 19, 1902. Neither of these will be found very satisfactory as a guide for calculating the probable saving at any other place. The Reading increased the capacity of a tunnel section 30 per cent., but we have no precise account of the procedure formerly employed. The Atchison made a large saving with freight trains (one hour in 23 miles), but the time consumed in giving train orders had formerly been excessive, because three and four enginemen had to be dealt with on each train, the grade of the line being so steep as to require helpers to that extent. But, whatever the *percentage* of time saved, it is certain that the electric train staff saves all that can be saved; for the second train desiring to use a section can always, at either end, and whether following or going in the opposite direction, get the right to the section the instant that the first one relinquishes it. No one has measured his aggregate saving; neither do we measure the savings accomplished by the telephone; yet everybody who uses a telephone saves time and brain-wear in such a marked degree that the change from old conditions forces itself on the mind almost every day.

For celerity, therefore, nothing can beat the electric train staff; not even automatic block signals (if depended upon by opposing trains, which they are not) would be more than half a minute quicker. When it comes to safety, everybody admits that the staff is to be classed as a block signal and that block signals are far ahead of the system that depends on the time-table, the time-interval, the time-piece, the despatcher, the operator, and the united action of the conductor's and the engineman's memories. The question is not between the "despatching system" and the staff, but between block signals and the staff; and this, as we have said, is too intricate a question to be settled in a paragraph, or a column. The train-staff principle, as exemplified in the old-fashioned English staff, without the electric improvement, is sui generis; nothing can fully take its place. It is a starting signal; having performed its function as such the starting-signalman is deprived of his power, and that power can be restored only by the voluntary action of the engineman for whom it was exercised. The electric staff preserves all the merits of the old staff, besides adding its own improvement, which virtually makes a single staff available at either of two places, miles apart, at the same moment. The only ground, we suppose, on which any one would think of questioning the entire accuracy of this assertion would be the possibility of imperfection in the machine. But, as careful signal engineers, who speak from intimate experience, have declared the electrical apparatus of the staff machine to be simpler and far more certain in operation than the electrical apparatus used in block signaling, it would seem to be reasonable to conclude that the staff apparatus is a reliable device; as simple and reliable, say, as the Morse telegraph, or the electric bells used in manual signaling.

Controlled manual block signals have not been much used on single track lines. The apparatus, if not as simple as that of the staff, certainly can be made so. The advantage possessed by the staff is its unique principle, already referred to. The advantage of controlled manual apparatus like the Sykes, is that the signalman does not have to get in touch with each engine as it passes. As compared with the simple manual or telegraph block system the staff and the controlled manual alike have the advantage of an electrical machine, simple and reliable, to control a fallible human machine.

Both the staff and the controlled manual are theoretically superior to automatic signals in having an attendant at each end of each block section, to watch for erroneous action, to hunt for defects when defects are indicated, and to co-operate in making each proceed-signal an assurance to the engineman that "all-clear" is given to him from both ends of the block section. That they are practically as well as theoretically superior, from a mechanical standpoint, is indicated by the fact that where automatic signals are used on single-track all the other safeguards against butting collisions are continued in force, the same as under the old régime, thus making of the automatic signals only an adjunct.

Besides celerity and safety there is the question of economy. If we take the position of the Railway Signal Association Committee (whose report was adopted) and decide that automatic signals are not suitable for single track; and if the despatching system is condemned by its slowness or its dangers, the question of economy lies between the controlled manual and the staff on one side and the telegraph block system on the other; and this resolves itself into the question whether the saving in time and the additional security against errors, as compared with the telegraph block system, are worth what it costs to put in and maintain the electrical apparatus. (The cost of apparatus to deliver staffs to fast-moving trains can be treated as a part of this.) As compared with the American despatching system, the saving in time is considerable, as has been shown. This saving has a definite money value unless the trains are so infrequent, slow and unimportant that delays are tolerable. As compared with the telegraph block system, the saving by the use of the staff should be much less, as each block signalman can learn the situation at the other end of the block section very quickly. To estimate for our correspondent how much it is worth to avoid errors we should have to have his collision record for a series of years and know the cost of collisions. If he is the superintendent, the value of his peace of mind would also have to be taken into account. Judging by the situation as it appears to us at present, we conclude that the staff apparatus costs so much that most of those superintendents who need it believe it their duty to get along without it a while longer. If their present system causes them anxiety—why that is what they are hired for!

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The German Vice-Consul, at Nantes, reports a very unsatisfactory condition of the shipping and ship building industries in France, a matter which is of particular interest at this time because of the recent agitation for some kind of a bounty system for American shipping, to be constructed on a basis not unlike that which has been in existence in France since 1893. The consul says that the sailing ship companies which were called into existence at Nantes and Saint Nazaire by the mercantile marine law of 1893, are realizing very poor results in spite of the high navigation premiums, and he attributes this in part to the extremely low freight rates, and in part to the high price which had to be paid for vessels purchased or ordered to be built. The French bounty system seems to have failed entirely, so far as may be judged by the fact that the sailing ship companies, after ten years under the bounty law, are now in bad shape and are disposing of their vessels at extremely low prices. In 1903 the tonnage built at the yards at Nantes, Chantenay and Raze aggregated 15,675 tons gross, as against 56,237 tons in 1902 and 78,201 tons in 1901. In fact, the vice-consul, in concluding his report, says: "The artificial system of bounties, by means of which ship building and shipping traffic would, it was hoped, receive a mighty impetus, has, up to the present, had a most unfavorable effect." A bill was passed in France a year or so ago providing a payment for each day's active service of a French steamer built abroad, the benefit to be confined to modern ships. In commenting on the provision early in 1902, John White's Annual Shipping Review, published in London, expressed the belief that it would enable French owners to buy British ships and reap a bounty which, with the cheaper first cost of the vessel, would probably pay them better than the larger bounty for a French built ship costing more. The continuous depression in the ship building and ship owning trade, however, which has become very marked in recent years, affords a good forecast of the results which could be expected in this country if a promiscuous ship subsidy law were passed. The first result of such a law would, of course be over-production of vessels to earn the subsidy. These new competitors in a traffic already too well provided for, would have the inevitable effect of forcing down rates and with the prevailing high cost of American construction and high wages, it is easy to see that they would from the very first be placed in a position where they would have to depend on their bounties alone, not simply for profit, but for the very means of existence. The way this has worked out in France, where neither cost of building nor wages are as high as in this country, should afford a valuable object lesson.

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## June Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of June, printed in another column, contains accounts of 24 collisions, 20 derailments and 3 other accidents. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | K. | I. |
|---|---|---|
| 2d, Perry, Iowa | 1 | 7 |
| 3d, Mastin, Kan. | 1 | 19 |
| 20th, Campton, N. H. | 1 | 6 |
| 25th, Tuttletown, Cal. | 2 | 3 |
| 25th, Delaware, Ohio | 2 | 2 |
| 27th, Dexter, Ohio | 1 | 11 |
| 27th, Buffalo, N. Y. | 2 | 11 |

The circumstances of these seven accidents require little comment in this place, other than that which, from the record, is obvious to every reader. Campton and Delaware are of interest as illustrating two very different kinds of trains. In the Campton case one passenger was killed and six injured by lumber which was pushed into a passenger

car, the train being a mixed one, freight and passenger. Running lumber next to passengers involves an obvious element of risk and it must be said that only the expected happened, the accident having been in other respects commonplace. At Delaware, on the other hand, the train was running at high speed and carried a large number of passengers, but all the cars in the train were of the latest and strongest construction, and they were of uniform design; no passengers were killed and only two seriously injured.

The number of electric-car accidents in June was 22; persons killed, 13; injured, 138. Of the 13 fatal injuries, ten occurred in two collisions, one at Wells Corners, near Norwalk, Ohio, on the 2d, and the other near Lima, in the same state, on the 23d. At Wells Corners, an eastbound "limited" passenger car of the Lake Shore Electric road met a westbound "package freight" car at full speed and six passengers in the smoking compartment, at the forward end of the passenger car, were instantly killed. It appears that the package car was behind time and that it had been ordered to meet the passenger car at Berlin Heights, a short distance east of the usual meeting point; and that this order was overlooked. At Lima, a light car, running between the city and McBeth Park, was entering a side track when it was struck by a heavy interurban car, which it was to meet at that point; and the injuries, fatal and non-fatal, counted up to more than twenty. The simple explanation of this collision is that the men on the interurban car thought that the other car had cleared the main line, but miscalculated. The Lima case emphasizes the danger of running heavy and strong cars on the same line with light cars, and in both cases a salient feature is that the passengers were in the most dangerous part of the "train." Discussion of the relative safety of different parts of a train or of a car may be unbusinesslike, and even unscientific, but there is no use in blinking the fact that the safety of passengers in a standard railroad train is to an appreciable degree dependent on the presence of one, two or more vehicles in the train ahead of the foremost passenger car. If the chances of being killed are to be compared, as between steam cars and electric, this condition must be taken into consideration. Formerly the rule to have a baggage car at the head of every passenger train (next behind the tender) was maintained with considerable strictness. Latterly it appears to be dropped out of mind, or to be definitely ignored, as in the case of one prominent trunk line, which regularly hauls many of its passenger trains ninety miles tail-end-first. This rule has lately been modified on the State railroads of Austria and Hungary by exempting from its requirement all trains running less than 29 miles an hour. In this country we seem to modify it according to what convenience may make desirable. Was the rule ever a reasonable one? Is it reasonable now? If reasonable now, what interest has the public in securing its adoption—or, rather, the adoption of the principle—on electric railroads? If the public has an interest, how ought it to be expressed?

The purchase by the New Haven road through its interurban sub-company, the Consolidated Railways Company of Connecticut, of the New London Street Railway Company, the Norwich Street Railway Company and the Montville Street Railway Company, is in rapid continuation of the recent aggressive policy of controlling interurban competition through ownership. These three new properties form a connected route on the west bank of the Thames River, from New London to Norwich, 10½ miles north, with short branches, paralleling directly the Central Vermont and indirectly the branch of the New Haven road on the east side of the river, which runs north through Norwich and Putnam to Worcester. The electric lines, however, only aggregate about 34 miles at present, part of which is in New London and Norwich. In view of the recent extensions of electric roads in the western part of the State, particularly in the vicinity of New Haven, Hartford, Bridgeport and Waterbury, it is rather singular that this little system, centering in New London and Norwich, constitutes at present the only electric mileage in the southeastern part of the State, including New London County and a greater part of Middlesex County, which adjoins it on the west and extends to a point on the shore of the Sound between Clinton and Madison. With the New London and Norwich lines as a strategic base, the New York, New Haven & Hartford is evidently in a position where it can prevent further encroachment on its territory along the sound east of New Haven. Extension of the New Haven system of electric lines east has at present only gone as far as Branford, nine miles from New Haven, out of the 50-mile stretch to New London, and with this control of the key systems at each end, the steam road would seem to be in safe possession of this suburban territory, which has been a constantly increasing source of short haul traffic within the last few years, particularly in the summer months. The important feature about the New London and Norwich purchase is that the steam road has taken over these potential competitors while they were yet in their infancy, and has secured its commanding position at small cost, instead of waiting until it should become necessary to deal with a fully organized and highly valued interurban system.

The Italian Government has until July 1, 1905, to make new contracts with the three great operating companies to which the State railroads were leased in 1885, to find new lessees, or to provide an organization for working them directly by the State. Both the State and the lessee companies gave notice that they would not renew the contracts on the old terms. The government announced to Parliament that it would prefer not to undertake the operation of its roads directly by the State; but as this may be necessary in case it is unable to lease on satisfactory terms, it has brought in a bill providing for an organization to work such lines as it may not lease. This organization is designed to keep, so far as possible, the railroad management out of politics, cabinet changes being frequent in Italy. There is to be an Executive Council and a General Manager, who together will have the powers exercised by the Minister of Public Works in most State railroad administrations; but supervision and inspection of the operation will be exercised by the Ministry of Public Works and of the finances and the accounts by the Minister of the Treasury. No elective officers may be paid officers of the railroad administration. Employees will be taken over provisionally from the present operating companies and secured the rights to pensions, salaries, etc., which they have acquired in such companies. All employees will be regarded as public officers, and as such subject to the provision of the criminal code, which declares that officials who leave their duties in consequence of an agreement of three or more of their number are liable to a fine of $100 to $600 and summary removal, and to loss of acquired rights to pensions. A special tribunal is established to hear and pass judgment on claims and complaints of employees, and in this tribunal the employees have a representative. The report accompanying the bill says that the aim is to make the railroad management as independent as possible, preserving to Parliament its power of supervision, the audit to the Court of Accounts and the inspection to the government.

## NEW PUBLICATIONS.

*Universal Directory of Railway Officials.* 1904. Compiled from official sources under the direction of S. Richardson Blundstone, Editor of the *Railway Engineer.* The Directory Publishing Company, Ltd., 3 Ludgate Circus Buildings, E. C. London. Subscription price, 7½s. After publication, 10s. Sole representative for the United States, E. A. Simmons, 83 Fulton street, New York.

The tenth issue of this extremely valuable reference book is now at hand, containing, as in previous years, a carefully revised directory of railroads all over the world, including also practically all electric lines in the United Kingdom. The railroads are classified by countries and after the name of each road there is a statement of its mileage and of the number of locomotives, coaches and freight cars it owns. Then follows a full directory of the important officers and their addresses. These officers are also listed alphabetically in the back of the book, with a reference to the railroads which they serve and the page on which their names may be found. This publication is quite indispensable, not only for the addresses which it contains, but for the handy information about the physical characteristics of railroads in remote parts of the world, of which the official documents are not readily accessible.

## TRADE CATALOGUES.

The July Bulletin of *The Buda Foundry & Manufacturing Co.*, Chicago, is devoted to Buda cars and wheels. Illustrations and descriptions of hand and push cars are given and a sectional view, with information, of the Buda steel wheel. The latter was tested by the University of Illinois in competition with another wheel and the results are given in the Bulletin. The Buda wheel was 12 lbs. heavier and required a load or 6,500 lbs. to cause permanent set, against 4,000 for the other. For relative stiffness, with the Buda as unity, the other was only one-seventh; that is, the load on the former was seven times that on the latter for equal amounts of compression. The Buda also showed superiority in the test for axle thrust. The report is summarized in the statement: "The Buda wheel is of the best form, considering strength, stiffness, side strength and general effectiveness."

A revised issue of the handbook (General Catalogue D) of the *Trussed Concrete Steel Company*, Detroit, Mich., is being sent out. This company controls the Kahn system for reinforced concrete. This handbook of 78 pages contains a complete description of the Kahn system and of numerous tests that have been made to determine the qualities of structures made in accordance therewith. Some of these tests have been described in the *Railroad Gazette*. The book also contains useful data relative to reinforced concrete designs, including tables of sizes and reinforcement for square panels, according to the Kahn system; also the method of calculation and tables for parabolic arches fixed at the springing and continuous over the crown. There are numerous engravings

and tables, and near the back a set of specifications for reinforced concrete.

*The Westinghouse Electric & Mfg. Company*, Pittsburg, Pa., sends us a pamphlet bearing the title "Machine Tool Drive." All users of machine tools will no doubt find this of interest, as it describes in detail the different methods of electric drives for machine tools, including alternating, direct current and three-wire balanced voltage systems. The book is handsomely illustrated throughout, showing the different applications of motor drives to machine tools. It also contains some very intresting comparisons, both financial and operative, between motor-driven and belt-driven tools.

*The Westinghouse Companies'* Publishing Department has just issued an illustrated folder which gives a brief history of the constituent companies controlled by the Westinghouse interests. It is illustrated throughout with half-tones, which show the products of the various companies. There are also a number of views given of the Westinghouse Companies' exhibit at St. Louis.

## The Growth of the Missouri Pacific.

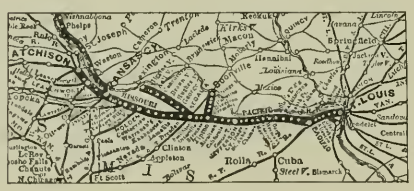
The Missouri Pacific, strongly intrenched within its territorial limits of traffic and aggressive in opening up and holding old and new competitive territory, is the keystone of the Gould railroad interests, and about it as a foundation has been built up a great system of closely allied railroads reaching from the Atlantic to the Rocky Mountains and controlling, almost single-handed, the large, undeveloped region to the south and west of the Mississippi. Jay Gould bought it, as he said, "to play with," but he and his associates gave it the start from which the younger generations of the Gould family have made of it a model railroad of its kind.

There have been two distinct periods in the growth of the Missouri Pacific. The original company, which built the line between St. Louis and Kansas City, was incorporated in 1849, and, with aid of State land grants, the road was opened through to Kansas City in 1865. It was 5 ft. 6 in. gage and ran through what was then a comparatively undeveloped country, in which what little traffic that originated was handled largely by the Missouri river packets. The road was changed to standard gage in 1871 and in 1872 was leased to the Atlantic & Pacific, which assumed all its numerous liabilities and guaranteed dividends on seven millions of the lessor's stocks. The Atlantic & Pacific carried its burden for three years, but in 1875 it defaulted its guarantee and the road was turned over to receivers for operation. Jay Gould, after his manipulation in Erie and the panic of 1873, was looking for some new plaything. His rival, William H. Vanderbilt, had worsted him in the battle for control of Erie and so he turned from the East, where he had failed, and sought out the obscure and unimportant Pacific Railroad of Missouri. The receivers of that road were only too glad to sell and Gould was willing to buy. For four millions he acquired a run-down railroad, 295 miles long, and after he had put in one of his famous "coördinate board of directors" he began to enjoy his new toy. He turned his energies, not to manipulating the stock on Wall Street, as he had done in Erie, for he and his associates owned all the stock among themselves and there was no one to "squeeze," but instead began to build up a system that in a few years became the largest collection of railroad mileage in the country.

The following statement of mileage owned and operated under lease for the period between the acquisition of the original Missouri Pacific in 1876 and the beginning of the second period of expansion in 1896, shows the remarkable growth of the system:

| Year. | Miles owned. | Miles leased and operated. | Total. |
|---|---|---|---|
| 1876 | 299 | 127 | 426 |
| 1878 | 296 | 127 | 423 |
| 1880 | 591 | 946 | 1,537 |
| 1882 | 1,803 | 4,024 | 5,877 |
| 1884 | 1,960 | 4,086 | 6,046 |
| 1887 | 3,713 | 3,261 | 6,974 |
| 1888 | 4,057 | 936 | 4,993 |
| 1890 | 4,353 | 772 | 5,125 |
| 1892 | 4,644 | 771 | 5,415 |
| 1894 | 4,332 | 1,046 | 5,378 |
| 1896 | 4,340 | 984 | 5,324 |

The increase in mileage during 1881 and 1882 was caused by the buying outright of the St. Louis, Iron Mountain & Southern and by the leasing on a basis of net earnings, of the Missouri, Kansas & Texas, the Texas & Pacific and the International & Great Northern. In addition to the mileage shown for 1884, the Wabash was held under lease to the Iron Mountain, so that the total mileage actually under the control of the Missouri Pacific aggregated about 10,000 miles. Many of the holdings of the company were poor and unproductive lines and the consolidation depended for its financial stability on the earning power of the parent company and one or two of the subsidiary roads which were in a prosperous condition. There




Missouri Pacific System in 1878.

was little or no unity in the organization beyond the duplication of directors and the looseness of the whole structure was fatal to any chance of building up a permanent and lasting system. Despite the efforts of the Missouri Pacific to hold the lines that had been acquired and to protect its position by heavy outlays for new construction, one by one the leased lines were turned over to receivers or reorganized as independent companies. First the lease of the Wabash and then the M., K. & T. with the I. & G. N. leases were abrogated for non-payment of rental during the years 1884 to 1888. During that time, however, many of the smaller branch lines were absorbed by a transfer of stock or securities and much new construction was completed, so that before the great industrial depression of 1892 and 1893 overtook the country the Missouri Pacific was in a position to weather the storm. As it was, dividends which had been paid regularly on a liberal scale were suspended in 1892 and all of the depleted income of the company was devoted to payment of interest on the floating and bonded debt. The very looseness of its organization saved the newly created Missouri Pacific from entire dissolution and bankruptcy.

The early history of the Missouri Pacific is interesting because it was the forerunner of the great railroad systems which have been built up within the last 10 or 15 years and which dominate the railroad situation to-day. It controlled the greater part of its mileage by leases, which implied no lasting obligation on its part, and which, on the contrary, gave little opportunity to weld the constituent companies into one strong organization under one management. Modern methods of consolidation are more intricate in their workings and more far reaching in their returns. Twenty years ago, when anti-trust legislation was almost unknown, the formation of such combinations as the first Missouri Pacific system was much simpler than at present, and much less safeguarded. Many of the failures and faults of that first "railroad trust," if it may be so called, have been avoided in bringing about the consolidations of such systems as the Pennsylvania, the Rock Island, the Southern and the Vanderbilt lines.

In 1892, when Jay Gould died, his son, George J. Gould, succeeded him in the management of the large railroad interests which he had acquired. Of the four roads in which his father had been a large stockholder, George J. Gould was made president of three—the Missouri Pacific, the International & Great Northern and the Texas & Pacific. The Wabash holdings were not materially increased and Gould simply retained his position as director.

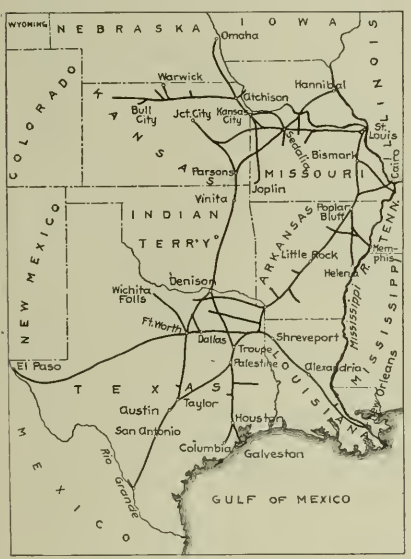
The son's conception of the responsibilities that were imposed by the trust which had come into his hands was very different from his father's conception before him. The father had earned a hard reputation as a ruthless pirate of finance and wrecker of railroads. How well the younger Gould has earned the far more enviable reputation of a railroad builder is shown by the fact that to-day the system which bears his name is ranked among the six great railroad systems of the country, controlling, as it does, some 16,300 miles of road, capitalized at more than $675,000,000, and the backbone of the Gould System is the Missouri Pacific, which operates under one management 6,107 miles of track in nine States. In its treasury are the large holdings of stocks and bonds which insure control by the Gould interests of the other roads which go to make up the system. Any study of this group of lines must begin and end with Missouri Pacific.

The development of the Missouri Pacific since the depression of 1892 and 1893 has been characterized by a conservative and farsighted policy of betterments and rational expansion with a view always of holding such competitive territory as had been opened and anticipating the needs of the undeveloped portions of the Southwest by new construction designed to ultimately form important links in the existing system of main lines and branches. The aim has been to bring about operating conditions which would reduce expenses as much as possible and to make new business by extending branch and connecting lines through those parts of the contributory territory of the system which are undergoing a rapid development. In this the management has been ably assisted by the efficient efforts of the operating officials under it. The improvements made in grades, alinement, structures, rolling stock and motive power, each in themselves on a liberal scale, have combined to bring about such economical operation as to put the road on a dividend-paying basis and to provide funds out of income to carry on the betterment work and to pay for much of the new construction. It is the purpose of this series of articles to review the work which has been and is being done and the results which have been accomplished by the management during the last ten years.

In order to explain the reasons for improvements on some of the old lines and the construction of new lines, all of which are a part of a definite plan for enlarging the traffic possibilities of the system, it is necessary to briefly touch upon the relation of the various lines which go to make up the Missouri Pacific System, to each other and to

the traffic centers in the territory which they serve.

The main line of the Missouri Pacific is an east and west trunk line from St. Louis through Missouri and Kansas to Pueblo, Colo. Kansas City, Omaha and St. Joseph, the three centers of the Missouri River Valley, are all closely connected and through Southwestern Missouri, Kansas and Eastern Nebraska there is a network of branch lines, all of which contribute business for the main line. From St. Louis south, the Iron Mountain forms the other leg of a right-angled triangle through Arkansas to Texarkana, with numerous branches covering the territory between the main line and the Mississippi and continuing on down into Louisiana. If the system began and ended here its importance would be small in comparison with others in the same field. With its connections and allied lines all under close and friendly control, however, it dominates the Southwest and holds a firm grip on the region lying between Kansas City and Ogden. The Denver & Rio




Missouri Pacific System in 1884.

Grande and the Rio Grande Western control practically the entire western half of Colorado and the southern and eastern part of Utah, giving a direct line from Salt Lake and Denver to the western terminus of the Missouri Pacific at Pueblo. In the south the Texas & Pacific and the International & Great Northern reach out across Texas to the two important gateways of Mexico, El Paso and Laredo, and give entrance to the Gulf ports of Galveston and New Orleans. In addition to these the St. Louis Southwestern is in friendly hands and the Wabash, with its possibilities as an Atlantic and Mississippi trunk line, gives an outlet to the east from St. Louis and Kansas City.

The direction of traffic on the lines operated by the Missouri Pacific was, until a few years ago, east and west to and from St. Louis and north and south from the same point to and from Arkansas and Texas. The first steps in the improvement of the system were, naturally, to improve the condition of the track, roadbed and structures on the main lines to the west and south and put them in shape for heavier and faster trains. Between 1893 and 1897 all of the available income was expended in reballasting, laying new rail and replacing old bridges with modern steel structures and it was not until 1898 that heavy expenditures were begun for the real work of improving grades and alinement on the old lines and building new cut-offs and low-grade lines to overcome the worst difficulties. The generally improved physical condition of the system and the resultant economies in operation, together with the heavy increase in the business of the road following the depression of a few years before, provided income enough to carry on the proposed plan of betterments out of earnings. A careful and comprehensive scheme of improvements covering the whole system was laid out with a view of deriving the greatest benefits in operation in the least time with the smallest amount of interference to traffic. The plans made in 1897 and 1898 have since been carried out with some few changes and additions and the results in operation, as will be shown later, have already more than repaid the expenditures made.

*(To be continued.)*

## Train Accidents in the United States in June.[1]

bc, 1st, Cumberland Valley, Scotland, Pa., butting collision between C. V. freight train No. 90 and a P. & R. freight, wrecking both engines and 14 cars. One engineman was killed and six other trainmen were injured.

†unf, 2d, Chicago, Milwaukee & St. Paul, Perry, Iowa, a passenger train was derailed by running into a washout and one passenger was killed and seven were injured.

bc, 3d, 7 p. m., Missouri Pacific, Mastin, Kan., butting collision between passenger train No. 1 and passenger train No. 36, wrecking the engines and front cars of both trains. A trespasser was killed and 18 passengers and one trainman were injured. The conductor and engineman of train No. 1 overlooked a meeting order which had been delivered to them.

*bc, 4th, Southern Railway, Harrodsburg, Ky., butting collision between freight train No. 62 and the engine of a work train, wrecking both engines and several cars. The engineman of the freight and one employee on the work-train engine were killed, and seven other employees were injured. The wreck took fire and was mostly burnt up. It is said that a flagman had been sent from the work train to stop the freight.

bc, 4th, Illinois Central, Horse Branch, Ky., butting collision of freight trains, both running at good speed, wrecking both engines and seven cars. One fireman was killed and several other trainmen were injured.

o, 4th, Southern Railway, Limestone, Tenn., the locomotive of a passenger train was badly damaged by the breaking of a side rod, and the engineman was injured.

bc, 5th, Detroit, Mich., butting collision between a passenger train of the Grand Trunk and an excursion passenger train of the Lake Shore & Michigan Southern; one fireman and two other trainmen were injured, the fireman fatally.

dr, 5th, Chicago, Indianapolis & Louisville, Rossville, Ind., an excursion train running at about 40 miles an hour was derailed at a defective switch, and the engine and several cars ran a considerable distance on the sleepers. The engine and baggage car were wrecked and the four passenger cars were derailed, but all of the 300 passengers escaped with slight injuries.

eq, 8th, Northern Pacific, Park City, Mont., westbound passenger train No. 3 was derailed while running at full speed and the engine and mail car were wrecked. The engineman, fireman and two express messengers were injured, and many passengers were cut by glass, which they broke in trying to escape from the cars. It is said that the derailment was due to the breakage of some part of the locomotive, the part falling to the ground.

dn, 8th, Southern Railway, Salisbury, N. C., northbound passenger train No. 40 was derailed at a misplaced switch and the engineman and fireman were killed; one other man was injured.

bc, 9th, Pere Marquette, Bay City, Mich., collision between an empty engine and some freight cars, doing slight damage. The engine, having been reversed and deserted, immediately ran backward some distance to a bridge, the draw of which was open, and fell into water 30 ft. deep.

xc, 10th, Western Maryland, Chambersburg, Pa., a coal train broke in two and the rear portion afterward ran into the forward one, wrecking five cars. Two trespassers riding on one of the cars were killed.

bc, 11th, Cleveland & Pittsburg, East Liverpool, Ohio, butting collision between a freight train and a gravel train; one employee killed, two injured.

eq, 11th, New York, Ontario & Western, Star Light, Pa., a freight train descending a steep grade was derailed by the breaking of a wheel, and 15 cars were wrecked.

rc, 12th, Minneapolis, Minn., collision between an excursion train of the Minneapolis & St. Louis and a train of empty cars of the Northern Pacific; two cars badly damaged; three passengers injured.

xc, 12th, 11 p. m., Watson, Ind., collision between an excursion train of the Cleveland, Cincinnati, Chicago & St. Louis and a passenger train of the Baltimore & Ohio Southwestern. Four passengers were injured.

unx, 13th, Chicago & Eastern Illinois, Danville Junction, Ill., several cars of a passenger train were derailed at a switch and the smoking car was overturned. Eleven passengers were injured.

unf, 14th, 3 a. m., Kansas City Southern, De Ridder, La., passenger train No. 1 was derailed by running over a cow, and the engine and first two cars were ditched. The engineman and fireman were killed.

unx, 14th, Tennessee Central, Watertown, Tenn., passenger train No. 4 was derailed; one man injured.

unx, 15th, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind., passenger train No. 46 was derailed and the engine was overturned. Five trainmen were injured.

unx, 16th, Chicago, Burlington & Quincy, Mendota, Ill., passenger train No. 13 was derailed and the engine was overturned. The engineman and fireman were injured.

bc, 19th, 1 a. m., St. Louis & San Francisco, Sapulpa, I. T., butting collision between a freight train and an empty engine, badly damaging both engines and a trestle bridge. One conductor and one fireman were killed and one other trainman was injured.

xc, 19th, Baltimore & Ohio Southwestern, Vincennes, Ind., collision between passenger train No. 1 and a freight train; 13 passengers and three trainmen injured. It is said that the collision was due to a misplaced or defective switch.

xc, 19th, Shannon's Point, Mo., collision between a freight train of the St. Louis Southwestern and a passenger train of the St. Louis & San Francisco at the crossing of the two roads. The engineman of the freight and two tramps were killed.

†20th, Boston & Maine, Campton, N. H., a mixed train was derailed and a passenger car and a car of lumber were badly damaged, and several passengers were crushed by lumber. One of these was killed and six were injured. It is said that the derailment was due to the breaking of some part of one of the trucks of the passenger car.

dn, 20th, Philadelphia, Baltimore & Wash-

[1]Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defect of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

ington, Laurel, Del., a passenger train ran into an open draw at the crossing of Laurel River, and the engine fell upon a schooner in the river. The engineman was killed and the fireman slightly injured.

xc, 22d, 3 a. m., Illinois Central, Isley, Ky., a passenger train collided with the caboose of a freight which was on a side track but fouled the main track, and all of the passenger cars were damaged. The fireman was fatally injured.

unx, 22d, Houston & Texas Central, Austin, Texas, the locomotive of a freight train was derailed and wrecked; the engineman and two other trainmen were injured, the engineman fatally.

unx, 23d, Louisville & Nashville, Saxton, Tenn., a work train was derailed, and the caboose, in which were a number of laborers, was overturned; two of the men were killed and seven were injured.

to, 23d, Lehigh Valley, Sugar Notch, Pa., The Black Diamond express train broke in two between the fourth and fifth cars, and a woman who was at that moment crossing from one car to another fell through and was killed.

bc, 24th, New York, Philadelphia & Norfolk, Bayview, Va., butting collision of freight trains, wrecking both engines and several cars. One engineman was killed and three other trainmen were injured. The wreck took fire and was mostly burnt up.

unf, 24th, Chicago, Rock Island & Pacific, Grayson, Kan., a passenger train was derailed by running over some cattle and the engine was overturned. The engineman and fireman were injured.

bc, 25th, Atchison, Topeka & Santa Fe, Fresno, Cal., butting collision of passenger trains, wrecking both engines and the forward cars of both trains. Six passengers and two trainmen were injured.

trc, 25th, Sierra Railway, Tuttletown, Cal., a work train ran into the rear of a preceding passenger train, wrecking an oil car at the rear of the passenger train and forcing it half way through the passenger car which was next. Two passengers were killed and three were injured. The collision is said to have been due to the work train becoming uncontrollable on a steep, descending grade.

unx, 25th, Cleveland, Cincinnati, Chicago & St. Louis, Delaware, Ohio, a southbound passenger train running at high speed was derailed at a switch, and the engine, baggage car and one passenger car were overturned and ditched. The engineman and baggageman were killed and two passengers were injured.

unx, 25th, 9 p. m., Norfolk & Western, Myrtle, Va., a freight train was derailed and many cars were ditched and wrecked. Two tramps were killed and five were injured.

*bc, 27th, 4 a. m., Central of Georgia, Fort Valley, Ga., butting collision of freight trains, wrecking 14 cars of fruit and merchandise, which took fire and were burnt up.

bc, 27th, Kanawha & Michigan, Dexter, Ohio, butting collision between a passenger train and an empty engine. Three trainmen and nine passengers were injured, one of the trainmen fatally. The collision occurred at the mouth of a tunnel, and it is said that the smoking car was split open for half its length. The engineman of the empty engine forgot about the passenger train.

†xc, 27th, Buffalo, N. Y., collision between a freight train of the New York, Chicago & St. Louis and a train of the Delaware, Lackawanna & Western, at the crossing of the two roads. The Lackawanna train had on board several hundred workmen going to the steel works. One workman was killed and 12 were injured, one of them fatally.

xc, 27th, Chicago, Burlington & Quincy, Newcastle, Wyo., passenger train No. 41 ran over a misplaced switch and into a freight train standing on the side track, wrecking the engine and one freight car. Two men were injured.

unf, 28th, Wheeling & Lake Erie, Greenough, Ohio, a freight train was derailed by running into a landslide and the engineman jumped off and was fatally injured.

bc, 29th, Southern Railway, Culpeper, Va., a freight train collided with a work train, which, it is said, was not properly protected by flag, and both engines were wrecked. The fireman of the work train was killed and two other trainmen were injured.

bc, 29th, Minneapolis & St. Louis, Shakopee, Minn., butting collision between a freight train and a work train, due to a misunderstanding of orders. One employee was killed and six others were injured.

eq, 29th, Norfolk & Western, Glenvar, Va., a freight train was derailed by a broken wheel and 20 cars were wrecked. A brakeman was killed.

unx, 29th, Kansas City Southern, Joplin, Mo., a southbound passenger car was derailed and the baggage car and smoking car were overturned. Two passengers and two trainmen were injured.

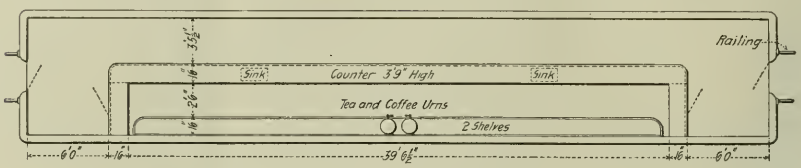
bc, 30th, Cincinnati, Hamilton & Dayton, Miamisburg, Ohio, butting collision of passenger trains, wrecking both engines and several cars. Three trainmen were injured.

o, 30th, Pennsylvania road, Ehrenfeld, Pa., the locomotive of a freight train was wrecked by the explosion of its boiler; three employees killed and two injured.

## Lunch Counter Car of the Pere Marquette.

The Pere Marquette has a heavy week-end passenger traffic to Michigan resorts at this season of the year, the noon trains out of Chicago on Fridays and Saturdays being quite crowded. Sunday evening the heavy travel is in the opposite direction. The trains in this service have been carrying café cars giving à la carte service, but it was quite impossible to accommodate more than a small part of those wishing to patronize them. After some study of the matter in an effort to make some provision for meeting the wants of the hungry patrons without running several dining cars in each train, General Passenger Agent Moeller hit upon the idea of a lunch car patterned after the quick-service restaurants.

An old parlor car was taken and converted, as shown in the engraving. A counter 3 ft. 9 in. high, 16 in. wide and 42 ft. 2½ in. long, with extensions at each end running to the side wall, was built in the car, leaving 6 ft. of space at each end and 3 ft. 5½ in. along the side. Shelving, cupboards, lockers, etc., were built behind the counter along the wall of the car similar to the usual restaurant arrangement, with steam-heated tea and coffee urns, and with sinks, with hot and cold water, under the counter, and overhead water tanks at each end of the shelving. All of the woodwork, except the top of the counter, which is walnut, is pine, stained and finished to match the rest of the car. Railings are placed on each side of the car doors so that it can only be entered from adjoining cars.




Floor Plan of Pere Marquette Lunch Car.

Sixty people can stand along the counter, and there is room in the car for 150 or 200 persons. The service is in charge of the Heusner Baking Company, of Chicago, which has a number of restaurants in the city. The provisions are of the usual bakery lunch variety, and the prices are moderate. The car runs to Hartford, Mich., giving nearly three hours and a half in which to serve the passengers. It "deadheads" back Friday night, but on Saturday it remains at Hartford to be picked up by the Sunday evening train to Chicago, to serve the returning crowd. The regular café cars are also run in these trains for the accommodation of through passengers. Although the lunch car has been in service but a short time, it was an immediate success and is much appreciated by Pere Marquette patrons. We are indebted to Mr. W. E. Wolfenden, General Western Passenger Agent, for data.

Interior of Pere Marquette Lunch Car.

## Block Signaling on the Chicago & North Western.

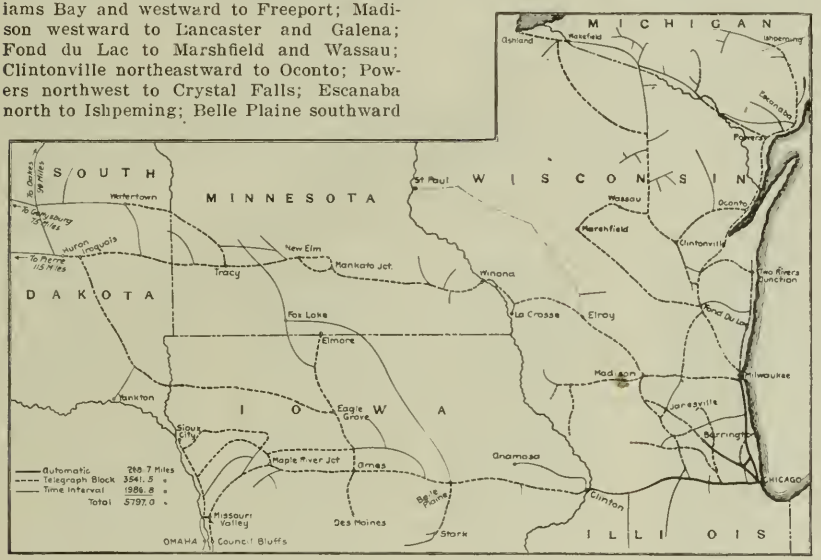
The Chicago & North Western has lately established the block system on certain of its lines in Iowa, and the total mileage now worked by the space interval is 3,810.2. An officer of the company has sent us a map which shows the whole of the company's lines and indicates the different methods of operation on different sections of the road. The map is self-explanatory. The automatic signals are all on the lines near Chicago, where is to be found the heaviest movement of traffic. The length of lines shown as worked by the telegraph block system is 3,541.5 miles, but on nearly one-half of this (1,639.5 miles) many of the offices are closed during the night and trains are run by the time interval, the block system being used only during the daytime. The lines of which the block offices are closed during the night are: Fox River switch northward to Williams Bay and westward to Freeport; Madison westward to Lancaster and Galena; Fond du Lac to Marshfield and Wassau; Clintonville northeastward to Oconto; Powers northwest to Crystal Falls; Escanaba north to Ishpeming; Belle Plaine southward to Stark; Jewell Junction southward and westward; Eagle Grove northward and westward; Tracy northward and westward, and a few short sections elsewhere.

Permissive block signaling is allowed as between freight trains, where necessary. On the 1,986.8 miles of less important lines, some of them having but few trains daily, the 10-minute time interval is used, and there is no block signaling.

The mileage signaled on each division is shown in the accompanying table.

SPACE INTERVAL AND TIME INTERVAL ON THE CHICAGO & NORTH WESTERN.

| Division. | Automatic. D. T. | Telegraph, D. & N. D. T. | S. T. | Teleg. Days. D. T. | Teleg. Days. S. T. | 10 Mins. S. T. | Total Miles. |
|---|---|---|---|---|---|---|---|
| Iowa | 138.1 | 350.4 | .... | .. | 59.2 | 149.6 | 559.2 |
| Galena | 138.1 | .... | 11 | .. | 156.9 | 150.9 | 456.9 |
| Wisconsin | 124.6 | 53.5 | 163.6 | .. | .... | 5.3 | 346.8 |
| Madison | 6.0 | 96.7 | 225.7 | .. | 136.6 | 39.5 | 504.5 |
| North Wisconsin | .... | 5.5 | 145.6 | .. | 129.6 | 51.1 | 331.8 |
| Sioux City | .... | .... | 75.9 | .. | 253.2 | 72.4 | 401.5 |
| North Iowa | .... | .... | 29.4 | .. | 211.3 | 115.0 | 355.7 |
| I. & M. | .... | .... | .... | .. | 58.6 | 268.7 | 327.3 |
| Minnesota | .... | .... | 221.2 | .. | 129.9 | 152.9 | 504.0 |
| Dakota | .... | .... | .... | 8.8 | 124.8 | 188.2 | 436.7 |
| Peninsula | .... | 8.7 | 106.2 | .. | 262.5 | 547.1 | 809.6 |
| Ashland | .... | .... | 408.8 | .. | 108.1 | 246.1 | 763.0 |
| Total | 268.7 | 514.6 | 1,387.4 | 8.8 | 1,630.7 | 1,986.8 | 5,797.0 |



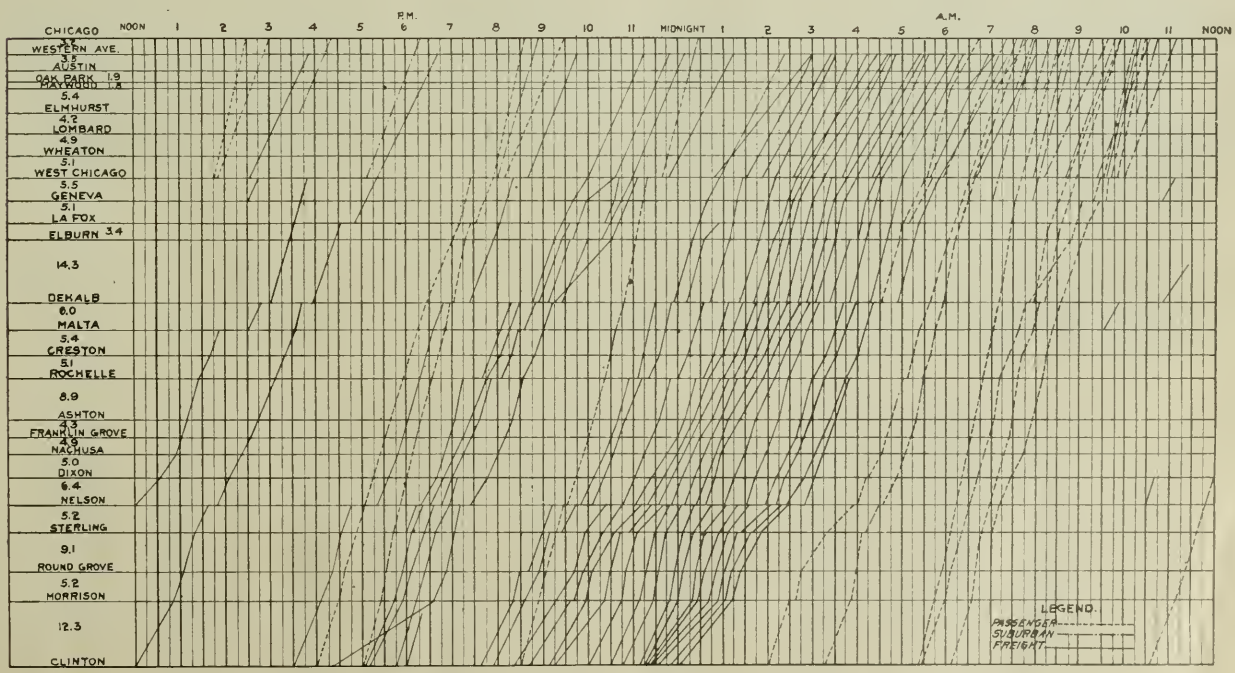

Block Signaling on the Chicago & North Western, June, 1904.

### LIVE STOCK MOVEMENT.

The Chicago & North Western's line from Omaha to Chicago has for many years been one of the principal carriers of live stock to the latter city, and the uniformly good time and prompt delivery made has reflected much credit on the officers of the road. The movement is always heaviest at the beginning of the week, and deliveries at Chicago on Monday average 700 cars.

On a recent occasion, from noon of Sunday until noon of Monday, the number of stock trains arriving in Chicago by this line was 26, and of ordinary freight trains two. Adding the through and local passenger trains, the total arrivals were 57. The number of cars of live stock was 730, and of other freight 62.

The main line from Clinton to Chicago, 138 miles, is equipped with Hall automatic block signals (enclosed disks). These signals for most of the way are set from 6,000 to 7,000 ft. apart, so that during a heavy movement like that here referred to, the road is used continuously for many hours to its full capacity. To make a graphic exhibit of this movement a photograph has been prepared, from data given in the train despatcher's sheet, which shows approximately the relative positions of 36 eastbound trains throughout their movements from Clinton




Chicago & North Western Railway—One Day's Train Movements, Clinton to Chicago.

to Chicago. A reproduction of this photograph is given herewith. This drawing does not represent the traffic on the day above mentioned, and it does not represent the precise position of the trains at all points of their respective journeys, as the lines are in their true positions only at those stations which are shown at the left of the drawing; but the intervals between each train and the one ahead of it and the one behind it are indicated with a considerable degree of accuracy. At the time this drawing was made, that portion of the line between Clinton and De Kalb was worked by manual block signals. Permissive signals were given where necessary to avoid serious delays to trains, but there were not so many of these as would appear from the drawing, for the reason that there were more block-signal stations than appear in the illustration; some were omitted in order to avoid confusing the lines in the drawing.

## Steel Car Design.

### V.

BY A. STUCKI.

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*Box Cars with Load Carried by the Sides.*

Box cars with steel body framing can be designed so that the sides form a deep truss strong enough to carry all of the load, leaving the center sills to transmit only the end shocks and thus to become a backbone for the car. In the diagrams, Figs. 15 to 17, the usual forms of truss framing are shown, with the posts and braces arranged in the proper way for a car of the dimensions adopted as standard by the American Railway Association. The figures show the maximum forces, in pounds, in all of the members of the framing and were obtained by considering only those panels loaded, which, in each case, would give the maximum stress for the panel members. To cover the most severe cases and to allow for variations in the method of connecting the posts, braces and top and bottom members, the maximum allowable load for the 50-ton car was taken at 120,000 lbs. instead of the usual 110,000 lbs. and the weight of the body was assumed as 28,000 lbs. A theoretical height of panel of 100 in. was also assumed. On the diagrams, the heavy lines indicate compression and the light lines indicate tension. A low fiber stress should be chosen to allow for vibrations and vertical oscillation. The stresses in the top and bottom chords of the side trusses should not exceed 8,000 lbs.

The end pressure exerted by the load when abrupt changes in the speed of the car occur can be assumed as 10,000 lbs. at the top of the end framing and 20,000 lbs. at the bottom, for a 50-ton car and 80 per cent. and 60 per cent. of these values for the 80,000-lb. and 60,000-lb. cars, respectively. These forces, however, are usually taken up by members of the framing, which are not subjected to any great stress, and for this reason they have not been considered in calculating the stresses shown on the diagrams.

Since it is not possible to introduce diagonal braces in the door opening panels of the side trusses, an unsymmetrical load will create bending stresses in the top and bottom chords, the bending moment being

$$M = f \times \frac{\text{door opening in inches}}{4}$$

where f is the vertical component of the forces which would exist in the diagonal braces if they were introduced into the panel. The following are values of f for the three-capacity cars.

5,890 lbs. for 100,000 lb. cars with 2 intermediate doorposts.

5,119 lbs. for 100,000-lb. cars with 1 intermediate doorpost.

4,770 lbs. for 80,000-lb. cars with 2 intermediate doorposts.

4,147 lbs. for 80,000-lb. cars with 1 intermediate doorpost.

3,651 lbs. for 60,000-lb. cars with 2 intermediate doorposts.

3,175 lbs. for 60,000-lb. cars with 1 intermediate doorpost.

The bending moments in the top and bottom chords are shown on the diagrams and they are resisted by the continuous members, the deepest sections, of course, doing most of the work.

The posts and braces in addition to the direct tension and compression which they resist as members of the side truss, are subjected to cross-bending stresses induced by

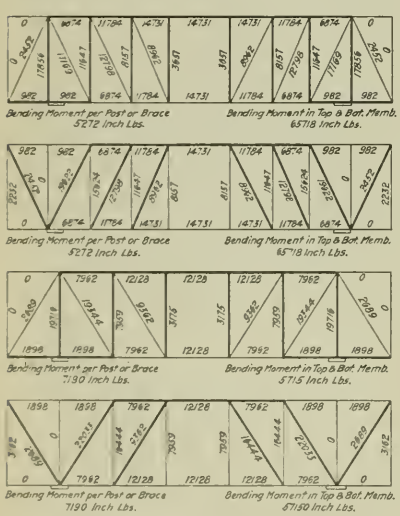

Bending Moment per Post or Brace 5272 Inch Lbs.
Bending Moment in Top & Bot. Memb. 65718 Inch Lbs.
Bending Moment per Post or Brace 5272 Inch Lbs.
Bending Moment in Top & Bot. Memb. 65718 Inch Lbs.
Bending Moment per Post or Brace 7190 Inch Lbs.
Bending Moment in Top & Bot. Memb. 57150 Inch Lbs.
Bending Moment per Post or Brace 7190 Inch Lbs.
Bending Moment in Top & Bot. Memb. 57150 Inch Lbs.

Fig. 15.

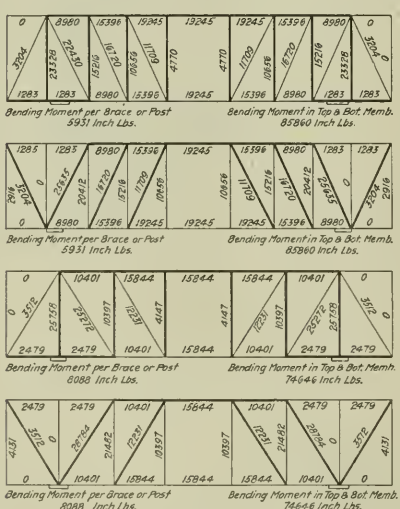

Bending Moment per Brace or Post 5931 Inch Lbs.
Bending Moment in Top & Bot. Memb. 85260 Inch Lbs.
Bending Moment per Brace or Post 5931 Inch Lbs.
Bending Moment in Top & Bot. Memb. 85260 Inch Lbs.
Bending Moment per Brace or Post 6088 Inch Lbs.
Bending Moment in Top & Bot. Memb. 74646 Inch Lbs.
Bending Moment per Brace or Post 8088 Inch Lbs.
Bending Moment in Top & Bot. Memb. 74646 Inch Lbs.

Fig. 16.

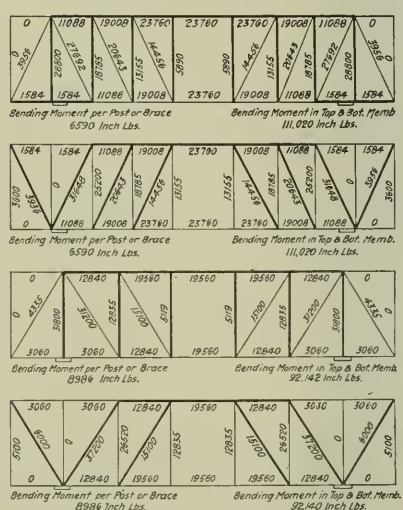

Bending Moment per Post or Brace 6590 Inch Lbs.
Bending Moment in Top & Bot. Memb. 111,020 Inch Lbs.
Bending Moment per Post or Brace 6590 Inch Lbs.
Bending Moment in Top & Bot. Memb. 111,020 Inch Lbs.
Bending Moment per Post or Brace 8986 Inch Lbs.
Bending Moment in Top & Bot. Memb. 92,140 Inch Lbs.
Bending Moment per Post or Brace 8986 Inch Lbs.
Bending Moment in Top & Bot. Memb. 92,140 Inch Lbs.

Fig. 17.

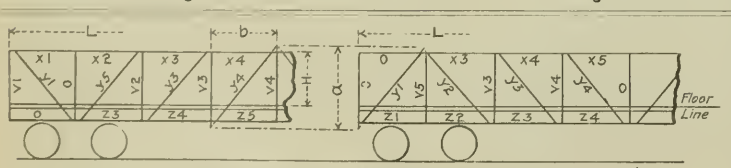



TABLE I.

FORCES IN STEEL SIDE TRUSS OF GONDOLA CARS OF 60,000 LBS. CAPACITY.

| | L = 36 Feet. | | | | | L = 40 Feet. | | | | | L = 44 Feet. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H= | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 |
| A | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 |
| B | 54 | 54 | 54 | 54 | 54 | 60 | 60 | 60 | 60 | 60 | 66 | 66 | 66 | 66 | 66 |
| $X_1$ | 2641 | 2300 | 2160 | 1981 | 1833 | 2935 | 2641 | 2392 | 2201 | 2031 | 3227 | 2904 | 2641 | 2420 | 2234 |
| $X_2$ | 2641 | 2300 | 2160 | 1981 | 1833 | 2935 | 2641 | 2392 | 2201 | 2031 | 3227 | 2904 | 2641 | 2420 | 2234 |
| $X_3$ | 13201 | 11880 | 10805 | 9900 | 9138 | 14688 | 13201 | 12000 | 11001 | 10155 | 16134 | 14521 | 13201 | 12100 | 11169 |
| $X_4$ | 21120 | 19008 | 17280 | 15840 | 14622 | 23468 | 21120 | 19200 | 17600 | 16246 | 25812 | 23232 | 21120 | 19360 | 17871 |
| $X_5$ | 23761 | 21384 | 19440 | 17821 | 16450 | 26416 | 23761 | 21612 | 19812 | 16525 | 29057 | 26151 | 23761 | 21793 | 20116 |
| $Z_1$ | 2641 | 2300 | 2160 | 1981 | 1833 | 2935 | 2641 | 2392 | 2201 | 2031 | 3227 | 2904 | 2641 | 2420 | 2234 |
| $Z_2$ | 2641 | 2300 | 2160 | 1981 | 1833 | 2935 | 2641 | 2392 | 2201 | 2031 | 3227 | 2904 | 2641 | 2420 | 2234 |
| $Z_3$ | 13201 | 11880 | 10805 | 9900 | 9138 | 14668 | 13201 | 12000 | 11001 | 10155 | 16134 | 14521 | 13201 | 12100 | 11169 |
| $Z_4$ | 21120 | 19008 | 17280 | 15840 | 14622 | 23468 | 21120 | 19200 | 17600 | 16246 | 25812 | 23232 | 21120 | 19360 | 17871 |
| $Z_5$ | 23761 | 21384 | 19440 | 17821 | 16450 | 26416 | 23761 | 21612 | 19812 | 16525 | 29057 | 26151 | 23761 | 21793 | 20116 |
| $Y_1$ | 3734 | 3568 | 3424 | 3309 | 3224 | 3920 | 3734 | 3568 | 3439 | 3330 | 4179 | 3930 | 3734 | 3583 | 3461 |
| $Y_2$ | 18672 | 17519 | 17121 | 16542 | 16119 | 19644 | 18672 | 17839 | 17187 | 16647 | 20926 | 19644 | 18672 | 17911 | 17301 |
| $Y_3$ | 11202 | 10702 | 10272 | 9925 | 9670 | 11786 | 11202 | 10702 | 10313 | 9988 | 12533 | 11986 | 11202 | 10747 | 10383 |
| $Y_4$ | 3734 | 3568 | 3424 | 3309 | 3224 | 3930 | 3734 | 3568 | 3439 | 3330 | 4179 | 3930 | 3734 | 3583 | 3461 |
| $Y_5$ | 22406 | 21087 | 20515 | 19851 | 19343 | 23574 | 22406 | 21407 | 20626 | 19977 | 25105 | 23574 | 22406 | 21494 | 20762 |
| $V_1$ | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 | 2641 |
| $V_2$ | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 | 13201 |
| $V_3$ | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 | 7919 |
| $V_4$ | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 | 5280 |
| $V_5$ | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 | 16000 |

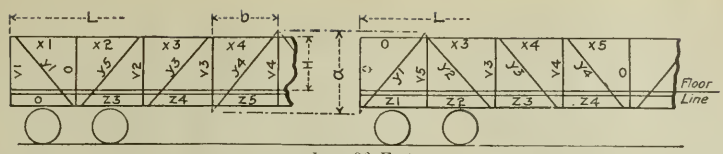



TABLE II.

FORCES IN STEEL SIDE TRUSS OF GONDOLA CARS OF 80,000 LBS. CAPACITY.

| | L = 36 Feet. | | | | | L = 40 Feet. | | | | | L = 44 Feet. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H= | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 |
| A= | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 |
| B= | 54 | 54 | 54 | 54 | 54 | 60 | 60 | 60 | 60 | 60 | 66 | 66 | 66 | 66 | 66 |
| $X_1$ | 3383 | 2968 | 2767 | 2537 | 2348 | 3759 | 3383 | 3064 | 2819 | 2602 | 4134 | 3721 | 3383 | 3100 | 2862 |
| $X_2$ | 3383 | 2968 | 2767 | 2537 | 2348 | 3759 | 3383 | 3064 | 2819 | 2602 | 4134 | 3721 | 3383 | 3100 | 2862 |
| $X_3$ | 16913 | 15221 | 13840 | 12684 | 11708 | 18792 | 16913 | 15375 | 14094 | 13010 | 20671 | 18604 | 16913 | 15503 | 14310 |
| $X_4$ | 27060 | 24354 | 22140 | 20295 | 18734 | 30067 | 27060 | 24600 | 22550 | 20815 | 33071 | 29766 | 27060 | 24805 | 22897 |
| $X_5$ | 30443 | 27398 | 24907 | 22832 | 21076 | 33844 | 30443 | 27690 | 25383 | 21250 | 37228 | 33505 | 30443 | 27921 | 25773 |
| $Z_1$ | 3383 | 2968 | 2767 | 2537 | 2348 | 3759 | 3383 | 3064 | 2819 | 2602 | 4134 | 3721 | 3383 | 3100 | 2862 |
| $Z_2$ | 3383 | 2968 | 2767 | 2537 | 2348 | 3759 | 3383 | 3064 | 2819 | 2602 | 4134 | 3721 | 3383 | 3100 | 2862 |
| $Z_3$ | 16913 | 15221 | 13840 | 12684 | 11708 | 18792 | 16913 | 15375 | 14094 | 13010 | 20671 | 18604 | 16913 | 15503 | 14310 |
| $Z_4$ | 27060 | 24354 | 22140 | 20295 | 18734 | 30067 | 27060 | 24600 | 22550 | 20815 | 33071 | 29766 | 27060 | 24805 | 22897 |
| $Z_5$ | 30443 | 27398 | 24907 | 22832 | 21076 | 33844 | 30443 | 27690 | 25383 | 21250 | 37228 | 33505 | 30443 | 27921 | 25773 |
| $Y_1$ | 4784 | 4571 | 4387 | 4239 | 4130 | 5034 | 4784 | 4571 | 4405 | 4266 | 5353 | 5034 | 4784 | 4590 | 4434 |
| $Y_2$ | 23923 | 22695 | 21936 | 21194 | 20651 | 25168 | 23923 | 22855 | 22021 | 21328 | 26780 | 25168 | 23923 | 22948 | 22166 |
| $Y_3$ | 14352 | 13712 | 13161 | 12716 | 12389 | 15100 | 14352 | 13712 | 13213 | 12797 | 16057 | 15200 | 14352 | 13769 | 13302 |
| $Y_4$ | 4784 | 4571 | 4387 | 4239 | 4130 | 5034 | 4784 | 4571 | 4405 | 4266 | 5353 | 5034 | 4784 | 4590 | 4434 |
| $Y_5$ | 28707 | 27266 | 26323 | 25433 | 24781 | 30202 | 28707 | 27426 | 26426 | 25594 | 32133 | 30202 | 28707 | 27538 | 26600 |
| $V_1$ | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 | 3383 |
| $V_2$ | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 | 16913 |
| $V_3$ | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 | 10147 |
| $V_4$ | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 | 6765 |
| $V_5$ | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 | 20375 |

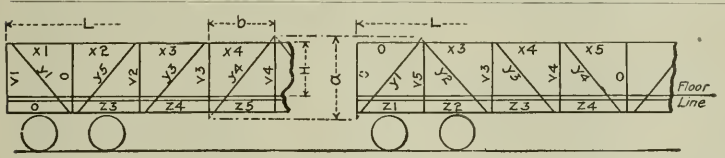



TABLE III.

FORCES IN STEEL SIDE TRUSS OF GONDOLA CARS OF 100,000 LBS. CAPACITY.

| | L = 36 Feet. | | | | | L = 40 Feet. | | | | | L = 44 Feet. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H= | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 | 3-0 | 3-6 | 4-0 | 4-6 | 5-0 |
| A= | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 | 54 | 60 | 66 | 72 | 78 |
| B= | 54 | 54 | 54 | 54 | 54 | 60 | 60 | 60 | 60 | 60 | 66 | 66 | 66 | 66 | 66 |
| $X_1$ | 4125 | 3712 | 3374 | 3093 | 2863 | 4583 | 4125 | 3736 | 3437 | 3173 | 5041 | 4537 | 4125 | 3780 | 3490 |
| $X_2$ | 4125 | 3712 | 3374 | 3093 | 2863 | 4583 | 4125 | 3736 | 3437 | 3173 | 5041 | 4537 | 4125 | 3780 | 3490 |
| $X_3$ | 20625 | 18562 | 16875 | 15468 | 14278 | 22916 | 20625 | 18750 | 17187 | 15865 | 25208 | 22687 | 20625 | 18906 | 17451 |
| $X_4$ | 33000 | 29700 | 27000 | 24750 | 22846 | 36666 | 33000 | 30000 | 27500 | 25384 | 40330 | 36300 | 33000 | 30250 | 27923 |
| $X_5$ | 37125 | 33412 | 30374 | 27843 | 25702 | 41272 | 37145 | 33768 | 30954 | 25975 | 45399 | 40859 | 37145 | 34049 | 31430 |
| $Z_1$ | 4125 | 3712 | 3374 | 3093 | 2863 | 4583 | 4125 | 3736 | 3437 | 3173 | 5041 | 4537 | 4125 | 3780 | 3490 |
| $Z_2$ | 4125 | 3712 | 3374 | 3093 | 2863 | 4583 | 4125 | 3736 | 3437 | 3173 | 5041 | 4537 | 4125 | 3780 | 3490 |
| $Z_3$ | 20625 | 18562 | 16875 | 15468 | 14278 | 22916 | 20625 | 18750 | 17187 | 15865 | 25208 | 22687 | 20625 | 18906 | 17451 |
| $Z_4$ | 33000 | 29700 | 27000 | 24750 | 22846 | 36666 | 33000 | 30000 | 27500 | 25384 | 40330 | 36300 | 33000 | 30250 | 27923 |
| $Z_5$ | 37125 | 33412 | 30374 | 27843 | 25702 | 41272 | 37145 | 33768 | 30954 | 25975 | 45399 | 40859 | 37145 | 34049 | 31430 |
| $Y_1$ | 5834 | 5574 | 5350 | 5169 | 5036 | 6138 | 5834 | 5574 | 5371 | 5202 | 6527 | 6138 | 5834 | 5597 | 5407 |
| $Y_2$ | 29174 | 27871 | 26751 | 25846 | 25183 | 30692 | 29174 | 27871 | 26855 | 26009 | 32634 | 30692 | 29174 | 27985 | 27031 |
| $Y_3$ | 17502 | 16722 | 16050 | 15507 | 15108 | 18414 | 17502 | 16722 | 16113 | 15606 | 19581 | 18414 | 17502 | 16791 | 16221 |
| $Y_4$ | 5834 | 5574 | 5350 | 5169 | 5036 | 0138 | 5834 | 5574 | 5371 | 5202 | 6527 | 6138 | 5834 | 5597 | 5407 |
| $Y_5$ | 35008 | 33445 | 32101 | 31015 | 30219 | 36830 | 35008 | 33445 | 32226 | 31211 | 39161 | 36830 | 35008 | 33582 | 32438 |
| $V_1$ | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 | 4125 |
| $V_2$ | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 | 20625 |
| $V_3$ | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 | 12375 |
| $V_4$ | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 | 8250 |
| $V_5$ | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 | 24750 |

the tendency of any load in bulk, such as grain, to bulge outward and also by the pressure of the load due to centrifugal force when the car is rounding a curve. The bending moment per post or brace due to the first cause is $M_1 = \frac{H^3 \tan^2\theta \; D \; W}{18 \times 1728}$ and the bending moment due to centrifugal force, assuming centrifugal force equal to four-tenths the load, is

$$M_2 = \frac{H^3 \; D \; W}{388{,}800}$$

The total bending moment in each post or brace at a point ⅓ H. from the floor is

$$M = H^3 \; D \; W \left( \frac{\tan^2\theta}{31{,}104} + \frac{1}{388{,}800} \right)$$

In the formulas

H = height of load in inches.

D = ½ distance between post in inches.

W = weight of lading in lbs. per cu. ft.

$\theta$ = ½ (90 deg. — angle of repose).

In calculating the bending moments shown on the diagrams, H was assumed to be 72 inches, W = 60 lbs. and $\theta$ = 30 deg.

Example: Design a 100,000-lb. capacity box car, M. C. B. standard inside dimensions, with steel framing, one intermediate post and diagonals in tension. To find the required sections for the principal members of the side truss.

The top chord or plate must resist a maximum stress of 19,560 lbs. near the center of the car. (See Fig. 17.) This requires at least 2.4 in. of effective cross-sectional area and for safety this might well be increased.

The bottom chord or side sill also carries 19,560 lbs. and should have quite as much, if not more, area than the side plate.

The bending moment in the top and bottom members is as high as 92,142 in.-lbs. and, assuming that the center sills are 12-in., 35-lbs. channels with a section modulus of 29.9, these sills will take care of the bending moment without exceeding a fiber stress of $\frac{92142}{29.9}$, or about 3,000 lbs. In order that the load at the middle of the car be transmitted from the sides to the center sills, the deep cross-bearers on each side of the cen-

TABLE VI.

BENDING MOMENTS IN INCH POUNDS IN STAKES AT FLOOR LINE.

| D. | 24 in. = H | 26 in. = H | 28 in. = H | 30 in. = H | 32 in. = H | 34 in. = H | 36 in. = H | 38 in. = H | 40 in. = H | 42 in. = H | 44 in. = H | 46 in. = H | 48 in. = H | 50 in. = H | 52 in. = H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 1197 | 1523 | 1902 | 2339 | 2839 | 3405 | 4042 | 4754 | 5545 | 6419 | 7380 | 8433 | 9582 | 10830 | 12182 |
| 26 | 1297 | 1650 | 2060 | 2534 | 3075 | 3689 | 4379 | 5150 | 6007 | 6954 | 7995 | 9136 | 10380 | 11732 | 13197 |
| 28 | 1397 | 1777 | 2218 | 2728 | 3312 | 3973 | 4716 | 5546 | 6469 | 7489 | 8610 | 9839 | 11179 | 12635 | 14213 |
| 30 | 1497 | 1903 | 2377 | 2923 | 3548 | 4257 | 5053 | 5943 | 6931 | 8023 | 9225 | 10541 | 11977 | 13537 | 15228 |
| 32 | 1596 | 2030 | 2535 | 3118 | 3785 | 4540 | 5390 | 6339 | 7393 | 8559 | 9840 | 11244 | 12776 | 14440 | 16243 |
| 34 | 1696 | 2157 | 2693 | 3313 | 4022 | 4824 | 5727 | 6735 | 7855 | 9093 | 10455 | 11947 | 13574 | 15342 | 17258 |
| 36 | 1796 | 2284 | 2852 | 3508 | 4258 | 5108 | 6063 | 7131 | 8317 | 9628 | 11070 | 12650 | 14372 | 16245 | 18273 |
| 38 | 1896 | 2411 | 3011 | 3703 | 4495 | 5392 | 6400 | 7527 | 8779 | 10163 | 11685 | 13353 | 15171 | 17147 | 19289 |
| 40 | 1996 | 2538 | 3169 | 3898 | 4731 | 5675 | 6737 | 7923 | 9242 | 10698 | 12300 | 14055 | 15969 | 18050 | 20304 |
| 42 | 2095 | 2664 | 3328 | 4093 | 4968 | 5959 | 7074 | 8320 | 9704 | 11233 | 12915 | 14758 | 16768 | 18952 | 21319 |
| 44 | 2195 | 2791 | 3486 | 4288 | 5204 | 6243 | 7411 | 8716 | 10166 | 11768 | 13530 | 15461 | 17566 | 19855 | 22334 |
| 46 | 2295 | 2919 | 3644 | 4483 | 5441 | 6527 | 7748 | 9112 | 10628 | 12303 | 14145 | 16164 | 18365 | 20757 | 23349 |
| 48 | 2395 | 3046 | 3803 | 4678 | 5678 | 6810 | 8085 | 9508 | 11090 | 12837 | 14760 | 16866 | 19163 | 21660 | 24365 |
| 50 | 2495 | 3172 | 3962 | 4872 | 5914 | 7094 | 8421 | 9904 | 11552 | 13373 | 15375 | 17569 | 19962 | 22562 | 25380 |
| 52 | 2594 | 3299 | 4120 | 5067 | 6151 | 7378 | 8758 | 10300 | 12014 | 13908 | 15990 | 18272 | 20760 | 23465 | 26395 |

ter should be made very stiff and strong.

The maximum stress in the posts is 31,800, and it occurs over the bolster. The bending moment in the post is 8986 in.-lbs. A 3-in. Z-bar, 11.4 lbs. per ft. and having a section area of 3.36 sq. in., has a section modulus of 2.98. The compressive stress due to bending is $\frac{8986}{2.98} = 3,020$ lbs. and the compression due to the load is $\frac{31800}{2.98}$ or 9,464 lbs. These two forces combined give a total compressive force of 12,484 lbs. per sq. in., which exceeds the safe stress somewhat, but not sufficiently to require a heavier section at this place, since the combined stress will rarely be reached in practice.

The diagonal brace nearest the body bolster requires the same section, since the rivet holes must be considered. The other posts and braces can be made much lighter.

*Gondola Cars with Sides Carrying the Load.* These may be divided into two classes, those having a steel truss side with wooden planks and those having a plate-girder side.

The treatment of cars having steel-trussed sides is similar to that for box cars with trussed sides. The center sills are designed to resist end shocks only and the entire load is considered as being carried by the truss members of the side frame. The diagonals may be arranged for tension or compression, and in Tables I. to III. the forces are given for the different arrangements, panel spacing and depth of side for all three-capacity cars. The side sill is usually formed by an 8-in. channel, and to provide for this construction the intersection of the center lines of the posts and braces has been taken as 5 in. above the top of the side and 13 in. below the floor level. All panels are of uniform width and the load was considered as being distributed uniformly over the length of the car. A load of 110,000 lbs. was assumed for the 100,000-lb. car and 22,000 lbs. as the weight of the car body. For the 80,000-lb. and 60,000-lb cars, 82 per cent. and 64 per cent. of the forces found for the 100,000-lb. car were taken. The fiber stress in none of the members should exceed 12,500 lbs.

The calculation of the strength of the side girders for plate side frame construction is very simple. The bending moment at any section, x inches from the end sill with a uniformly distributed load is

$$M = \frac{Px}{2}\left(\frac{x}{l} - 1 + \frac{c}{x}\right).$$

To find the bending moment at the center of the car put $x = \frac{l}{2}$. The table below gives the combined bending moment in the center of the car due to load and weight of car body for different lengths of the three-capacity cars. The loads were taken as 110,-

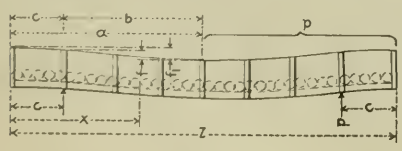



Fig. 18.

000 lbs., 88,000 lbs. and 66,000 lbs., respectively, and the weights of the bodies as 24,000 lbs., 22,000 and 20,000 lbs.

*Table IV.—Moments in Center of Car.*

| Length Over End Sills. | Distance c. to c. Trucks. | 60,000 Lb. Cars. | 80,000 Lb. Cars. | 100,000 Lb. Cars. |
|---|---|---|---|---|
| 34 ft. ... | 24 ft. | 1,842,000 | 2,358,000 | 2,855,000 |
| 36 ft. ... | 26 ft. | 2,043,000 | 2,615,000 | 3,167,000 |
| 38 ft. ... | 28 ft. | 2,253,000 | 2,912,000 | 3,647,000 |
| 40 ft. ... | 28 ft. | 2,064,000 | 2,642,000 | 3,199,000 |
| 42 ft. ... | 30 ft. | 2,276,000 | 2,913,000 | 3,528,000 |
| 44 ft. ... | 32 ft. | 2,611,000 | 3,342,000 | 4,047,000 |
| 46 ft. ... | 34 ft. | 2,848,000 | 3,645,000 | 4,414,000 |
| 48 ft. ... | 36 ft. | 3,096,000 | 3,963,000 | 4,799,000 |

TABLE V.

MOMENT OF INERTIA I AND SECTION MODULUS Z FOR PLATE GIRDER GONDOLA CAR SIDES.

$e_0 = \frac{H}{2}$ $e_1 = \frac{H}{2}$

| Top Angle. | H = 36 in. I. | Z. | H = 38 in. I. | Z. | H = 40 in. I. | Z. | H = 42 in. I. | Z. | H = 44 in. I. | Z. | H = 46 in. I. | Z. | H = 48 in. I. | Z. | H = 50 in. I. | Z. | H = 52 in. I. | Z. | H = 54 in. I. | Z. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 x 3 x 5/16 | 2016.6 | 112.0 | 2338.1 | 121.8 | 2635.7 | 131.7 | 2986.1 | 142.2 | 3383.9 | 152.8 | 3777.2 | 162.9 | 4208.6 | 175.2 | 4646.9 | 187.1 | 5177.4 | 199.0 | 5711.0 | 211.5 |
| " 1/2 | 2206.0 | 122.5 | 2557.5 | 132.9 | 2872.5 | 143.5 | 3248.4 | 154.7 | 3653.4 | 165.9 | 4061.5 | 176.9 | 4506.8 | 188.4 | 4980.2 | 200.2 | 5587.9 | 214.8 | 6153.2 | 228.0 |
| " 7/16 | 2393.2 | 132.9 | 2775.2 | 144.0 | 3110.9 | 155.0 | 3507.0 | 166.9 | 3942.3 | 179.3 | 4397.3 | 191.9 | 4891.3 | 204.6 | 5426.6 | 217.1 | 6091.1 | 230.8 | 6591.2 | 244.1 |
| " 1/2 | 2580.2 | 143.3 | 2994.8 | 155.0 | 3339.4 | 166.9 | 3765.5 | 179.3 | 4231.2 | 192.4 | 4717.0 | 206.0 | 5228.8 | 218.3 | 5798.6 | 231.6 | 6394.3 | 245.8 | 7027.1 | 260.2 |
| 3½ x 3½ x 5/16 | 2780.0 | 134.3 | 3214.3 | 145.4 | 3588.0 | 157.6 | 4050.9 | 168.7 | 4553.2 | 183.3 | 5011.8 | 196.5 | 5541.8 | 212.1 | 6166.1 | 226.7 | 6941.8 | 242.8 | 7646.6 | 258.8 |
| " 7/16 | 2947.0 | 144.3 | 3406.5 | 156.8 | 3806.5 | 168.7 | 4296.1 | 180.8 | 4829.5 | 195.2 | 5374.2 | 208.4 | 5890.5 | 222.0 | 6541.1 | 236.0 | 7366.1 | 250.1 | 8146.6 | 264.8 |
| " 1/2 | 3122.8 | 153.7 | 3644.5 | 167.6 | 4044.5 | 182.1 | 4560.4 | 196.5 | 5136.2 | 210.1 | 5724.3 | 224.1 | 6329.3 | 238.5 | 6972.3 | 253.2 | 7656.1 | 268.1 | 8495.5 | 283.5 |
| " 9/16 | 3286.8 | 157.6 | 3807.5 | 171.1 | 4225.5 | 185.0 | 4760.4 | 199.5 | 4825.5 | 175.7 | 4816.8 | 188.0 | 5316.8 | 200.7 | 5841.1 | 213.7 | 6495.5 | 229.9 | 7165.4 | 246.6 |
| 4 x 4 x 5/16 | 2399.5 | 149.9 | 2767.2 | 162.8 | 3167.2 | 176.2 | 3667.4 | 191.1 | 4263.3 | 208.3 | 4761.3 | 220.5 | 5292.9 | 236.9 | 5880.5 | 254.4 | 6464.2 | 272.5 | 7165.4 | 293.1 |
| " 7/16 | 2538.1 | 158.3 | 2967.6 | 174.1 | 3387.4 | 189.4 | 3887.6 | 204.7 | 4649.6 | 211.3 | 5185.5 | 225.4 | 5756.9 | 239.9 | 6366.3 | 254.7 | 7013.8 | 270.8 | 7700.6 | 285.2 |
| " 1/2 | 2849.4 | 168.3 | 3249.4 | 181.1 | 3989.5 | 199.4 | 4489.5 | 213.8 | 5025.8 | 228.4 | 5598.5 | 243.3 | 6209.2 | 258.7 | 6859.7 | 274.4 | 7549.3 | 290.3 | 8280.7 | 306.7 |
| " 9/16 | 3093.7 | 171.8 | 3524.2 | 185.5 | | | | | | | | | | | | | | | | |

*The Deflection* of a plate girder side between the center of the car and the end (see Fig. 18) is

$$f_1 = \frac{p}{EI}\left(\frac{b^3}{3} + \frac{cb^2}{2} - \frac{a^3}{8}\right)$$

and the deflection measured between the center of the car and the bolster is

$$f = \frac{p}{EI}\left[\frac{b^3}{3} - \frac{a^3}{24}\left(\frac{c^4}{a^4} - \frac{4c}{a} + 3\right)\right]$$

In the above equations

E = modulus of elasticity, usually 25,000,000.

I = moment of inertia.

p = load on one girder between the center and the end.

a = ½ length of car.

b = ½ distance between bolsters.

c = distance between end sill and bolster.

It will be found, usually, that the section modulus of the sides is so large that the fiber stresses are well below the safe working stress. The following table, Table V., shows the section modulus and moment of inertia for different depths of side and reinforcing angles. In calculating the values shown in the table, it was assumed that equal amounts of material were distributed in the top and bottom portions, so as to bring the neutral axis half way up. In most

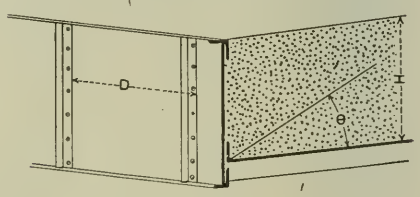



Fig. 19.

cases there is more material in the bottom portion, but the above method is justified because it simplifies the calculations and any additional material in the bottom portion can be considered as helping to resist the end shocks. To find the bending moment in the stakes at the floor line due to bulging of the load and centrifugal force, assuming

W = 57 lbs. per cu. ft. for coal.

H = depth of load, level with side of car.

D = distance between stakes.

$\theta$ = ½ (90 deg. — angle of repose) or 30 deg.

The moment due to bulging is

$$M_b = \frac{H^3 D W \tan^2\theta}{6 \times 1728} \text{ or } .00185\ D\ H^3$$

The moment due to centrifugal force is

$$M_c = .00176\ D\ H^3$$

The combined moment is, therefore, M = .00361 D H³

The accompanying table, Table VI., gives the moments calculated by this formula for different values of H and D.

If the stakes themselves or the cross-beams under the floor are not strong enough to resist these moments, ties should be inserted across the car near the tops of the sides or else additional gusset sheets should be put in at the connections of the stakes to the cross-beams to keep the car body in shape.

---

The Austrian State railroads and most of the private railroads have agreed to offer the laborers in their employ the following reductions in fares: For those who have served their railroad uninterruptedly for three years, a reduction of 50 per cent. in the third class fare; for those five years in service, the rates of regular employees for themselves and a reduction of 50 per cent. in the third class fare for members of their families; for those who have served ten years, free passes for themselves and a reduction of 50 per cent. for members of their families.

### History of the Railroad in the German Protectorate in China.*

It will be remembered that the German-Chinese Treaty of March, 1898, followed by the concession of June, 1899, provided for building a railroad in the province of Shan Tung. This railroad was planned to extend from Tsing Tow to Tsin Anfow, the capital of the province of Shan Tung. Branch lines were also provided for. The railroad system is to extend 800 miles in the shape of an equilateral triangle, which will surround the mountainous interior, while the railroad itself will run through partly hilly and partly flat country, densely populated and very fruitful. The population is almost exclusively agricultural, which fact would point to an important passenger and freight traffic in the future. The line also intersects several of the largest coal fields.

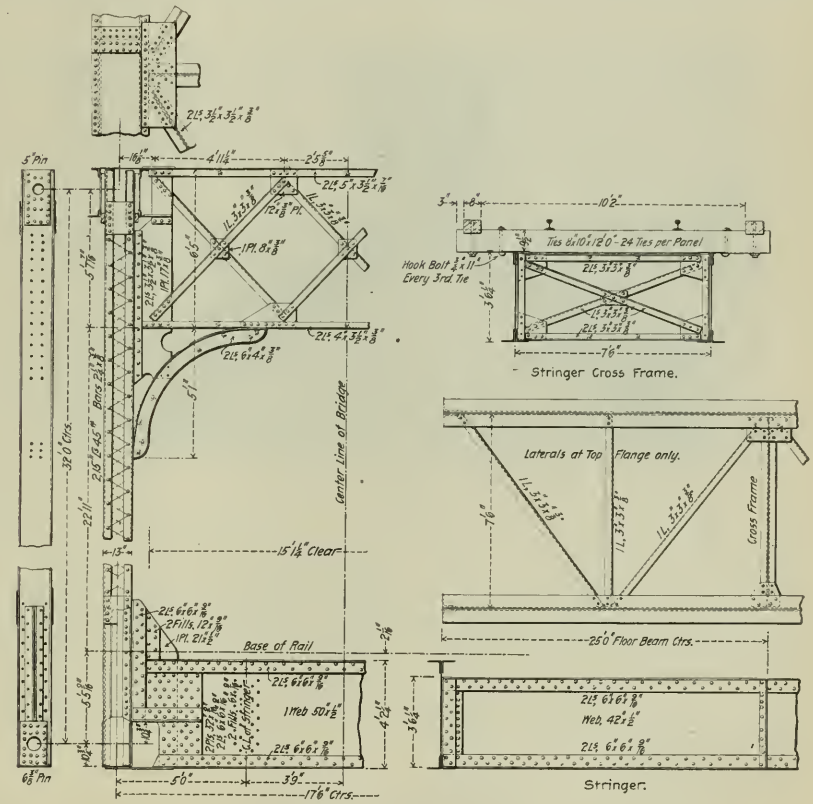
About 275 miles of the railroad are already complete and in operation. The difficulty of building it was largely the result of the inborn conservatism of the Chinese and their dislike of foreign interference. In acquiring the necessary land for the line, the familiar obstacle of the graves of their ancestors being disturbed had to be skillfully met. After a great deal of diplomacy proper compensation was fixed to the satisfaction of the bereaved Chinese. It turned out that the spirits offended by the coming of the foreign railroad had no more objections to raise as soon as any material advantage resulted from the railroad's presence; and ancestor worship yielded to the payment of a regular price per grave. The recent Boxer difficulties also constituted a serious hindrance to railroad building. Native workmen were largely employed, numbering at one time 25,000. The wages paid varied from 10 to 15 cents per day. Cement had to be brought from Europe, as well as the steel and iron used.

Beginning with April, 1901, successive sections of the railroad have been opened to the public. The management of the freight and passenger traffic seems to be skillful, and an increasing amount of business being done, though the difficulties to be contended with are very great. For instance, a system of agencies has had to be established as go-betweens between the railroad and the public. The province which the railroad traverses is half as large as the kingdom of Prussia, the size of its population twice as great. The railroad forms the only means of ready communication with the interior. Much is hoped from the prospective traffic in petroleum, cotton, iron and rice. Eventually the road is to be connected with the Chinese Railroad System constructed under British auspices.

*Condensed from the Journal of German Railroad Directors for June 1, 1904.

### Kaw River Bridge of the Chicago Great Western and the Missouri Pacific.

The new bridge across the Kaw River at Kansas City for the joint use of the Chicago Great Western and the Missouri Pacific (Omaha line) was opened to traffic on May 24. This bridge replaces the old bridge of these two companies, which was wrecked in the flood of last year. The old structure was a combination wood and iron affair, with three spans of about 200 ft. each, resting on steel cylinder piers. The entire superstructure was destroyed and the channel piers were overturned. The new bridge occupies a site about 100 ft. north of the old one, there being two reasons for the change: Primarily the location was a better one in relation to the yards and terminals of the Great Western on both sides of the river, and, secondly, it avoided tearing out the abutments and other remains of the substructure of the old bridge. The new structure consists of three through pin-connected truss river spans 200 ft. long center to center of end pins, and a through plate-girder span at each end 80 ft. 1⅛ in. long, all on concrete piers. Piers 1 and 6, supporting the land ends of the girder spans, are steel cylinder piers on piling foundations, with concrete filling. The specifications required the piling to be driven to a depth of not less than 18 ft. below the bottom of the cylinder and to be cut off 16 ft. above the bottom. The sand inside the cylinders was required to be excavated so as to have a depth of not more




Details of Kaw River Bridge.

Kaw River Bridge, Chicago Great Western and Missouri Pacific, at Kansas City.

than 6 ft. above the bottom of the cylinder after the piles were driven.

In the original plans the foundations of piers 2 and 5 were to have been of the same design, namely, an open caisson with piles driven inside, and filled with concrete. But in sinking the caisson for No. 2, instead of the river silt which the soundings had indicated at that point, an old stone dyke 6 in. thick was encountered about 15 ft. below the surface of the water. Finding it impossible to get through this with the dredging apparatus on hand, the caisson was finally sunk to position by putting on a roof and employing the pneumatic process. The roof was then removed and the piles driven and concrete placed according to specifications. With pier 5, owing to difficulties encountered in sinking the open caisson and the shortness of the time remaining for the completion of the work, the contractor concluded to sink this pier also with a pneumatic caisson and it was carried down to bed rock.

Portal View, Kaw River Bridge.

Channel piers 3 and 4 were sunk by pneumatic caissons to bed rock. During the sinking of No. 4 a corner of the caisson had to be cut through the iron span of an up-river bridge which was wrecked by the flood. The metal was encountered in the loose silt a few feet below the bottom of the river, in about 20 ft. of water, and considerable difficulty was experienced and time consumed in getting through.

The superstructure is designed for a load of two 154-ton consolidation engines followed by a train load of 4,000 lbs. per lin. ft. of track. However, parts of the floor system which are especially affected by concentrated loads have been made about 25 per cent. heavier than the above loading would require in order to provide for possible future increase in loading. Otherwise the design follows generally adopted lines in the working out of details, presenting no special features to which to direct attention. The elevation of base of rail is 2.3 ft. above the high-water mark of last year. The total weight of the superstructure is 1,673,000 lbs. The last truss was swung from the false work on March 24 and the first train crossed 60 days later.

The bridge was designed and built for the joint owners by the Chicago Great Western. The substructure was built by the Kahman-McMurray Company, Kansas City. The steel work was furnished by the Pennsylvania Steel Company, and was erected by the Missouri Valley Bridge & Iron Company, Leavenworth, Kan.

We are indebted to Mr. A. Munster, Acting Chief Engineer, for blueprints and information.

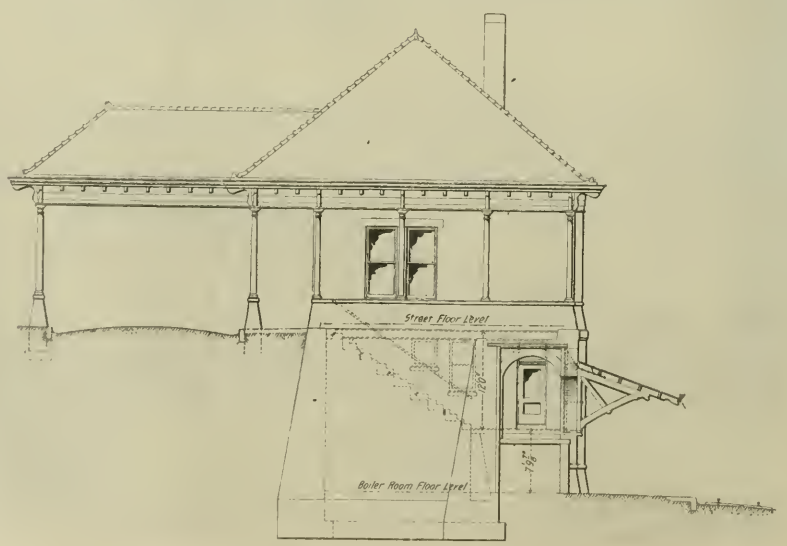
## New Station of the Lackawanna at Roseville Avenue, Newark.

In the description of the D., L. & W. improvements and change of grade on the Morris & Essex Division through Newark, N. J., which was given in the *Railroad Gazette*, November 25, 1903, mention was made of the new station which was to be built at Roseville avenue, and one of the illustrations showed the concrete retaining walls of the excavation in which the station will stand. From High street, about a mile west of the new Broad street station, the tracks are depressed in a concrete walled cut with overhead street bridges, and this depression continues out to the city limits of Newark. At Roseville avenue, the double-tracked Montclair branch turns off to the north and the M. & E. division continues on west with three tracks, one being used for express trains. The old station, which was a frame building, stood on the street level in the apex of the angle formed by the main line and the Montclair branch. The new station building, however, will be located on the eastbound track of the Montclair branch, about 400 ft. from the junction and the train platform running in front of it extends down to the angle formed by the retaining walls of the cut and around the corner along the westbound track of the main line. There is no shelter over the westbound platform of the Montclair branch, but a large enclosed shelter house will be built for the eastbound platform of the main line. Two stairways from each of the three isolated platforms give access from and exit to the street.

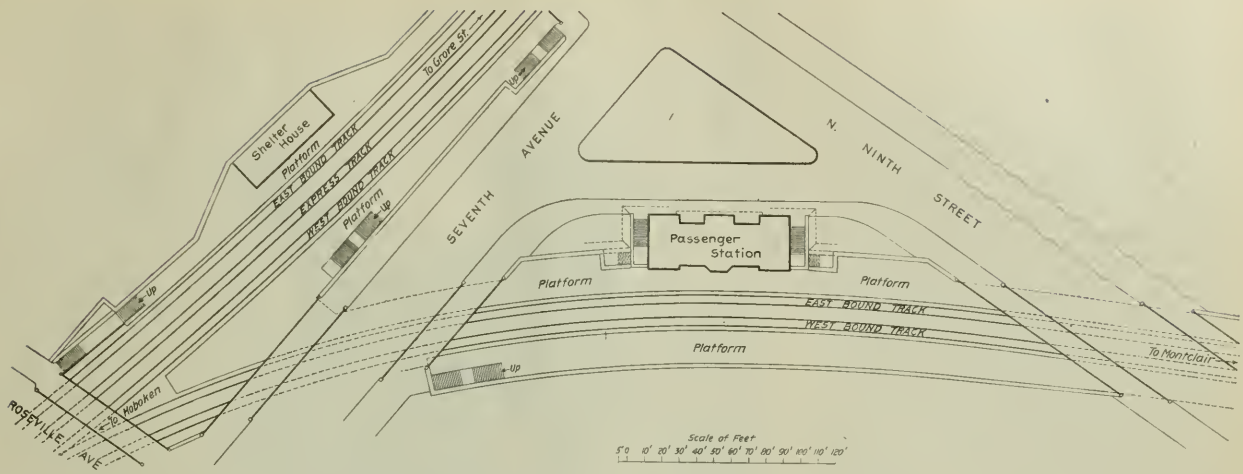
The station building, which is of brick, two stories high, is 103 ft. long and 30 ft. 6 in. wide. The platforms at the track level are 19 ft. below the surface of the street, and only one story of the building projects above ground. On the main floor, which is at the street level, are the main waiting room and ticket office, which occupy the center of the building, with the baggage room and ladies' waiting-room and toilet at either end. The entrance is from the plaza formed by Seventh avenue and North Ninth street, through three doors in the center of building. A covered portico shelters the entrance over the driveway and a canopy roof, supported on columns, extends around the three sides of the station. Broad covered stairways lead down to the train platforms at each end on the outside and two stairways lead down from the waiting-room on the street level to the other waiting-room on the lower floor. In the center of this room is the news stand, and leading off from the lower landing of one of the stairways is the men's waiting-room and toilet, which is located just below the ladies' room on the floor above. Under the baggage room is a storage room and shaft for the elevator which connects with the baggage room above. The back part of this lower floor is lighted and ventilated from two broad light wells or areaways built in the back wall. A canopy roof supported on brackets built in the wall of the building shelters the train platform in front of the station. Passengers taking trains either westbound on the Montclair branch or eastbound on the main line will purchase tickets in the waiting-room on the ground floor of the station and then walk over to the stairways leading down to these platforms from Seventh avenue and Roseville avenue.

Work on the retaining walls for the depressed tracks is nearly completed for their entire length, and the station is now in course of construction. It is expected to have the tracks in on the low level and the station ready for use before the end of this year.

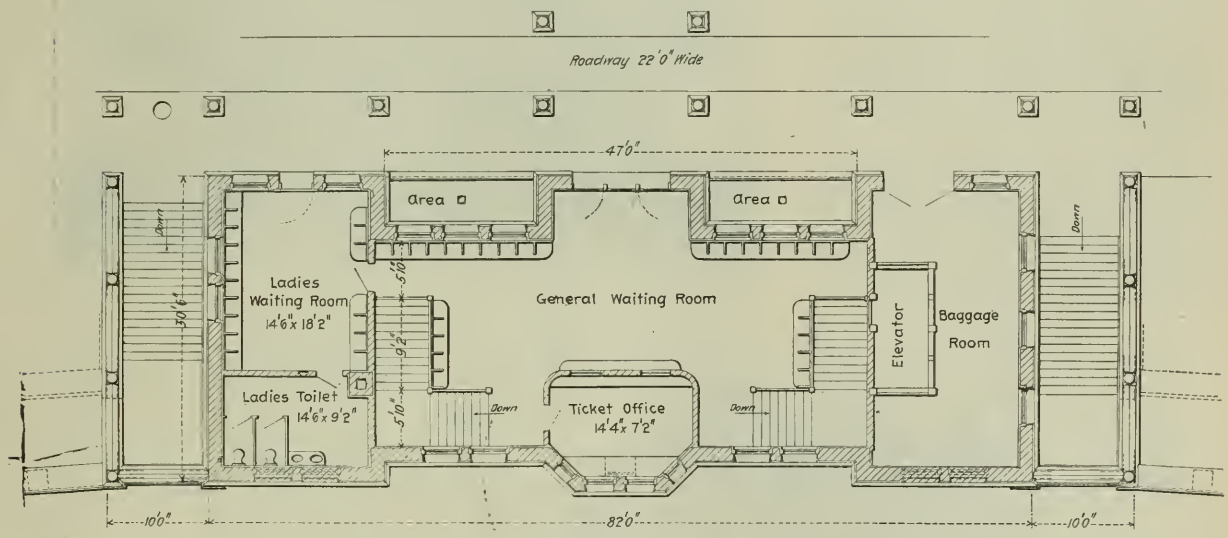
We are indebted to Mr. Lincoln Bush, Chief Engineer, for the drawings.



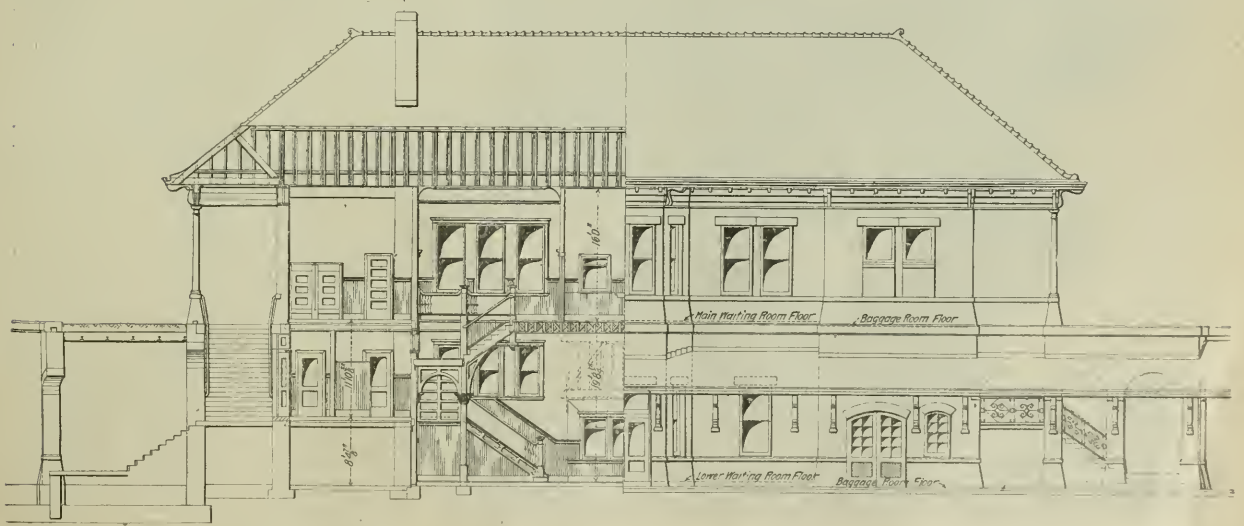

End Elevation of Roseville Avenue Station, at Newark.




General Plan of D., L. & W. Station at Roseville Avenue, Newark.




Street Floor Plan of Roseville Avenue Station—D., L. & W.




Longitudinal Section and Front Elevation of D., L. & W. Station at Roseville Avenue, Newark.

## Railroad Shop Tools.

(*Continued.*)

### BORING MILLS.

The 10-ft. boring and turning mill shown in Fig. 1 is made by the J. Morton Poole Company. This machine will take work 125 in. in diameter and 72 in. high under the cross rail and toolholders. The bed is cast in one piece and is braced with internal ribs. The uprights have a 14-in. face and are 11 ft. 2 in. high and are 50 in. deep at the bottom of the face. Each upright is secured to the bed by six 2-in. studs, and a stiff cross brace connects them at the top. The table is 96 in. in diameter by 8½ in. deep and is 30 in. above the floor; it has a flat annular bearing 4¾ in. wide at its extreme outer edge and is automatically lubricated. It has 24 table speeds in geometrical progression from four-tenths to twenty-four r.p.m., and is provided with 12 1¼-in. tee slots. The cone has three steps, 24, 22 and 20 in. in diameter for a 6-in. belt. Four rates of friction back gear are provided, giving ratios of 12, 36, 95 and 285 to 1; the back gears are in the bed and are protected from dirt and chips. Any back gear speed can be obtained without stopping the machine. Eight speeds in geometrical progression from ½ to 20 r.p.m. can be obtained. A Morse silent chain transmits the power from the cone pulley shaft or motor shaft to the back gear shaft.

The spindle is ground on dead centers and is bolted to the table; it rests on a step bearing at its lower end provided with taper wedge and adjusting screw for slightly elevating the table from its annular bearings when running at high speeds. The diameter of upper bearing is 18 in. and lower bearing is 14 in.; both are provided with adjustable boxes to take up wear and are supported in heavy bonnets bolted to the bed. Hindley worm gearing running in oil is used to drive the table; the worm wheel is 64 in. in diameter and the driving worm is 12 in. in diameter. Any adjustment or wear of the table bearing does not affect the alinement of the worm; the worm shaft is journaled in bronze bushings in the bed and the end thrust of the worm is taken by steel and bronze plates against a faced boss of the bed. Eight rates of horizontal, vertical or angular power feed in either direction can be obtained without stopping the mill, and independent feeds of 1/64 in., 1/32 in., 1/16 in., 1/12 in., ⅛ in., ¼ in., ½ in., and ⅔ in. per revolution of table are provided for each head. Feeds are reversed at the ends of the cross rail by means of friction hand wheels. Change gears for cutting thread are provided. Power traverse is provided for the cross heads and tool bars at a speed of 15 f.p.m. It is impossible to throw in the traverse and power feed at the same time. The usual hand wheels on cross heads for operating the tool bars are not required.

Belt driven mills have a pulley at the left side of the machine, which is driven at a constant speed from the countershaft. Motor-driven mills have a silent chain within the bed, which drives the traversing shaft from the back gear shaft. The cross rail is the box-girder form, 27½ in. high and 25 in. deep at the center and weighs complete 12,000 lbs. It is raised and lowered by power at a speed of 6⅔ f.p.m. The cross heads are made right and left, so that either head can be brought to the center for boring; they are entirely independent in their movements, both as to direction and amount of feed and can be set at any angle up to 45 deg. in either direction. The tool bars have a vertical feed of 42 in. Either head can

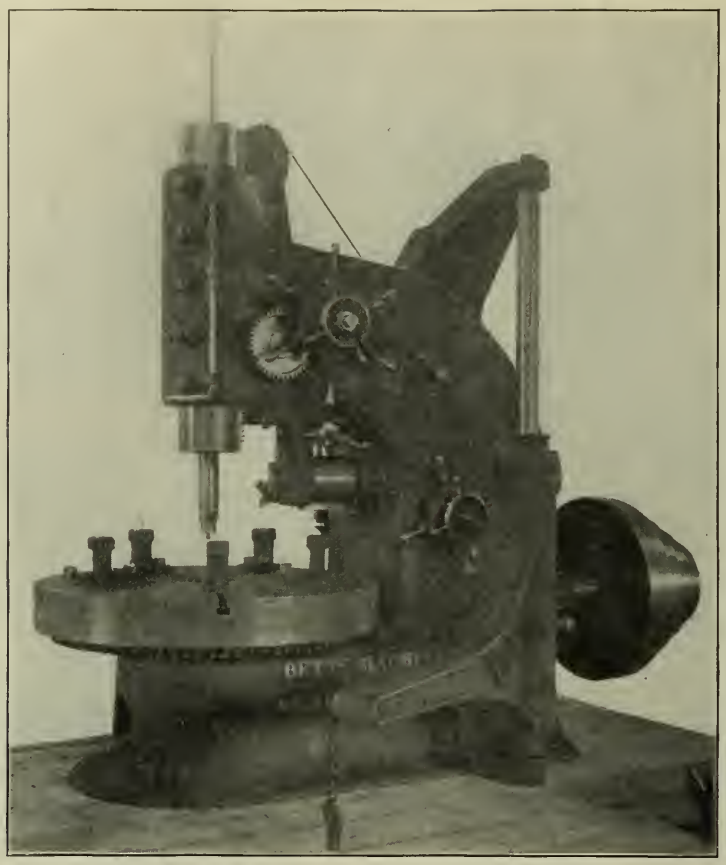


Fig. 4—The Betts 52-in. Car Wheel Boring Machine.

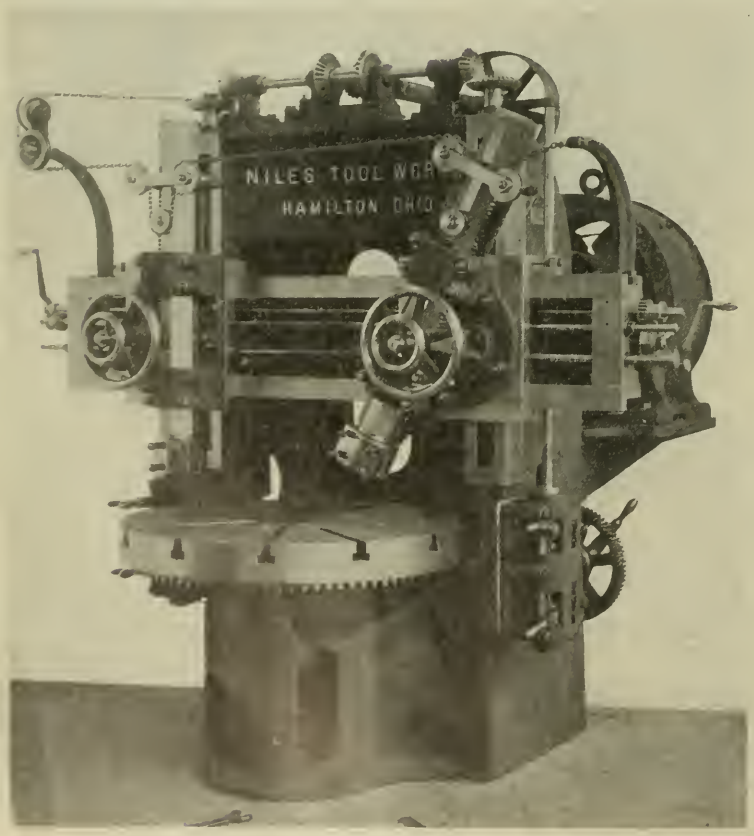



Fig. 1—The Poole 10-ft. Boring Mill.

be furnished with a revolving spindle. The countershaft has two friction pulleys 22 in. in diameter for a 6-in. belt and should run at 144 and 240 r.p.m. The floor space required for the machine is 10 ft. 6 in. x 16 ft. 3 in., and the net shipping weight is 63,000 lbs.

The illustration, Fig. 2, shows the general arrangement of the driving mechanism. The worm wheel has 96 teeth, 2.06 in. pitch and the outside diameter is 64 in. The steel driving worm has eight threads. Gears G and H, which are keyed to their shaft, drive the loose friction gears A and E. The driven chain gear T runs freely at the side of G and carries the pinion L, which drives the back gears U, S and R, the latter being loose on the shaft. The chain gear can drive the back gear shaft direct if the friction clutch between G and T is operated, or a back gear ratio of eight to one can be obtained by engaging the clutch O, which is keyed to the shaft, with the hub of gear R. These four back gear ratios and the two-speed countershaft give eight table speeds without shifting the cone belt. When the mill is motor driven the motor takes the place of the cone pulley and a speed reduction of 50 per cent. by any system of control gives the entire range of table speeds.

The 32-in. boring mill shown in Fig. 3 is made by the Rogers Machine Tool Company. This mill will take work 32 in. in diameter and 15½ in. high. The driving mechanism is fitted with a single pulley drive. The feeds are positive and all operating handles are convenient to the operator. Automatic trips are provided for the horizontal and vertical feeds. The head can be swiveled 30 deg. either way from the center. A five-hole turret is fitted to the tool stake. The adjustment and wear is taken up by means of taper gibs. The mills are usually fitted with a three-jaw chuck. A plain table or a four-jaw chuck is furnished when desired. The weight of this machine is 5,600 lbs.

The 52-in. car wheel boring mill made by the Betts Machine Company is shown in Fig. 4. The facing head of this machine is supported close to cut, and it is constructed so that it can be slid back entirely out of the way when chucking the wheels. The chuck is 52 in. in diameter; it has five jaws, which are universal and independent, and readily adjustable for wheels of any size from 42 in. diameter to 10 in. diameter, inclusive. Eight changes of speed are obtained by means of two speeds on the countershaft, arranged so that the change from boring to facing is done without moving the cone belt. The countershaft also has a powerful friction brake, enabling the operator to make rapid changes. The boring spindle has 25 in. travel, and is counterbalanced. The boring spindle and facing head are each provided with six automatic feeds, arranged so that the change from roughing to finishing can be made instantly, and without stopping the machine. A rapid hand movement is also provided for each. The facing head slide has a 7-in. travel and it is provided with a square guide. A power crane operated either by a belt or compressed air is attached to the machine. The weight of the machine is 17,000 lbs. All of the gears are cut from the solid.

*(To be continued.)*

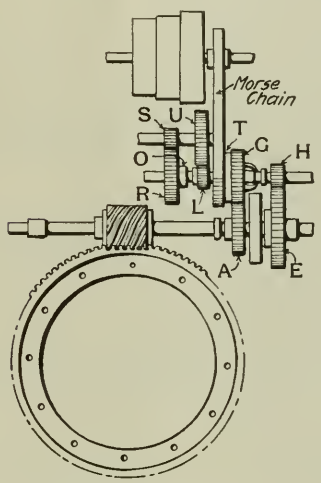



Fig. 2—General Arrangement of Driving Mechanism on the Poole Mill.

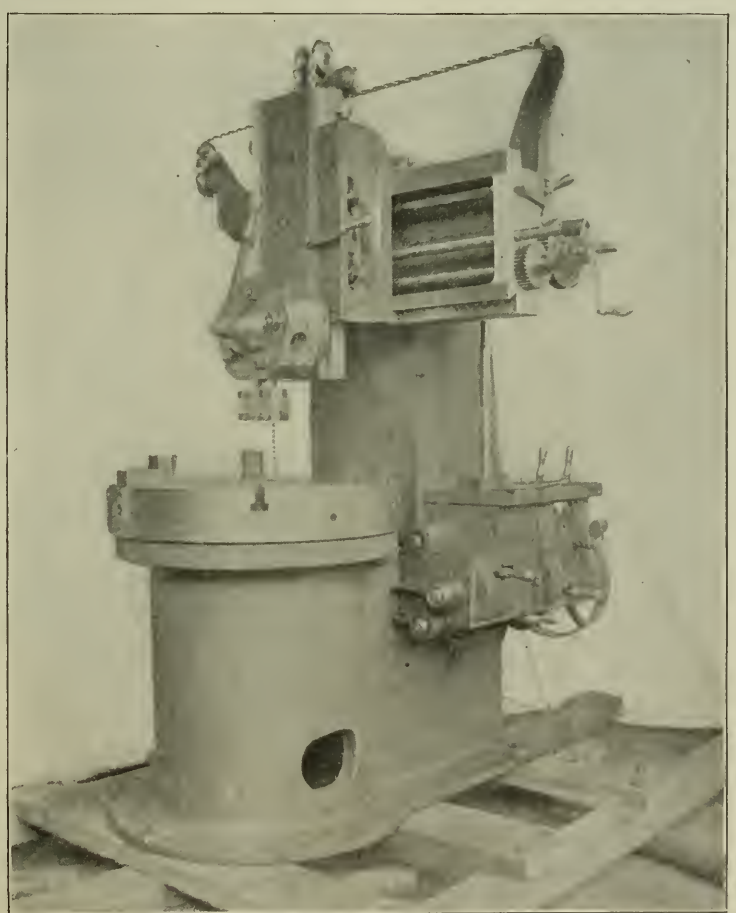


Fig. 3—The Rogers 32-in. Boring Mill.

## Locomotive Tests of the Pennsylvania at St. Louis.

The first part of Bulletin No. 3 issued by the Pennsylvania was published in the *Railroad Gazette* last week. The remainder of the bulletin follows:

OBSERVED DATA.

196. Duration of test, hours.....

*Speed.*

197. Total revolutions .....
198. Average revolutions per minute.....
199. Equivalent speed in miles per hour.....
200. Equivalent piston speed in feet per minute...

*Position of Levers.*

201. Reverse lever, notches from front end.....
202. .....
203. Throttle lever .....
204. .....
205. .....

*Temperature, Degrees Fahrenheit.*

206. Of smoke-box, by thermometer.....
207. Of smoke-box, by pyrometer.....
208. Of laboratory, dry bulb.....
209. Of laboratory, wet bulb.....
210. Of steam in branch pipe.....
211. Of feed water.....
212. Of fire-box, by pyrometer.....
213. .....
214. .....
215. .....
216. .....

*Pressure, Pounds per Square Inch.*

217. In boiler, average .....
218. In boiler, maximum .....
219. In boiler, minimum .....
220. In branch pipe .....
221. In laboratory, barometric .....

*Draft, Inches of Water.*

222. In smoke-box, front of diaphragm.....
223. In smoke-box, back of diaphragm.....
224. In fire-box .....
225. In ash pan .....

*Injectors.*

Hours in action.

226. Total, right .....
227. Total, left .....

*Quality of Steam.*

228. In dome .....
229. In branch pipe .....
230. Degrees of superheat in branch pipe.....
231. .....

*Coal, Sparks and Ash.*

232. Coal fired, kind .....
233. Coal fired, total, pounds.....
234. Coal as fired, per cent. of moisture.....
235. Dry coal fired, total, pounds.....
236. Combustible, by analysis, total, pounds.....
237. Ash, by analysis, total, pounds.....
238. Cinders collected in smoke-box, total, pounds.
239. Sparks discharged from stack, total, pounds.
240. Cinders and sparks, total, pounds.....

*Analysis of Coal.*

241. Fixed carbon, per cent.....
242. Volatile matter, per cent.....
243. Moisture, per cent.....
244. Ash, per cent.....
245. Sulphur determined separately, per cent.....
246. .....
247. .....

*Calorific Value in B. T. U., per lb.*

248. Of dry coal .....
249. Of combustible .....
250. Of cinders and sparks.....
251. .....
252. .....

*Analysis of Smoke-Box Gases.*

253. Oxygen—O, per cent.....
254. Carbon monoxide—CO, per cent.....
255. Carbon dioxide—$CO_2$, per cent.....
256. Nitrogen—N, per cent.....
257. .....
258. .....

*Water, in Pounds.*

259. Delivered to injectors.....
260. Lost, from boiler .....
261. Lost, from .....
262. Lost, from .....
263. Lost, total .....
264. Delivered to boiler and presumably evaporated

*Dynamometer.*
Pull in pounds.

265. Average .....
266. Maximum .....
267. Minimum .....

*Cut-off, Per Cent. of Stroke.*

268. High pressure cylinder, right, head end.....
269. High pressure cylinder, right, crank end....
270. High pressure cylinder, left, head end.....
271. High pressure cylinder, left, crank end.....
272. Low pressure cylinder, right, head end.....
273. Low pressure cylinder, right, crank end.....
274. Low pressure cylinder, left, head end.....
275. Low pressure cylinder, left, crank end.....

*Release, per Cent. of Stroke.*

276. High pressure cylinder, right, head end.....
277. High pressure cylinder, right, crank end....
278. High pressure cylinder, left, head end.....
279. High pressure cylinder, left, crank end.....
280. Low pressure cylinder, right head end.....
281. Low pressure cylinder, right, crank end.....
282. Low pressure cylinder, left, head end.....
283. Low pressure cylinder, left, crank end.....

*Beginning of Compression, Per Cent. of Stroke.*

284. High pressure cylinder, right, head end.....
285. High pressure cylinder, right, crank end....
286. High pressure cylinder, left, head end.....
287. High pressure cylinder, left, crank end.....
288. Low pressure cylinder, right, head end.....
289. Low pressure cylinder, right, crank end.....
290. Low pressure cylinder, left, head end.....
291. Low pressure cylinder, left, crank end.....

*Pressure from Indicator Cards.*
Initial pressures, pounds per sq. inch.

292. High pressure cylinder, right, head end.....
293. High pressure cylinder, right, crank end....
294. High pressure cylinder, left, head end.....
295. High pressure cylinder left, crank end.....
296. Low pressure cylinder, right, head end.....
297. Low pressure cylinder, right, crank end.....
298. Low pressure cylinder, left, head end.....
299. Low pressure cylinder, left, crank end.....
300. .....

*Steam Chest Pressures, Pounds per Sq. In.*

301. High pressure, right side.....
302. High pressure, left side.....
303. Low pressure, right side.....
304. Low pressure, left side.....
305. .....

*Pressures at Cut-off, Pounds per Sq. Inch.*

306. High pressure cylinder, right, head end.....
307. High pressure cylinder, right, crank end....
308. High pressure cylinder, left, head end.....
309. High pressure cylinder, left, crank end.....
310. Low pressure cylinder, right, head end.....
311. Low pressure cylinder, right, crank end....
312. Low pressure cylinder, left, head end.....
313. Low pressure cylinder, left, crank end.....

*Pressures at Release, Pounds per Sq. In.*

314. High pressure cylinder, right, head end.....
315. High pressure cylinder, right, crank end....
316. High pressure cylinder, left, head end.....
317. High pressure cylinder, left, crank end.....
318. Low pressure cylinder, right, head end.....
319. Low pressure cylinder, right, crank end....
320. Low pressure cylinder, left, head end.....
321. Low pressure cylinder, left, crank end.....

*Pressures at Beginning of Compression, Pounds per Sq. Inch.*

322. High pressure cylinder, right, head end.....
323. High pressure cylinder, right, crank end.....
324. High pressure cylinder, left, head end.....
325. High pressure cylinder, left, crank end.....
326. Low pressure cylinder, right, head end.....
327. Low pressure cylinder, right, crank end.....
328. Low pressure cylinder, left, head end.....
329. Low pressure cylinder, left, crank end.....

*Least Back Pressure, Pounds per Sq. Inch.*

330. High pressure cylinder, right, head end.....
331. High pressure cylinder, right, crank end....
332. High pressure cylinder, left, head end.....
333. High pressure cylinder, left, crank end.....
334. Low pressure cylinder, right, head end.....
335. Low pressure cylinder, right, crank end.....
336. Low pressure cylinder, left, head end.....
337. Low pressure cylinder, left, crank end.....

SUMMARY OF AVERAGE RESULTS.

*Boiler.*

338. Dry coal fired, per hour, pounds.....
339. Dry coal fired, per hour, per sq. ft. of grate surface, pounds .....

*Evaporation, Pounds.*

340. Moist steam per hour.....
341. Dry steam per hour .....
342. Dry steam per hour, per sq. ft. of heating surface .....
343. Dry steam per hour, per pound of dry coal..

*Equivalent Evaporation from and at 212 Degrees F.*

344. Per hour, pounds .....
345. Per hour, per sq. ft. of heating surface, pounds .....
346. Per pound of coal as fired, pounds.....
347. Per pound of dry coal, pounds.....
348. Per pound of combustible, pounds.....
349. Boiler horse power .....
350. Efficiency of boiler.....

SUMMARY OF AVERAGE RESULTS—ENGINE.

*Mean Effective Pressure, Pounds per Sq. Inch.*

351. High pressure cylinder, right, head end.....
352. High pressure cylinder, right crank end.....
353. High pressure cylinder, left, head end .....
354. High pressure cylinder, left, crank end.....
355. Low pressure cylinder, right, head end.....
356. Low pressure cylinder, right, crank end.....
357. Low pressure cylinder, left, head end. ...
358. Low pressure cylinder, left, crank end.....

*Receiver.*

359. Pressure right side .....
360. Pressure left side .....

*Number of Expansions.*

361. Right side, head end.....
362. Right side, crank end.....
363. Left side, head end.....
364. Left side, crank end.....

*Indicated Horse Power.*

365. High pressure cylinder, right, head end.....
366. High pressure cylinder, right, crank end....
367. High pressure cylinder, left, head end.....
368. High pressure cylinder, left, crank end.....
369. Low pressure cylinder, right, head end.....
370. Low pressure cylinder, right, crank end.....
371. Low pressure cylinder, left, head end.....
372. Low pressure cylinder, left, crank end.....

*Division of Power.*

373. High pressure cylinder, right side.....
374. High pressure cylinder, left side.....
375. Low pressure cylinder, right side.....
376. Low pressure cylinder, left side.....
377. Right side, total .....
378. Left side, total .....
379. Total .....

*Per I. H. P. per Hour.*

380. Dry coal, pounds .....
381. Dry steam, pounds.....
382. B. T. U. .....

SUMMARY OF AVERAGE RESULTS—LOCOMOTIVE.

383. Dynamometer horsepower.
384. Dry coal per D. H. P. per hour, pounds.....
385. Dry steam per D. H. P. per hour, pounds....
386. B. T. U. per D. H. P. per hour, pounds.....

*Per One Million Foot Pounds at Drawbar.*

387. Dry coal, pounds .....
388. Dry steam, pounds .....
389. B. T. U. .....
390. I. H. P. per square foot of heating surface..
391. I. H. P. per square foot of grate surface....
392. D. H. P. per square foot of heating surface..
393. D. H. P. per square foot of grate surface....
394. Tractive Power based on M. E. P., pounds..

*Machine Friction of Locomotive in Terms of,*

395. Horse power .....
396. M. E. P., pounds.....
397. Drawbar pull, pounds.....

*Efficiency.*

398. Machine efficiency of locomotive, per cent...
399. Efficiency of locomotive, per cent.....

*Ratios.*

400. Total weight of locomotive to maximum I. H. P.....
401. Total heating surface to maximum I. H. P...
402. .....
403. .....
404. .....
405. .....
406. .....
407. .....

SUMMARIZED STATEMENT OF AVERAGE RESULTS.

196. Duration of test hours.....
198. Number of revolutions per minute.....
199. Speed in miles per hour.....
268 to 271. Approximate cut-off in high pressure cylinder, in per cent. of stroke.....
203. Position of throttle.....
217. Boiler pressure in pounds per sq. in.....
220. Branch pipe pressure in pounds per sq. in...
222. Draft in front of diaphragm, inches of water
338. Dry coal fired per hour, pounds.....
341. Dry steam used per hour, pounds.....
344. Equivalent number of pounds of water from and at 212 deg. F. per pound of dry coal..
379. Indicated horse power .....
383. Dynamometer horse power .....
395. Frictional horse power .....
265. Drawbar pull, pounds.....
380. Dry coal per I. H. P. per hour, pounds.....
384. Dry coal per D. H. P. per hour, pounds.....
381. Dry steam per I. H. P. per hour, pounds....
385. Dry steam per D. H. P. per hour, pounds....
350. Efficiency of boiler .....
399. Efficiency of locomotive.....

OBSERVED DATA.

All instruments will be read at intervals of ten minutes during the test. Observations of the more important facts will be taken by two methods, and all calculations will be carefully checked.

Item No. 196. The locomotive will be gradually brought to the required conditions of speed and drawbar pull, and after it has been running under these conditions for a sufficient time to secure uniformity in the rate of firing and to allow all parts to come to their normal working condition, the test will be started.

The heavy power tests will continue until 30 lbs. of water have been evaporated per sq. ft. of heating surface, the lighter power test being stopped at the end of four to six hours.

The duration of test, given in hours and decimals of an hour, is the elapsed time from the start as given above to the close of test.

Item No. 197. A return crank, attached to the rear pair of drivers, is connected to a rotating revolution counter, which will be read at the beginning and end of test, and every ten minutes as well. A reciprocating revolution counter is connected with the corresponding supporting axle. From the diameters of the driving wheel and supporting wheel, a factor will be obtained by which the number of revolutions shown on supporting wheel counter can be compared with the number shown by driving wheel counter.

A tachometer will also be driven by the supporting axle, and this will provide a check for the average revolutions.

Item No. 206. For the smoke-box temperature a thermometer with carbon dioxide above the mercury will be used as a check on the indications of the pyrometer.

Items Nos. 207 and 212. Le Chatelier couples and a galvanometer reading to millivolts, will give the smoke-box and fire-box temperatures.

The couple in the smoke-box will remain in position; the couple in the fire-box will be inserted through an opening in the side, about midway of its length, and at a height above the bed of coal of about 12 in. After it has been in position with the fire door closed a sufficient time to assume the temperature of the fire-box, readings will be taken and the couple withdrawn from fire-box.

Item No. 210. The temperature of the steam in branch pipe will be calculated from the observed pressure of steam in same and from the observed pressure and temperature of the steam in the calorimeter connected to the branch pipe.

Item No. 211. The feed water temperature will be taken in the receiving tank.

Items Nos. 217, 218, 219 and 220. Steam pressures will be obtained by special test gages; the gage for indicating boiler pressure will be located on the steam dome on the calorimeter pipe connection, and the gage for branch pipe outside of smoke front, connected to branch pipe by as short a pipe as possible. The pressure gage located in pipe from boiler or branch pipe and leading to throttling calorimeter will be read (after the other calorimeter readings have been taken) with the valve between boiler or branch pipe and calorimeter closed on account of the drop in pressure in the pipe leading to the calorimeter while that valve is open.

Item No. 221. The barometric pressure will be measured by use of a mercurial barometer, readings being corrected for temperature, and readings in inches of mercury converted into pounds per square inch.

Items Nos. 222 to 225. The draft will be measured by "U" tube draft gages, the readings of which will be checked by recording draft gages of an approved type.

Items Nos. 228, 229 and 230. The quality of steam in dome and branch pipe will be obtained by Peabody throttling calorimeters, provided with mercurial gages reading to tenths of pounds, and thermometers reading to half degrees.

The quality of steam, and degrees of superheat, for the throttling-calorimeter, will be calculated as follows:

Let $x$ = the "quality of the steam" or the number of pounds of "dry" ("saturated") steam of the same boiler pressure per square inch and containing the same quantity of heat as one pound of steam under test. $x$ therefore may be greater or less than unity according as the steam is superheated or moist and equal unity when that steam is dry or saturated.

$\lambda$ = Total heat of dry steam due to the absolute boiler pressure.

r = Latent heat of dry steam due to the absolute boiler pressure.

q = Heat of the liquid due to the absolute boiler pressure.

$r + q = \lambda$.

$\lambda_1$ = The "total heat" of dry steam due to the absolute pressure in the calorimeter.

$t_1$ = The temperature due to saturated steam at calorimeter pressure.

$t_s$ = The temperature of the steam in the calorimeter in any case.

$t_{s_0}$ = The temperature of the steam in

the calorimeter in case the steam in the boiler is dry.

k° = The number of degrees of superheat in case of superheated steam.

The following formula is then derived on the assumption that no heat is lost by the steam in its passage from the boiler to the calorimeter, and that 0.48 is the "specific heat" of steam.

$$xr + q = \lambda_1 + .48\,(t_s - t_1)$$

consequently, the quality of steam, Items Nos. 228 and 229, is

$$x = \frac{\lambda_1 + .48\,(t_s - t_1) - q}{r} \quad \ldots\ldots(1)$$

The steam under test is dry (saturated) when $x = 1$ and in that case, $t_s$ becoming $t_{s_0}$ as defined above,

$$t_{s_0} = \frac{(r + q) - \lambda_1 + .48\,t_1}{.48} = \frac{\lambda - \lambda_1 + .48\,t_1}{.48};$$

so that when the temperature $t_s$ in the calorimeter is higher than $t_{s_0}$ or that due to dry steam, the steam is superheated and the number of degrees of superheat, Item No. 230, will be $t_s - t_{s_0} = k°$

$$k° = t_s - \frac{\lambda - \lambda_1 + .48\,t_1}{.48} = \frac{\lambda_1 + .48\,(t_s - t_1) - \lambda}{.48}$$
$$= \frac{(x - 1)\,r}{.48} \quad \ldots\ldots(2)$$

When the temperature in the calorimeter is less than $t_{s_0}$, the priming is $(1-x)$, $x$ being found as per formula above given. If, however, $t_s$ drops to $t_1$ the limit of the calorimeter is reached and $x = x_0 = \frac{\lambda_1 - q}{r}$ at most, and the priming $(1 - x_0) = 1 - \frac{\lambda_1 - q}{r}$

$= \frac{\lambda - \lambda_1}{r}$ at least.

Therefore, for any case where $t_1$ is equal to $t_s$, the priming is equal to or greater than the capacity of the calorimeter, and to determine such greater amount of priming, Carpenter's separating calorimeter, also attached to the dome on the same connection will be used whenever the temperature in the calorimeter falls close to, or to within, say, 5° of the limit referred to.

In this case, the quality $x$ is determined as described by Carpenter in his "Text Book of Experimental Engineering," or as follows:

Let $w$ = Weight of dry steam discharged at the exhaust orifice of the calorimeter, the amount being known from calibration to agree very approximately with Napier's Rule, namely, "The flow in pounds per second" = $^1/_{70}$ part of the product obtained by multiplying the pounds per square inch absolute pressure in calorimeter by the area of the orifice in square inches.

W = Weight of the water drawn from the separator of the calorimeter.

R = Weight of the water of condensation in the calorimeter, due to radiation from the same.

And if we now call $W_1$ the portion of W left after deducting the radiation, the weight of dry steam that would have been discharged had there been no radiation, is $w + R$ and the total steam and water delivered to the calorimeter is

$$(W_1 + R) + w = W + w, \quad \text{so that}$$
$$x = \frac{w + R}{W_1 + R + w} = \frac{w + R}{W + w}$$

If the radiation is neglected, $x = \frac{w}{W + w}$ .....(3)

which with the instrument provided will be considered correct, as the radiation loss is very small.

The "quality of steam" being thus determined, the "correction for quality of steam" is found as follows:

Let F = "The factor of correction for quality of steam" desired.

Let $x$, $\lambda$, r and q stand for the same quantities as in the above formula for the quality of the steam.

$q_1$ = "Heat of the liquid" due to the feed water, the temperature of which will be observed.

Then the amount of heat actually added to each pound of feed water, making steam of quality $x$, is

$$x\lambda + (1 - x)\,q - q_1 \text{ or } x\,(\lambda - q_1) + (1 - x)\,(q - q_1)$$

and $(\lambda - q_1)$ is the amount of heat that would have been required by each pound of the same feed water to make dry steam at same pressure.

Consequently, the amount of dry steam equivalent to one pound of the actual mixture (*i. e.*, the amount of dry steam requiring for its generation the same supply of heat as that actually supplied to each pound of feed water) is

$$F = \frac{\lambda + x\,(1 - x)\,q - q_1}{\lambda - q_1} =$$
$$\frac{x\,(\lambda - q_1) + (1 - x)\,(q - q_1)}{\lambda - q_1} =$$
$$x + (1 - x)\,\frac{q - q_1}{\lambda - q_1} \quad \ldots\ldots(4)$$

Formula (3) is the general one for F and may be used in any case but when the steam is superheated, $x$ is greater than unity, consequently more convenient will be

$$F = x - (x - 1)\,\frac{q - q_1}{\lambda - q_1} \quad \ldots\ldots(4a)$$

and as the degrees of superheat are known from the formula (2) for degrees of superheat, the simpler formula

$$F = 1 + \frac{48\ k°}{\lambda - q_1} \quad \ldots\ldots(4b)$$

may be used, that is, of the formulæ (4), (4a), and (4b) each one gives the same value for "the factor F of correction for quality of steam."

In case observations are made of the actual temperature T and of the pressure p of the superheated steam itself, the degrees of superheat will be more directly obtained by subtracting from this T the t given in Peabody's steam tables corresponding to the pressure p. The value of F in that case is also more directly obtained from

$$F = \frac{(\lambda - q_1) + .48k°}{\lambda - q_1} = 1 + \frac{.48k°}{\lambda - q_1} \quad \ldots(5)$$

as already given.

Item No. 232. All coal used will be furnished by one mine throughout the entire period of the tests, precautions being taken to have it as uniform as possible.

Items Nos. 233 and 234. The coal will be brought to the testing plant loaded in boxes containing approximately 1,000 lbs. These boxes will be moved by the traveling crane, as needed, to a calibrated platform scale, weighed, and the coal box moved to firing platform and the coal dumped. After dumping and before sprinkling, if this is necessary, a small sample will be taken and placed in a covered box, so located that the coal contained will not be exposed to heat. The empty box will then be weighed on the platform scale, and the difference of the gross and tare weights so obtained will give the coal used; the amount set aside as sample being subtracted from the actual total coal charged to the boiler. The amount of water used in sprinkling coal will be noted and correction made if necessary.

The coal taken as a sample will be crushed to the size of an almond, and reduced, by quartering, to about 15 lbs. weight. The latter will be weighed on an accurate balance, and dried by an electric heater until loss of weight ceases; the loss in weight will be considered as the moisture contained in the coal as fired.

Item No. 235. The total dry coal fired will be obtained by deducting from the total coal fired the weight of moisture.

Items Nos. 236 and 237. Both of these quantities will be found by analysis, because the draft in a locomotive fire-box is so great as to draw a part of the ashes through the flues and give incorrect data if actual weights were taken. If the ash is found by analysis, the combustible must necessarily be obtained in the same manner.

Item No. 238. The smoke-box front will be cleaned at the beginning of test and at close, and the quantity of cinders which have collected during the test will be weighed by an accurate scale.

Item No. 239. The stack, by which the smoke will be removed from the building, is provided with a deflector and a receptacle into which the sparks which strike the deflector will fall. This receptacle will be cleaned at commencement of test and at close, the sparks which have been collected during the test being carefully weighed.

Items Nos. 241 to 246. The analysis of the coal will be made in accordance with the method decided on by the Committee of the American Chemical Society, and given in Volume 21, No. 12, of their Journal.

Items Nos. 248 to 250. The calorific value of the coal and cinders and sparks will be determined in the Thompson calorimeter.

Items Nos. 253 to 256. The analysis of smoke-box gases will be conducted by the use of the Orsat apparatus.

Item No. 259. The water used by the boiler will pass through two calibrated water meters to two steel measuring tanks holding about 1,500 lbs. of water each; and from thence to a receiving tank holding about 17,000 lbs. of water.

The measuring tanks rest on calibrated platform scales, so that their capacities can be calibrated at frequent intervals, correction being made for temperature.

To obtain the total water delivered to injectors, the number of times each tank is emptied will be multiplied by their calibrated capacities at the average temperature of water during the test, and the fractional part of tank weighed out at close, added.

At the beginning of test the level of water in the boiler and receiving tank will be noted; the levels of water in both will be kept slightly below these levels during the test. At the close sufficient water will be fed into the receiving tank to restore the initial level. The level in the boiler will be noted, and when not the same as at the start, a correction will be made.

The quantities found by the measuring tanks are checked by two meters. Provision being made to catch and measure the small amount of water wasted in filling the tanks, the meter readings less this waste will be a check on the quantity delivered by the measuring tanks.

Items Nos. 260 to 263. The water which escapes from the injector overflow pipes will be caught and returned to receiving tank; and no credit will be given the boiler for the rise in temperature, if any, of this water.

Great care will be taken to prevent leakage from the boiler; the air pump and steam heat throttles will be disconnected so that leakage may be detected and the throttles made tight.

Leakage tests, when necessary, will be made on boiler after close of test, due allowance being made for change of temperature of water.

Item No. 265. The pull exerted by the locomotive will be measured by a traction dynamometer, already described in Bulletin No. 2.

The pen on the dynamometer will give a

continuous record of the drawbar pull, which will be measured at ten-minute intervals; the average of these measurements to the scale of springs used will give the average drawbar pull.

An integrating attachment records the square inches of the area included between the line of zero pull, or the base line, and the line of drawbar pull; this area, divided by the length of diagram will give the average height and provides a check for the mean height obtained in the method first described.

Items Nos. 266 and 267. The maximum and minimum drawbar pull will be found by measuring the diagram after the test, or will be registered by an automatic attachment.

Items Nos. 268 to 291. The percentages of stroke, at which cut-off, release, and beginning of compression take place, will be determined by locating on each card the points at which these events occur. This will be done by the same method throughout the entire series of tests.

The length of each indicator card will be measured and an average obtained for cards for each end of each cylinder; the length of stroke up to the time cut-off takes place will be measured and averaged in a similar manner. The percentage that this average length of cut-off forms of the average length of card, will be the result on the data sheet. The percentage of stroke at which the other events mentioned take place will be calculated in a similar manner.

Items Nos. 292 to 299 and 306 to 329. The points showing the events of the stroke on indicator card at which pressures are measured, are described in the preceding paragraph, with the exception of the point representing the initial pressure, which also will be measured.

The pressures of steam corresponding with the several events of stroke in cylinder, as shown by the indicator card, will be measured by appropriate scale, and the results for each end of each cylinder averaged for each event. The average thus obtained will be corrected for the error of the spring under the conditions and pressure, *i. e.*, whether under increasing or decreasing pressure.

Items Nos. 301 to 304. Indicator cards will be taken from indicator on steam chest, the pressure given is the average pressure of these cards.

Items Nos. 330 to 337. The least back pressure will be measured in the same way as the pressures under Items Nos. 292 to 299, and the results averaged.

The exact location on the card of the point of least back pressure will vary somewhat on different cards of the same test, but the least back pressure will be taken without regard to exact location.

SUMMARY OF AVERAGE RESULTS.

*Boiler.*

Items Nos. 340 and 341. The "moist steam per hour," Item No. 340, is the average water evaporated by boiler per hour uncorrected for moisture in steam, while "dry steam per hour," Item No. 341, is corrected for moisture by multiplying No. 340 by the "factor (F) of correction for quality of steam."

Item No. 344. The equivalent evaporation from and at 212 deg., pounds per hour, is found by multiplying the dry steam per hour, Item No. 341, by the factor of evaporation.

The factor of evaporation $= \frac{\lambda - q_1}{965.8}$ when

$\lambda$ = total heat of steam at observed pressure.

$q_1$ = Heat of feed-water at observed temperature.

Item No. 346. The equivalent evaporation from and at 212 deg., per lb. of coal as fired, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of coal as fired, Item No. 238 ÷ Item No. 196.

Item No. 347. The equivalent evaporation from and at 212 deg. per pound of dry coal, is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of dry coal, Item No. 338.

Item No. 348. The equivalent evaporation per pound of combustible is found by dividing the equivalent evaporation per hour, Item No. 344, by the weight per hour of combustible, Item No. 236 ÷ Item No. 196.

Item No. 349. The boiler horse-power will be found by dividing the equivalent evaporation per hour, No. 344 by 34.5.

Item No. 350. The efficiency of the boiler is found by multiplying the equivalent evaporation per pound of dry coal, No. 347, by 965.8, and dividing the product by No. 248, the number of thermal units in one pound of dry coal.

No credit is given the boiler for heat units used in evaporating moisture contained in fuel as fired.

*Engines.*

Items Nos. 351 to 358. All indicator cards will be integrated twice by different computers.

After the average mean effective pressure of the indicator cards for each end of each cylinder has been ascertained, the card most nearly approximating the average. will be selected to represent the test. In case these cards are subject to correction, resulting from a calibration of the indicator spring, the following method will be used:

Vertical lines dividing the length of card into ten or twelve equal parts will be drawn. At the points where these lines intersect the lines of the card, the card will be corrected (correction curves having been made for each spring); if an increasing pressure, for the error of the spring under similar conditions, if descending, in like manner. A new card will be drawn through the points thus located and the relation of the area of the rectified to the actual card will give a factor which will be used in finding the corrected M. E. P.

The corrected average area of card, divided by the average length of card, and multiplied by the scale of spring used, will give the mean effective pressure.

Items Nos. 359 and 360. Receiver pressure on compound locomotives will be observed by gages attached as closely as possible to the receivers.

Items Nos. 361 to 364. The number of expansions, for simple locomotives, will be found by dividing the volume at release plus the volume of clearance, by the volume at cut-off plus the volume of clearance. For head end of right cylinder, on simple locomotives,

Number of expansions

$$= \frac{\text{No. 276} \times \text{No. 188} + \text{No. 40} \times \text{No. 188}}{\text{No. 268} \times \text{No. 188} + \text{No. 40} \times \text{No. 188}} = \frac{\text{No. 276} + \text{No. 40.}}{\text{No. 268} + \text{No. 40.}}$$

The formula for the other items are similar in form, with the corresponding percentage of stroke substituted.

For compound locomotives, the form of the expression used is as follows, but until the path followed by the steam is known for each locomotive, formulæ cannot be given.

$$\frac{\text{Volume at Release, L. P. Cylinder + Volume of Clearance L. P. C.}}{\text{Volume at Cut-Off, H. P. Cylinder + Volume of Clearance, H. P. C.}}$$

Items Nos. 365 to 372. The indicated horse-power is found by multiplying together the I. H. P. constant, the average revolutions per minute and the mean effective pressure.

For the head end of right high pressure cylinder, the indicated horse-power = No. 180 × No. 198 × No. 351.

The formula for the other items will be similar in form, with the corresponding quantities substituted.

Item No. 381. The dry steam per indicated horse-power per hour is found by dividing the dry steam per hour, Item No. 341, less the steam used by calorimeters or other instruments, by the total indicated horse-power, Item No. 379.

Or if L = pounds of steam used per hour by calorimeters, etc.

$$\text{Dry steam per I. H. P. H.} = \frac{\text{No. 341} - \text{L}}{\text{No. 379}}$$

Item No. 382. The B. T. U. per I. H. P. per hour is found by multiplying the dry coal per I. H.-P. per hour, Item No. 380, by the calorific power of one pound of dry coal, Item No. 248.

*Locomotive.*

Item No. 383. The dynamometer horse-power is found by multiplying together the D. H.-P. constant, Item No. 179, the average revolutions per minute, Item No. 198, and the average drawbar pull, Item No. 265, or D. H.-P. = No. 179 × No. 198 × No. 265.

Items Nos. 384 to 386. The pounds of coal, steam and B. T. U. per D. H.-P. hour are found in the same manner as the corresponding items for indicated horse-power hour.

Items No. 387 to 389. The number of foot-pounds is found by multiplying together the average drawbar pull, Item No. 265, the average circumference of the driving wheels in feet, Item No. 13, and the total revolutions, Item No. 197.

As the coal, steam, etc., have been reduced to hourly quantities, for convenience, the product obtained by the multiplication in the preceding paragraph will be divided by the duration of tests in hours, Item No. 196, or the foot-pounds at drawbar per hour.

$$= \frac{\text{No. 265} \times \text{No. 13} \times \text{No. 197}}{\text{No. 196.}}$$

Using the figure thus obtained, the coal, steam and B. T. U. per 1,000,000 ft.-lbs. at drawbar is found in a similar manner to Items Nos. 380 to 382.

Item No. 394. Since the I. H.-P., Item No. 379, has already been determined from the mean effective pressure as a basis, the tractive force T can most conveniently be obtained as the product of the constant ratio (33,000 to No. 13) by the variable ratio No. 379 to No. 198 or by formula as follows:

$$T = \frac{33000}{\text{No. 13}} \times \frac{\text{No. 379}}{\text{No. 198}}$$

This may be checked by obtaining the tractive power of each cylinder separately directly from the mean effective pressure, Nos. 351 to 358, and taking their sum; for the high-pressure cylinder, right side, head end, the formula would then be as follows:

$$T_h = 0.7854 \times \frac{\text{No. 351 (No. 32}^2 - \text{No. 78}^2) \text{ No. 36}}{\text{No. 13}}$$

and correspondingly for each of the other cylinders, treating the head and crank ends separately.

Item No. 395. The machine friction of locomotive in terms of horse-power, is the difference between the average indicated horse-power and the average dynamometer horse-power. This does not take into account the friction due to engine truck and trailing wheels and axles.

Item No. 396. The machine friction in terms of pounds mean effective pressure, for simple engines, will be taken as the machine friction in horse-power (No. 395), di-

vided by the average horse-power constant and the average revolutions per minute.

Item No. 397. The machine friction in terms of pounds drawbar pull is the frictional horse-power, No. 395, multiplied by 33,000 to convert it into foot-pounds, divided by the distance in feet per minute. Or machine friction in terms of pounds drawbar pull

$$= \frac{\text{No. 395} \times 33{,}000}{\text{No. 198} \times \text{No. 13}}$$

Item No. 398. The machine efficiency of locomotive in per cent. will be taken as 100 times the ratio of the D. H.-P., No. 383, to the I.H.-P., No. 379.

Item No. 399. Efficiency of locomotive will be found by dividing the heat equivalent of one horse-power for one hour, by the B. T. U. per dynamometer horse-power hour, No. 386, shown by test. This quantity multiplied by 100 will be the efficiency in per cent.

Efficiency of locomotive per cent.

$$= \frac{254498.7}{\text{No. 386.}}$$

CALIBRATION OF INSTRUMENTS.

*Indicators.*

An approved type of inside spring steam engine indicator has been purchased.

Indicator springs have been tested on steam drum with automatic dead weight valve, in which the volume of the steam remains practically constant, and the pressure may be varied by changing the weights on the valve.

Each spring has been tested, and the errors noted both for ascending and descending pressures at intervals of 10 lbs. throughout the range of the spring. These tests will be repeated at intervals of one week throughout the period of the tests, unless by reason of unsatisfactory results it is found necessary to make tests at shorter intervals.

All indicators have been tested for parallelism of pencil movement, by removing the spring, and pushing the pencil to the top of card and allowing it to fall, at several points on the circumference of the drum.

The perpendicularity of these vertical lines to the longitudinal line drawn by revolving the drum with the pencil motion to its lowest position, and the parallelism of the vertical lines to each other show the correctness of the parallelism of the pencil movement.

The parallelism of the piston movement to the drum axis with the spring in place is determined by verifying the angle between the atmospheric line and a steam line made with the drum at rest.

By the use of a device similar to the Brown drum spring testing device, diagrams for various tensions of drum springs have been obtained, and before each test, diagrams of the drum spring tension for each indicator will be taken and the tension adjusted to give the best results at the speed at which test is to be run.

The influence of the inertia of the moving parts of the indicators has been ascertained by taking cards at very slow speeds, and others at the highest speed which will be attained; the difference in length of the card shows the influence of inertia.

*Steam Gages.*

All steam gages have been tested at intervals of 10 lbs. on dead weight gage tester, and errors noted both for increasing and decreasing pressures. The recording steam gage has been tested in the same way, no readings being taken unless piston of tester was revolving.

*Steam Calorimeters.*

A design of throttling-calorimeter, which has been approved by Prof. Peabody, and which is essentially a Peabody calorimeter, has been made, and three calorimeters were manufactured on this design.

The calorimeters have been tested to a water pressure of 400 lbs., and made tight at that pressure.

Removable orifices have been provided, which will deliver about 200 lbs. of steam per hr., the diameters of the eleven sizes of orifices being appropriate for pressures ranging from 180 to 250 lbs. The deliveries of these orifices have been carefully calibrated by a coil condenser, all the steam passing through calorimeter being condensed and weighed.

The calorimeters are lagged with an asbestos cover, 2½ in. of hair felt and a casing of Russia iron outside of the hair felt.

No correction will be made for radiation from the calorimeter.

*Weighing Scales.*

Standard weights have been provided with which all scales will be tested at intervals of one month, or oftener, if the results indicate the necessity for more frequent tests.

*Water Meters.*

Both water meters have been tested by passing water through them, and weighing the water, and observing the temperature.

Tests have been made at rates of flow varying from 3 to 15 cu. ft, per minute, both for intermittent and continuous flows.

The correction factor, for the average rate of flow during the test will be used in comparing the results of metering and weighing the feed water.

The pyrometers for measuring fire-box and smoke-box temperatures consist of thermo-couples, each couple being composed of a junction of platinum with platinum-rhodium wire, forming the pyrometer Le Chatelier.

The temperature reading is obtained by means of a milli-voltmeter showing the electromotive force set up in the thermo-couple, when heat is applied. The couples and milli-voltmeter have been compared with the official standards of the Bureau of Standards at Washington, D. C., and all temperature readings will be corrected by reference to their certificate.

*Thermometers.*

Thermometers have been provided as follows:

Six reading from 0 to 212 deg. F. for feed water.

Ten reading from 0 to 400 deg. F. for calorimeters.

Six reading from 0 to 600 deg. F. for calorimeters.

Four reading from 0 to 500 deg. F. for smoke-box.

Of these thermometers, two of each kind have been calibrated at a number of points throughout their respective ranges, by the Bureau of Standards, Washington, D. C., and these certified thermometers will be recalibrated at intervals and will be used as standards for the determination of the errors of all other thermometers used.

*Barometer.*

For observation of the atmospheric pressure, a mercurial barometer will be used. This instrument has been calibrated by the Bureau of Standards, Washington, D. C., and a curve of true pressure has been plotted which will be used to correct all readings.

*Draft Gages.*

"U" tube gages containing water will be used to obtain the smoke-box, fire-box and ash-pan pressures. The gages have been tested by the Bureau of Standards, Washington, D. C., for accuracy of graduation of scales and uniformity of bore of tubes. These corrections have been plotted and will be applied to all readings.

To measure the lower pressures in the calorimeters single tube mercury pressure gages will be used. These gages have a range from 0 to 7 lbs. per sq. in. and have been tested by the Bureau of Standards at Washington, D. C., for accuracy of scale readings and uniformity of bore of tube, and the plotted curve of these tests will be used to correct all readings.

*Coal Calorimeter.*

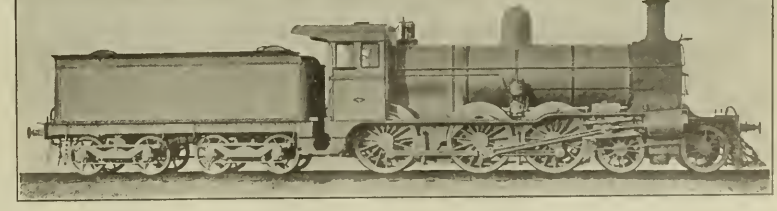
The calorimeter to be used is the William Thompson calorimeter with some slight modifications to facilitate working and output. This calorimeter has been standardized by testing in it two samples of coal which were previously tested in ten different bomb calorimeters, including a test in the bomb calorimeter at the Bureau of Standards, Washington, D. C. The mean of these ten determinations is taken as representing the heat units in these two coals, and these coals when tested in the Thompson calorimeter, enable it to be standardized so as to give results the same as the bomb calorimeter. Furthermore, a sufficient amount of these two coals has been prepared so that the Thompson calorimeter can be frequently checked. It also provides a means of ready standardization, in case of accident to any of the parts of the Thompson calorimeter, or in case of getting a new instrument complete.

*Orsat Apparatus for Analysis of Smokestack Gases.*

The Orsat apparatus to be used in analyzing the smoke-box gases has had its measuring pipette carefully calibrated by filling with water at room temperature, and then weighing this water as a whole and in successive portions corresponding to the graduations on the measuring pipette. The necessary corrections, where any were found requisite, will be used in reading the percentages from the measuring pipette.

## Rolling Stock on the Victoria State Railways.

Mr. T. H. Woodroffe, Chief Mechanical Engineer of the Victoria Government Railways, sends us the accompanying photograph of one of the new 10-wheel locomotives recently designed by him. These engines are intended for passenger and freight service on the main and branch lines and are of only moderate weight. Eleven of this design have already been turned out of the railroad company's shops, ten more are under construction in the company's shops and seven are being built by contract in outside shops at Melbourne. With the excep-



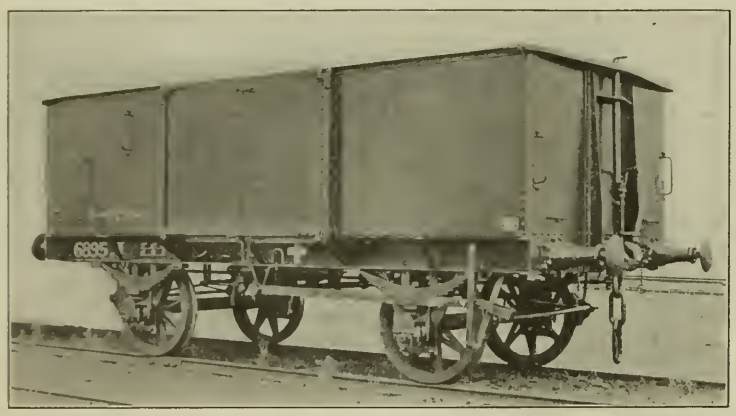
New Ten-Wheel Locomotives for Victoria State Railways.

tion of one or two special engines, these are the first that have been built in the company's shops, all of the motive power for the lines having been bought from outside concerns in Victoria. The engines have the following principal dimensions:

| | |
|---|---|
| Gage | 5 ft. 3 in. |
| Cylinders | 18 in. x 26 in. |
| Valves | Piston |
| Diameter of drivers | 60 in. |
| Driving wheel base | 13 ft. |
| Engine wheel base | 24 ft. 3½ in. |
| Total wheel base, engine and tender | 48 ft. 4 in. |
| Grate area | 22.5 sq. ft. |
| Fire-box heating surface | 120 sq. ft. |
| Tube heating surface | 1,288 sq. ft. |
| Total heating surface | 1,408 sq. ft. |
| Working steam pressure | 175 lbs. |
| Water capacity of tender | 4,000 imp. gallons |
| Coal capacity of tender | 5 tons |
| Weight on drivers | 84,000 lbs. |
| Total weight of engine | 114,240 lbs. |
| Weight of tender | 89,600 lbs. |

The engine has a Belpaire boiler with copper fire-box and brass tubes.

The other illustration shows the standard goods wagon in use on the Victorian Railways. It is built entirely of steel and has a marked capacity of 15 long tons. It has a cubic capacity of 687 cu. ft. and will carry 15 tons of coal, wheat in bulk or similar articles. The tare weight of these cars is from 12,200 lbs. to 14,000 lbs., depending on the weight of the wheels on which they are mounted. These and all other cars for passenger and freight service are built in the company's own shops.



Standard 15-ton Car, Victoria State Railways.

A number of all-metal cars built as far back as 1860 and 1870 are still in use on this road and all new cars and replacements have been built of steel throughout for several years past. There are now about 2,000 in service. This company's experience has been that in Victoria, at least, all-metal cars can be built for less money, their cost of maintenance is considerably less, damage from collision more easily repaired, and the ultimate life more than double that of wooden or composite cars.

## Inside Cylinder Locomotives.

BY F. W. DEAN.

The appearance in this country of a number of locomotives having inside and outside cylinders, shows that the dislike of the crank axle is not so strong as to prevent its use if any important end is thereby accomplished. The only argument that I have ever heard against crank axles is that they are unreliable. The persistency of their use in England shows that this is not so. On American locomotives there are important parts which are as unreliable and troublesome as crank axles. Present methods of construction and present qualities of materials have made the crank axle safe for locomotive use. Large locomotives are giving much trouble by breaking cylinders, and the repair bill for this item is serious. A great part of this expense can be saved by building locomotives with inside cylinders. The present simple locomotive is an exceedingly wasteful machine from cylinder condensation, and is proportionately lacking in speed therefrom. The inside cylinder locomotive will reduce this condensation and the speed will be increased on account of absence of sluggishness of wet steam and the greater ease of keeping up boiler pressure. The nosing of the engine will be reduced and the wear of wheel flanges, wheel hubs, axle box flanges and axle collars will be diminished, and possibly rails will have increased life. The internal friction of the engine will also be reduced.

In large locomotives the centers of outside cylinders are so far apart, and the points of fastening of the frames are so near the center of the engine that the strain on the neck of the cylinder casting is so great, considered as a girder, that it cannot be met except by increasing the dimensions, which has several disadvantages. There are initial strains in the foundry and strains from the heating and cooling of the castings in service which almost inevitably crack cylinders. The cast-iron overhung girders that the cylinders form would be tolerated in scarcely any other structure, and especially in one which is subjected to the frequently repeated and violent dynamic strains of locomotive cylinders. The inside cylinder forms a girder which is supported at the ends by the frames and loaded between, and is therefore good engineering construction. It is deep necessarily in proportion to its length and forms a satisfactory girder for taking the load, while its outside companion is remarkably bad in this respect. Incidentally, there may be a reduction of some importance in cylinder breakages from the absence of overhung cylinders fouling the cylinders of other engines, cars, etc. The reduction in weight would be most important, amounting in many cases to 4,000 or 5,000 lbs.

There would, of course, be a limit to the size of cylinders, but 23-in. cylinders can be used, if we can judge by the size of the inside low-pressure cylinders of French four-cylinder compound locomotives. With the long stroke that is now used sufficient cylinder volume for most cases can be obtained, especially with the very high steam pressures now carried. As locomotives are now built with fire-boxes whose length is not limited by the axles, the crank axle even of a long stroke engine will not reduce the grate area, nor will it force the height of the boiler above present limits.

There is something lacking in the present large engines. They do not accomplish what they ought, and something radical ought to be done to make them better mechanical structures, to economize steam and to make them steam better. The adoption of inside cylinder locomotives will do a great deal to bring this and all of the above-mentioned advantages to realization. As long ago as 1895 the late J. N. Lauder told the writer that if it were not for the crank axle he would begin to build inside cylinder locomotives.

The crank axle can be designed in several different ways, but I should prefer a built-up axle, made of nine pieces, crank arms, crank pins and straight pieces of the axle all separate, forced together with tapered fits and keyed, as is frequently done in marine practice. This method is used by the Lancashire and Yorkshire, of England. By doing away with eccentrics on the axle a center bearing can be used, and this will reduce the strain on the axle. Doing away with eccentrics, of course, raises the question as to the design of the valve gear. I hope that the appearance in this country of the Mallet and DeGlehn four-cylinder compounds, both with Walschaert valve gear, will bring about the use of this admirable device. It is a more scientific gear than the Stephenson, which is a reversing makeshift. In order to render the center bearing of the crank axle possible the Walschaert gear can be driven by a return crank from the outside crank pin.

Referring still further to the limit of size of inside cylinders, occasionally in England and on the continent, there are seen locomotives with outside frames, and such locomotives have been built in this country for narrow-gage railroads, by the Baldwin Locomotive Works. With such frames inside cranks far apart can be used with a center bearing, and ample room for the largest cylinders can be provided. There will also evidently be room enough for eccentrics on the axle each side of the center bearing. Such locomotives, although they would look strange to our eyes, would have all of the advantages which the inside cylinder locomotive possesses.

## Guard Rail Brace.

The illustration shows a serviceable guard rail brace, with the special feature of raising the guard rail higher than the running rail or guarding a heavy rail with a light one. Frequently much trouble and delay is occasioned by slight accidents due to the conditions of guard rails, and considerable wear and tear on frogs is caused by the guard rail not remaining rigid. These conditions can be remedied by using a guard rail brace that supports the guard and running rail, as well as braces the guard rail and directly connects the guard and running rail. These guard rail braces are furnished either with or without bolts or filler blocks, and can be supplied to cover any conditions specified, whether it is desired to raise the guard rail or not. They are made by the G. H. L. Rail Joint Co., 150 Nassau street, New York.

G. H. L. Guard Rail Brace.

RAILROAD GAZETTE

## THE STEAM TURBINE SITUATION.

The steam turbine, as a commercial and economical success, is less than 20 years old. It does not follow, however, that the turbine is as far from perfection as the steam engine was 20 years after its inception by James Watt. In the early days of steam engine building, the laws of thermodynamics were not well understood, the facilities for making engines were crude, there were no expert engineers to direct the design and manufacture, and the demand for steam power was limited. All these factors and others tended to retard the art of steam engine building. In fact, only within the past 30 or 40 years has the steam engine been greatly perfected.

The steam turbine has entered the field in the face of a strong competitor, so that what success it has met with has been won by merit. The best performance on record for a steam engine was reported by Prof. Schroeter, of Munich, and Prof. Webber, of Zurich. The tests were made on a triple-expansion four-cylinder horizonal Sultzer engine using steam superheated 230 degrees at 180 lbs. per sq. in. pressure. With a load of 2,860 horse-power the steam consumption was 8.97 lbs. per indicated horse-power per hour, which in this case is equivalent to about 14.25 lbs. of steam per kilowatt per hour. Of course, the above results are not, nor can be, obtained in commercial practice, but they serve to show the possibilities of the steam engine. It is not unusual, however, for large power plants using multiple expansion condensing engines to operate with a steam consumption of from 12 or 14 lbs. per indicated horse-power, which is equivalent to 19 to 22.1 lbs. of steam per kilowatt per hour, assuming a combined efficiency of 85 per cent. for the engine and generator. The steam turbine, by reason of its high rotative speed, is particularly well adapted for direct connection to electric generators. The largest turbine installations, so far, have been built for central power plants, so that in point of steam economy they must compete with the best multiple expansion engines. Steam turbines of 2,600 k. w. capacity, operating with a steam pressure of 185 lbs., a superheat of 186 deg., and a vacuum of 28 inches, have developed an electrical horse-power on 11.02 lbs. of steam per hour which would be equivalent to about 9.38 lbs. of steam per indicated horse-power per hour, a figure which compares favorably with the best steam engine performance, and which is much better than that usually obtained from steam engines. It is now not difficult to design a steam turbine with a guaranteed performance of 14½ or 15 lbs. of steam per electrical horse-power per hour when using steam at moderate pressures, superheated about 100 degrees Fahr., and with a vacuum in the condenser of 27 in.

The steam turbine has certain limitations, but these will no doubt be overcome in time. It is not reversible, its rotative speed is high, and real economy cannot be obtained without a good vacuum in the condenser and without superheated steam. Reversibility is not essential except for marine and some industrial purposes. The high rotative speed is, as before noted, a decided advantage for central power station work, but for many commercial and manufacturing purposes it is objectionable. In those types of turbines which employ a relatively low rotative velocity, the necessity for high degrees of superheat is not so important as in turbines running at high velocity. The function of the superheat in a steam turbine is to prevent fluid friction due to condensation of the steam while passing through the blades. It has been found by the late Dr. Thurston that with a 10 in. disk the loss due to fluid friction amounted to one horse-power for every 275 drops at 200,000 revolutions per minute. In a steam engine the function of superheated steam is to supply enough heat to the cylinder walls to prevent cylinder condensation. In steam turbines cylinder condensation does not have to be considered, and it is therefore found that, although higher economy may be obtained with higher degrees of superheat, a moderate degree is more desirable, as it entails less trouble with the superheaters.

The turbine will probably always hold first place for economy in space. Owing to the perfect balance of the rotating parts, it is not necessary to provide heavy foundations. Furthermore, the turbine has few bearing parts. It has been claimed that the blades wear by erosion but as in hydraulic work, the erosion is proportional to the fluid velocities, and is increased, by moisture in the steam, in the same manner as sand affects the blades of a Pelton wheel. Turbines which run at relatively low velocities have not suffered much from erosion.

## A STANDARD COUPLER.

If the Master Car Builders' Association decides to act favorably on the recommendation contained in the President's address to the last convention advocating the adoption of a standard coupler, it will find itself confronted with a task almost as difficult as that which it imposed upon itself seventeen years ago, when it took the first radical step in the solution of the coupler problem and adopted a standard type of automatic coupling. There is not the imperative necessity of action now that there was in 1887, nor will the benefits to be derived compare with the saving in life and in cost of operation which have resulted from the adoption of the automatic coupler instead of keeping the old bull-nose or link and pin couplers in use. Manifold advantages, however, would result from the adoption of one form of coupler as standard, which would warrant to a great degree, at any rate, the time and money which would be spent in bringing about the proposed change. The situation in which the railroads find themselves as a result of the general use of a diversity of makes of couplers grows in seriousness as the number of cars in service increases and action of the sort recommended seems to be the obvious way of affording relief. With the 40 or 50 different makes of couplers at present used, every road which handles cars in interchange is compelled to carry a stock of coupler repair parts representing an investment of thousands of dollars. Much of this stock is seldom drawn upon; nevertheless a supply of parts for all makes of couplers must be kept on hand to insure against delays in making repairs to foreign cars. A large part of the money thus invested is tied up indefinitely and yields no return, but, with a standard coupler in use, the stock of repair parts carried could be reduced to a minimum determined by the average demand for a given period and the money now invested in stocks of couplers and parts would be released for other purposes. Additional economies would be realized by saving space in storehouses and in the care and handling of stock, as well as in the simplification of records and accounts. Perhaps the greatest pecuniary benefit would result from the ease and quickness with which repairs could be made, not so much because of the actual saving in expense, although this would be considerable, as from the direct effect on the earning power of the cars in lessening their detention from service on account of repairs. This would be true not only in the repair yards, but on the road as well, where many costly delays to loaded cars and oftentimes to the trains in which they belong, would be avoided.

Many of the difficulties and obstacles which were encountered when the Association adopted the vertical, plane type of coupler as standard will be encountered again if an attempt is made to pick out from the couplers now in use a standard design which will meet all the requirements of efficiency and strength or to design an entirely new form which would combine the best features of each of several existing makes. It was the original intention of the Association in 1887 to fix upon some one of the very numerous forms of coupling devices which had been brought out by ingenious inventors and to adopt that particular form as a standard. The hopelessness of such a task can well be imagined, for at the time the tests to decide what form was the best were made at Buffalo, some 46 different makes were represented and these were only a few of the three or four thousand attempted solutions which had been patented up to that time. When the tests were made the different couplers were divided into classes, according to their principle of operation and the best that the committee to which was intrusted the task of selection could do was to recommend the type of coupler of which the Janney was characteristic. In its report the committee said:

> These tests and this method of procedure were important steps in the evolution of the subject, because they raised the question from the endeavor to select one coupler from the great number in existence, to a selection from among types as these classes virtually corresponded to types. This advance was very important, because it permits the various railroad companies a range in the selection of what coupler they will adopt in the event of the proposed type being approved by the Association; because it enables inventors to concentrate their abilities on increasing the number of couplers in the preferred type and to devise improvements in those already in existence; it protects railroad companies against extortion, as would be the case if any one coupler instead of a type of couplers interchangeable among themselves was adopted as the standard of the Association.

All of this was undoubtedly true at that time, but it hardly holds as an argument against the adoption of one form of coupler as standard at the present time. The same report says in another place.

> The difficulty has not been to find the best coupler from a large number of very meritorious devices as might reasonably be supposed from ex-

perience with other inventions made in such vast numbers, but to find even one device which did not possess grave disadvantages.

This was notably true at that time and, unfortunately, more or less fits the case at the present time. The President of the Association in making his recommendation for a standard coupler at the last convention pointed out the necessary mechanical features which a generally satisfactory automatic coupler adapted to modern service conditions should embody. These are automatic knuckle opening, automatic locking of the knuckle by gravity when two cars come together under any conditions of track, a positive lock-set and an efficient lock to the lock. It is important that the knuckle will not pull out if the knuckle pin breaks and some provision should be made for taking up wear on the moving parts and those in contact with each other when the cars are coupled. There are, to-day, nearly 8,000 patents on coupling devices and attachments, covering seemingly every possible combination of any merit and many of these are conflicting in more than one claim. It seems hardly possible, therefore to design a new coupler which would embody every point considered essential to a satisfactory device without becoming entangled in legal controversies without end. Of these 8,000 or more patented devices there are perhaps ten makes of couplers now in extensive use which exist by virtue of the principle of the survival of the fittest, and were any coupler fixed upon as standard it would be from among these, or if a new design were prepared it would almost of necessity infringe on some one or more features of these ten. The Janney type of coupler originally adopted was fully covered by patents, but the owners of the patent were prevailed upon to waive their rights to the exclusive use of the contour lines which were adopted as part of the standard. It might be possible to select from the few makes of couplers now in extensive use the best mechanical features of each and so combine them as to obtain the desired result in an entirely new design, but it is not probable that the makers would all agree to waive their rights for little or no consideration and with no assurance of an equitable division of the business of making and selling the new design of coupler. This, however, seems to be the only way around the difficulty, and it remains to be seen whether or not it can be done.

Fully as important as the mechanical design is the quality of the metal of which couplers are made. Cheap couplers can be bought and are bought by some roads with a false idea of economy, on the ground that coupler breakages are becoming so numerous that the least expensive way out of the difficulty is to buy the cheapest makes for replacements. Just as much depends on the quality of material in couplers as in cast-iron wheels and the most expensive in first cost are the cheapest in the end. One large Western road early adopted and has continued to use exclusively a make of coupler containing uniformly high-grade material and its records for the last year show that approximately twice as many coupler failures occurred on foreign cars on its lines as occurred on its own cars on foreign lines. This is a convincing argument for the use of couplers made only of the best material.

## A STUDY IN RAILROAD RECEIVERSHIPS.

In a summarized form the returns for receiverships of American railroad properties unfortunately do not go back beyond the year 1876. They do not, therefore, cover the immediate years following the panic of the autumn of 1873. But they do take in the so-called "long drag" up to 1880, following the former year of financial disaster, and thus they allow an inclusion of its effects. Including the year 1903, for which the returns have come in during the present year, there is a total of 28 years through which the subject can be reviewed and the mutations of the figures analyzed. Taken in their entirety and marking their variations, they offer not merely some instructive lessons of the past, but some suggestive hints for the future.

The summary for 28 years, or more than a quarter of a century marked by immense railroad expansion, shows that 652 railroads with 114,855 miles of track, and capitalized at $6,415,055,000 in stocks and bonds, have gone under receiverships. Even allowing for duplicated receiverships of railroad properties, returns which show thus that, in par values, about one-half of the stocks and bonds of the railroads of the United States have gone into the hands of receivers—and about the same ratio of railroad mileage—give us facts of impressive magnitude. There are, of course, qualifying circumstances. Besides the duplicate receiverships referred to, not all the stocks and bonds—especially the stocks—have represented cash paid in; and there have been *pro forma* receiverships and receiverships for "protection of interests" which might, with foresight more wise or more unselfish, have been avoided. Still, the great majority of the receiverships have been the outcome of genuine financial stress and emergency and their striking totals stand to prove the vicissitude of American railroad investment.

Taking the massive figures up in detail it will be found that the receiverships have had three climacteric periods corresponding, as was to be expected, with times of depression in finance and industry, but with somewhat divergent causes back of those periods. That part of the "long drag"—following the crisis of 1873—for which we have the summarized returns, give us the annexed table:

| | Miles. | No. of Roads. | Stocks and Bonds. |
|---|---|---|---|
| 1876..... | 6,662 | 42 | $467,000,000 |
| 1877..... | 3,637 | 38 | 220,294,000 |
| 1878..... | 2,320 | 27 | 93,385,000 |
| 1879..... | 1,102 | 12 | 39,367,000 |
| 1880..... | 885 | 13 | 140,265,000 |
| Total..... | 14,606 | 132 | $960,311,000 |

The second high point in what may be called the receivership curve appears during the three years, 1883-85, inclusive, and gives the following returns:

| | Miles. | No. of Roads. | Stocks and Bonds. |
|---|---|---|---|
| 1883..... | 1,990 | 11 | $108,470,000 |
| 1884..... | 11,038 | 37 | 714,755,000 |
| 1885..... | 8,286 | 44 | 385,460,000 |
| Total..... | 21,314 | 92 | $1,208,685,000 |

The third period, and one very striking in both the relative and absolute amount of the entries, is expressed in the table subjoined.

| | Miles. | No. of Roads. | Stocks and Bonds. |
|---|---|---|---|
| 1892..... | 10,508 | 36 | $357,692,000 |
| 1893..... | 29,340 | 74 | 1,781,046,000 |
| 1894..... | 7,005 | 38 | 395,791,000 |
| 1895..... | 4,089 | 31 | 369,075,000 |
| 1896..... | 5,441 | 34 | 275,597,000 |
| Total..... | 56,383 | 213 | $3,179,201,000 |

The three brief tables, whether taken together or apart, are extremely interesting. Thirteen out of the 28 years of receiverships return stocks and bonds involved of $5,348,197,000, or about 83 per cent. of the total, corresponding figures for mileage being 92,303, or about 80 per cent., and for number of roads 337, or somewhat more than one-half the total number. If we take up the causes and apply them to the three periods, the first must be assigned almost exclusively to the fever of railroad construction which led up to the panic of 1873; the second period to speculative collapse of a much more general type; and the third period to both the foregoing causes, combined to which are to be added, as very important factors, the disturbance in national finances with the silver question in the foreground and the "currency famine" of 1893 as one of the unique phenomena. Logically, with three such potent causes of disaster blended, the third period looms large in its returns, which show, for only five years, receiverships for 213 roads with 56,383 miles and $3,179,201,000 in stocks and bonds—about one-half the total of stocks and bonds for the whole period of 28 years. The dark year, 1893, with its 74 roads, mileage of 29,340, and stocks and bonds of $1,781,046,000, in this connection is to be especially noted.

If we take the year 1873 as the beginning of the first receivership epoch, the returns show the receivership periods almost exactly ten years apart. It is, doubtless, to a large extent a coincidence. Yet the fact may be recalled that during the high swell of speculation of three or four years ago some of the best financial prophets were forecasting panic and collapse at just about the time which would have filled out another decade. Happily the panic has not come. The wave of speculation rolled high but did not break, and there has been instead a quiet recession of the tide and a steady but not sharp shrinkage of market values which has left few wrecks and almost no railroad receiverships behind it, notwithstanding the new era of "high finance" in railroads. The causes of the happy avoidance of disaster are not far to seek in the better organization of American capital to avert panic and the more solid industrial prosperity of the country. But when, at a time which no man can fix, and which, we trust, is far away, another receivership period dawns, it may be interesting as well as pathetic to observe the effects on "holding" corporations and on railroad systems in which hundreds of millions of bonds with foreclosure powers have been substituted for old dividend-paying stocks.

When that inevitable period comes there will be yet another element to be studied and reckoned with. According to recent computations the street railways of the country have reached the enormous capitalization of $1,700,726,898 in stock and $1,401,664,048 in bonds, or $3,102,390,946 in the two sets of securities together. When the street railways, with their great over-capitalization, pass through the ordeal of a receivership period, some questions of import will be raised. Will such a period synchronize with a time of trouble in the steam roads also, or will it be a thing apart? How long will it be belated by the popularity of electric railway travel? How far will it reach down in fore-

closure proceedings, and shall we see the theory of "protection of interests" repeat itself, or will senior mortgages, in general, take the properties and reorganize them, and, if so, on what basis? These questions will be answered in time, and meanwhile we face, as a salient and conspicuous fact, such a rapid and large expansion of street railway properties that their problems in magnitude begin to mate those of the steam roads, and, in many respects, are more complex and nebulous.

The most specific single lesson in the Government's eleventh accident bulletin, which is given on another page, is that train orders containing references to the second section of a train are peculiarly liable to be misread. Four collisions have occurred within a year in consequence of men reading orders and not seeing the word "Second," though it was undeniably there. Whether the readers were unusually careless or the penmen were particularly slovenly does not appear; and it does not much matter, for every superintendent knows that both in writing and in reading, his only safe course is to persistently follow up the work of all of his men, both operators and trainmen. Careless work on both sides is, unfortunately, too common to escape notice, unless the superintendent deliberately shuts his eyes. One thing, however, which might be done, and with little loss of time, would be to require such orders to be written "Second (2d)," and to require operators to leave a wider margin. One engineman offered the excuse that his thumb covered the word that he failed to see. Perhaps the only practicable way to secure wide margins would be to use larger sheets. Possibly a rule should be adopted requiring the use of the words "the" and "section" ("the second section of twenty-seven"). Does any one say that this would be clumsy and slow? Granted. But why not admit frankly that the despatching system is very weak unless it is elaborate and time-consuming? Those who have made full use of the block system do practically admit this —to themselves. And they also admit that the block system is the only practicable remedy. Bulletin 11 is significant in one other feature: two collisions, numbers 1 and 5, injuring seven persons and damaging road and equipment to the amount of $6,200, were caused by despatchers' mistakes. Despatchers represent—or they come as near as any department to representing—a well-managed department; the men are selected from a large number who have been tried in train work, they are not usually overworked, and they are probably as conscientious and energetic as any similar class of men; and yet these costly errors are frequently reported. In fact, the moral, "Adopt the block system," is forced on the attention by the collision record at every turn. Two accidents reported in Bulletin 11, costing $21,900, were caused partly by a very unusual occurrence, the freezing of packing leather in air-brake cylinders—a result of the remarkably severe temperatures of last January.

Some ten years ago at the outset of a period of business depression President Clark, of the New York, New Haven & Hartford, expressed himself as deeply amazed at a sudden falling off on his road in the summer traffic, which, on its face, was related to pleasure rather than business. If the report is true that the summer business of the New Haven Company shows a falling off of something like 25 per cent. as compared with last year, President Mellen must be running much the same gauntlet of feeling as President Clark and sees an economic necessity for the wholesale and radical reductions of train service which he has ordered and which have roused the communities on his lines to vigorous protest. There is nothing, however, very phenomenal in this particular aspect of the situation. The New Haven system serves an immense summer population on the shore and in the rural uplands. Part of it, undoubtedly, has been affected by the St. Louis Exposition and another part is responsive to such industrial depression as affects Fall River and other New England factory centers; while business travel, merged with summer traffic, and, to some extent indistinguishable from it, reflects the same influence. But, in economic aspects, there are larger things which President Mellen has to consider. Paradox it may be, but the more than half century old New Haven system under his policy is in a state of radical transition. He has a big and novel electric policy, an intricate and expansive scheme at Poughkeepsie bridge and beyond, bridge reconstruction on a vast and expensive scale, new rolling stock to buy antecedent to his theory of the heavier train load and a medley of allied problems to be worked out. All these signify expenditure synchronous with the maintenance of an 8 per cent. dividend, which the holders of what has been called in Connecticut an "Old Maid's Stock" demand. The reduction of trains is probably not a cheerful ordeal for President Mellen to face at a time when the echoes of the welcomes at Board of Trade dinners have hardly died and when but a few months must lapse before he asks a Connecticut legislature to change the four-day car detention law; and irony, as regards his passenger train service, can find its theme in the rich promise of his coming and a certain aridity of fulfillment. But time alone will tell whether he has bought the remoter good by the immediate evil, and as head of the waxing New Haven system, President Mellen is yet young.

Prince Khilkov, the Russian Minister of Transportation, reported that June 1, 34 additional sidings or passing tracks had been completed on the Siberian Railroad, and that it was possible to despatch 12 trains each way daily the whole length of the road; while 69 more turnouts were under construction. Rewards are offered to the contractors on the line around the south end of Lake Baikal for the early completion of their contracts, and the reports of the time of its probable completion vary from the middle of August to "in time for the winter traffic" —which latter would be a great misfortune, for men and supplies for the whole winter should be in Manchuria before winter sets in. To strengthen the operating force, 700 enginemen, firemen, switchmen, etc., have been transferred from the Transcaucasian Railroad alone, and so much rolling stock has been taken from the European lines that it is feared that they will be crippled for their grain traffic after harvest.

The semi-annual statistics of pig-iron production, compiled by the American Iron & Steel Association, reflect accurately the retrenchment characteristics of the present industrial period. Yet, although the unsold stocks have increased somewhat since the last half year, and very greatly since the boom ending about a year ago, there is nothing panicky about the figures, and the decrease in total output, amounting to a decline of 1½ per cent. from the last half of 1903 and of 15 per cent. from the first half of 1903, is not alarming. Eleven years ago, when there was genuine stringency, pig iron production fell off 41 per cent. in the same period, while at the present time, although railroads and manufacturing interests everywhere in the country are on the lookout for economies and are restricting new work as much as possible, it is noteworthy that the iron production, in spite of the decrease from 1902 and 1903, was greater than in any six months previous to the latter half of 1901, and nearly equaled the entire twelve months' output of as recent a year as 1896.

## NEW PUBLICATIONS.

*Boiler Construction*, by Frank B. Kleinhaus, first edition, 1904. The Derry-Collard Company, New York. Four hundred odd pages, including 334 illustrations and five large plate engravings. Price $3.

This book gives a practical explanation of modern methods of boiler construction from the laying out of the sheets to the completed boiler. It includes detailed descriptions and drawings of boiler fittings, such as check valves, whistle valves, fusible plugs, blow-off cocks, water glass, throttle lever, etc. The line drawings and half-tones are well selected and clear. There are 55 pages devoted to illustrations, descriptions and care of boiler-shop machinery, considering the limited space the selections of the machines are good. The book closes with a number of tables, including areas and circumferences of circles, logarithms of numbers, natural tangents and sines, tensile strength of bolts, weights of material, etc.

*Association of Transportation & Car Accounting Officers*: Proceedings of the Washington meeting: G. P. Conard, Secretary, 24 Park place, New York.

Secretary Conard has issued the first publication of this new association, being the record of what was done at Washington, May 24 and 25, when the Car Accountants' Association and the Railway Transportation Association were disbanded and the new association organized. The pamphlet contains, besides reports and discussions, the constitution of the new association, the names of the officers of both of the old associations from their organization, in 1876 and 1899, respectively, and a digest of those recommendations of the old associations which are still of interest.

## TRADE CATALOGUES.

*Bettendorf Axle Company*, Davenport, Iowa, is sending out an attractive catalogue of its trucks, bolsters, tank cars, underframes and railroad specialties. The truck, tank car and car for the Illinois Tunnel Company were illustrated and described in the *Railroad Gazette*, June 10, 17 and 24, respectively. The catalogue contains a series of half-tone illustrations from photographs showing the rapidity with which the truck may be dismantled and reassembled. There is also shown a tender truck similar to the car truck, but having some additional features of novelty. Bolsters are quite fully illustrated and described and some discussion of the bolster problem given, including a series of curves showing the results of static and drop tests on several types and capacities of bolsters. The book contains 50 pages and is neatly designed and printed.

*The American Locomotive Company* has issued a pamphlet which describes their ex-

hibit at the Louisiana Purchase Exposition. Their exhibit consists of 12 locomotives which represent the present tendencies of American design and which include the four-cylinder balanced compound locomotive built for the New York Central for high-speed passenger service and the four-cylinder articulated compound locomotive built for the Baltimore & Ohio for heavy freight service. The last-named engine is the heaviest and most powerful locomotive built. The pamphlet opens with descriptions and drawings of the important details of these engines and is followed by a full-page half-tone illustration of each engine exhibited and the essential data concerning them. A diagram showing the company's method of classification of locomotives and an explanation of the same is given on the last page.

The Passenger Department of the *Michigan Central* has prepared an appropriate and attractive folder in honor of the G. A. R. encampment at Boston, August 15 to 20, inclusive. It contains a number of good half-tone views of interesting and historical points and scenes in Boston and along the route; also some reproductions of old prints of events connected with the early history of Massachusetts. The program for the week is given and also full information as to rates, side trips and 21 different routes that may be chosen.

*The Penn-Allen Portland Cement Company*, Allentown, Pa., sends a pamphlet in which is given a description of their works at Penn-Allen, Pa. Their property consists of about 160 acres of land which is rich in limestone and cement rock. The buildings are of concrete steel construction. The works have a capacity of 1,000 barrels per day, and it is the company's intention to double their capacity in the near future. A number of interesting tests of the cement are given.

*The Joseph Dixon Crucible Company* has just issued their August number of "Graphite," which is devoted to a description of the different forms of graphite and their respective uses. A copy can be procured free of charge by all persons interested in the subject.

*The United States Metallic Packing Company*, Philadelphia, Pa., has issued a catalogue describing their packing for marine and stationary engines. A full, detailed description and illustration of the packing is given.

## CONTRIBUTIONS

### Power Distribution in Automatic Signaling.

Swissvale, Pa., July 27, 1904.

To the Editor of the Railroad Gazette:

Mr. H. S. Balliet's last article, entitled "Performance of Automatic Signals Under Unfavorable Conditions" (*Railroad Gazette*, July 8, page 135), while ably written and deserving of careful consideration by all railroad men interested in automatic signaling and in the natural trend of development in this direction, is nevertheless open to question in a few of its statements.

First: Contrary to the report of the Railway Signal Association referred to by Mr. Balliet, the economical use of storage cells charged through power lines is distinctly advantageous over the use of primary cells for the operation of modern motor signals controlling blocks of one mile in length upon single and double track roads.

Second: The use of one set of storage cells for the joint operation of two or more block signals is not advisable where the set constitutes one of a series charged through a power line from a central station, unless each set can be economically adapted to the operation of a sufficient number of signals (or other devices) to entail from each an approximately uniform rate of discharge. Each set of batteries so arranged should be in duplicate, so that each may be alternately transferred from the charging line to the service circuits without at any time forming electrical connection between the charging line and that set of batteries in service, if the best results are to be secured.

Third: Conditions undoubtedly now exist and will continue to exist which preclude the economical use of storage batteries in this capacity charged from central points through wire lines. The use of portable storage cells, periodically removed to convenient power centers for charging, is a method to be then adopted, provided, however, the period of activity of the cells without re-charging can be extended over a month or more without incurring undue risk of serious sulphating, which inevitably shortens the life of the battery.

To what extent storage cells can be economically substituted for primary batteries under conditions which preclude the charging of the former from central stations through line wires cannot well be stated in general terms, but there is no gainsaying the fact that the method may be employed under many conditions advantageously. The method, however, can never be so advantageous, from a purely engineering point of view in the maintenance of the batteries themselves, as the use of batteries permanently located at the signals, to be charged at frequent intervals at a moderate rate and from central points through suitable conductors.

Fourth: Mr. Balliet wrongly, though evidently unintentionally, states that portable storage cells can be charged at electric interlocking plants (in conjunction with the batteries of the interlocking, and by means of the generator provided for the batteries of the interlocking) "with no additional cost for fuel or attendance." Waiving the question of attendance, in which he is probably right, it is evident that in the matter of fuel he is wrong, for the generator, if of an ampere capacity equal to the needs of the interlocking batteries only, must be run solely for the signal batteries when these are being charged; or, if of ample ampere capacity for the simultaneous charging of *both* sets of batteries must develop a greater horse-power when charging both than when charging the interlocking batteries alone—a feat impossible without additional consumption of fuel. Mr. Balliet no doubt intended to imply that the additional fuel consumed under these circumstances might reasonably be ignored as being too small to materially affect the conclusions to be reached, though the writer does not feel that even this statement should go unchallenged where it pertains to comparative costs of two methods.

*Air Mains.*—Concerning the rupture of pipe lines of pneumatic block systems during the past winter, referred to by Mr. Balliet as an argument against systems depending upon power developed at central points, it is only fair to state that this trouble was not common to all localities nor to all plants in the same locality, but was peculiar only to several plants installed from 10 to 15 years ago, in which due provision for expansion and contraction under the extreme temperatures prevailing during the past winter had not been made. Modern plants such as those on the Philadelphia division of the Pennsylvania Railroad and on the Philadelphia, Baltimore & Washington, more recently installed, were not only entirely exempt from this character of trouble, but were also absolutely free from trouble arising from frozen condensation within the air system. Users of pipe lines are fully aware of the several obvious courses to pursue in guarding against the trouble in future.

J. P. COLEMAN.

### Pig Iron Production, First Half of 1904.

According to the *Bulletin* of the American Iron & Steel Association, the total production of pig iron in the first half of 1904 was 8,173,438 gross tons, against 8,301,885 tons in the last half of 1903 and 9,707,367 tons in the first half of 1903. The decrease in production in the first half of 1904, as compared with the second half of 1903, amounted to only 128,447 tons, but, as compared with the first half of 1903, it amounted to 1,533,929 tons. The united production of the second half of 1903 and the first half of 1904 amounted to 16,475,323 tons, against 18,720,100 tons in the second half of 1902 and the first half of 1903, when the boom was at its height, a falling off of 2,244,777 tons. And yet the production in the first half of 1904 was greater than in any half year prior to the second half of 1901.

*Classified Production.*—The production of Bessemer pig iron in the first half of 1904 was 4,530,946 gross tons, against 4,509,289 tons in the last half of 1903 and 5,480,619 tons in the first half of 1903. The figures for the first half of 1904 include 87,582 tons of low-phosphorus pig iron, against 110,699 tons in the last half of 1903 and 89,723 tons in the first half of that year.

The production of basic pig iron in the first half of 1904 was 1,061,901 gross tons, against 836,923 tons in the last half of 1903 and 1,203,803 tons in the first half of 1903. Basic pig iron made with charcoal is not included in these figures.

The production of charcoal pig iron in the first half of 1904 was 213,356 gross tons, against 272,040 tons in the last half of 1903 and 232,717 tons in the first half of 1903. In addition there were produced in Wisconsin and Washington 927 tons of mixed charcoal and coke pig iron in the first six months of 1903. No iron has been made with this fuel since the first half of 1903.

The production of spiegeleisen and ferromanganese in the first half of 1904 was 114,206 gross tons, against 81,986 tons in the last half of 1903 and 110,675 tons in the first half of 1903. The production of ferromanganese alone in the first half of 1904 amounted to 26,541 tons, against 14,118 tons in the last half of 1903 and 21,843 tons in the first half of that year. In addition to the above Tennessee made 304 tons of ferrophosphorus in the first half of 1904.

*Production by Fuels.*—The production of bituminous coal and coke pig iron in the first six months of 1904 amounted to 7,337,279 gross tons, of anthracite and coke mixed to 607,624 tons, of anthracite alone to 15,179 tons, and of charcoal to 213,356 tons. Included in the bituminous figures is a small quantity of ferro-silicon made with electricity.

*Unsold Stocks.*—The statistics of unsold stocks do not include pig iron sold and not removed from the furnace bank, or pig iron manufactured by rolling-mill owners for their own use, or pig iron in the hands of consumers. The stocks which were unsold in the hands of manufacturers or their agents or were under their control in warrant yards or elsewhere on June 30, 1904, amounted to 623,254 tons, against 591,438 tons on December 31, 1903, 126,301 tons on June 30, 1903, and 49,951 tons on Decem-

ber 31, 1902. On June 30, 1904, the American Pig Iron Storage Warrant Company had 78,600 tons of iron stored in its various yards, virtually all of which was controlled by the makers, and all of which is included in the 623,254 tons of unsold iron reported on that date. On December 31, 1903, the company had 47,200 tons in its yards, of which 40,149 tons were controlled by the makers and 7,051 tons were in other hands. No pig iron whatever was stored in its yards on June 30, 1903, or on December 31, 1902.

*Furnaces in Blast.*—The whole number of furnaces in blast on June 30, 1904, was 216, against 182 on December 31, 1903, 320 on June 30, 1903, 307 on December 31, 1902, and 286 on June 30, 1902. The number of furnaces idle on June 30, 1904, was 209. Of the active furnaces on June 30, 1904, 170 used bituminous fuel, 26 used anthracite coal and coke mixed, 2 used anthracite coal alone, and 18 used charcoal alone.

## New Stations on the St. Louis & San Francisco.

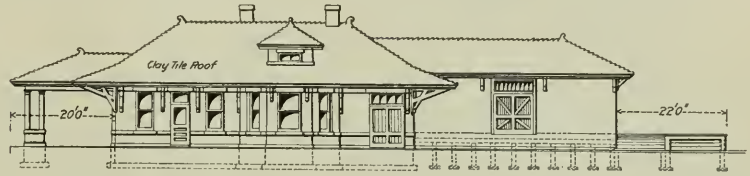
The St. Louis & San Francisco has built 10 or 12 new passenger stations at different points on its main and branch lines in the last two years, some of which are fine examples of modern station architecture. Most of the buildings for the smaller towns and cities are modifications of a standard design and two examples of such stations are shown in the accompanying plans, the one at Bloomfield, Mo., being a combination passenger station and freight house. The stations at Ft. Smith, Ark.; Wichita, Kan., and Tower Grove avenue, St. Louis, are each of special design and are particularly handsome.

The standard design of building for small stations, similar to the Bloomfield and Chickasha stations, is a one-story pressed brick building with cut stone trimmings, corrugated clay tile roof and wood trimmings. The arrangement inside is substantially the same in all. The agents' office is in the center on the track side and extends out in a bay beyond the building line to give a clear view of the track. The baggage room occupies the whole or part of one end of the building and a general waiting room the other end. The main entrance is from the porch or covered platform at the end of the station, opening into the general waiting room. Doors open out to the train platform from the general waiting room and smoking room and an entrance from the rear of the stations is also provided in the general waiting room. The baggage room has sliding doors opening out to the train platform and to the rear of the station also. The roof is carried out 8 ft. beyond the walls to protect the platforms on all four sides. It is supported on ornamental wood brackets. The train platforms in front of the stations are 16 ft. wide and beyond the station at either end are 10 ft. wide. They are concrete and are 300 ft. long. A 10-ft. walk is built around the other three sides of the building and also beyond the covered platform, as in the Chickasha station.

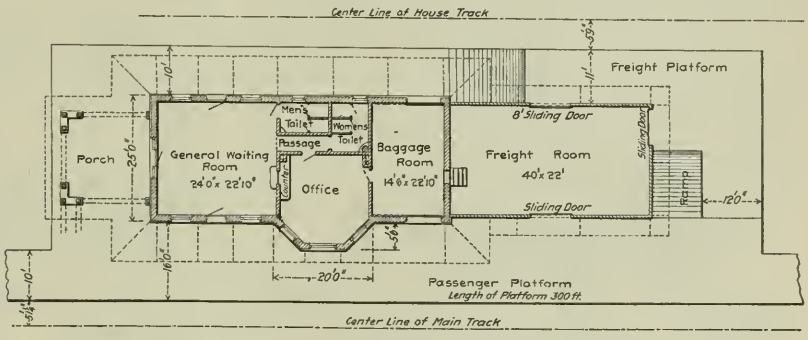
In the combination stations, such as the one at Bloomfield, the freight house is built of wood, sheathed with corrugated iron plates and covered with a tile roof. A raised wooden platform with inclined runways from the street and train platform is built along the rear side and the end. The floor of the building is on a level with the loading platform.

The new station at Ft. Smith, Ark., is the most imposing of any of the new structures. It replaces an old wooden station and is situated a block further west at the corner of Garrison avenue. It is built after the Ionic style, of white dressed stone closely resembling marble, which is quarried near Carthage, Mo. The colonnade at the front faces on Garrison avenue and the portico is supported on ten massive columns with Ionic bases and caps extending up to the full height of the building, arranged in two groups of three columns each, in the center, and flanked by single columns at the corners of the portico. The main part of the building is two stories high, the upper floor being occupied with the offices of the trainmaster, roadmaster and train despatcher.

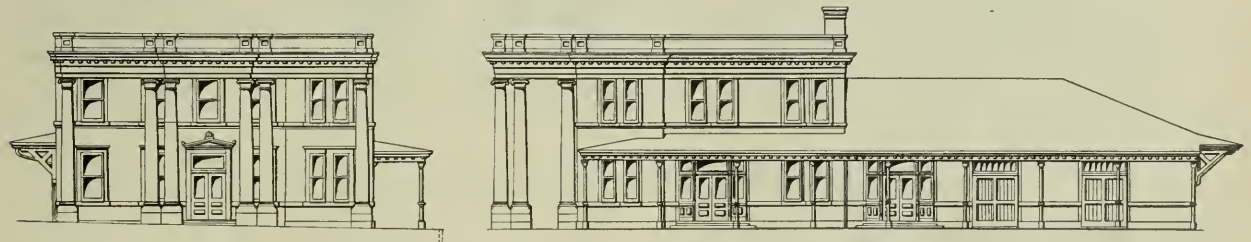
The entrance to the station opens into the main waiting room, which is 26 ft. x 36 ft. 3 in. The ticket office is in one corner, a women's rest room occupies another corner



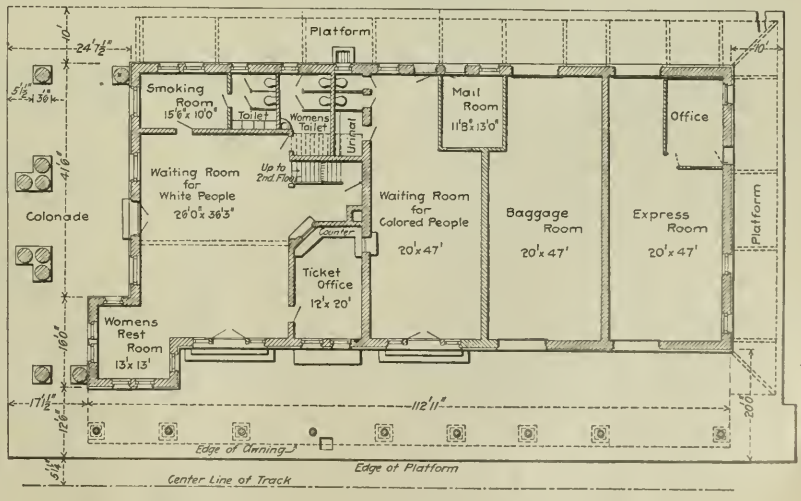

Track Elevation.



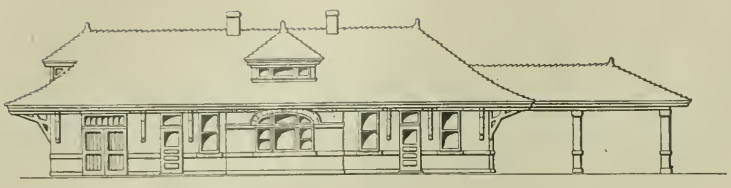

Plan and Elevation of 'Frisco Combination Depot at Bloomfield, Mo.



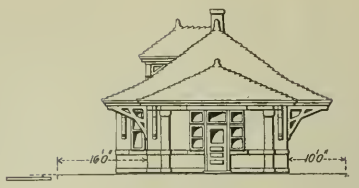
Front and Track Side Elevation of 'Frisco Station at Ft. Smith, Ark.



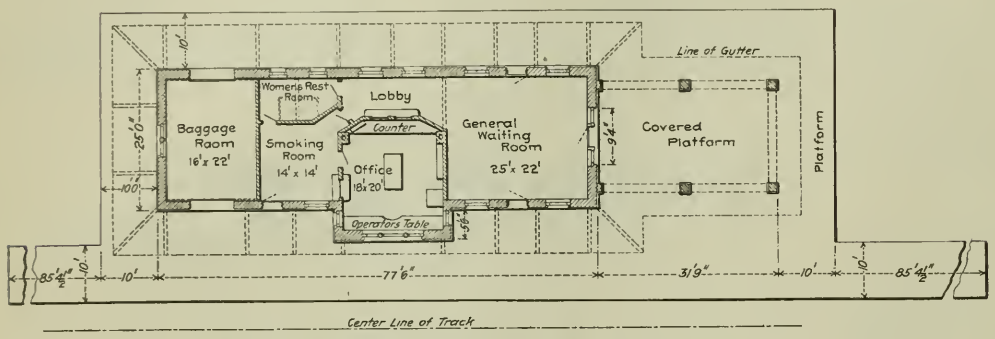

First Floor Plan of 'Frisco Station at Ft. Smith, Ark.



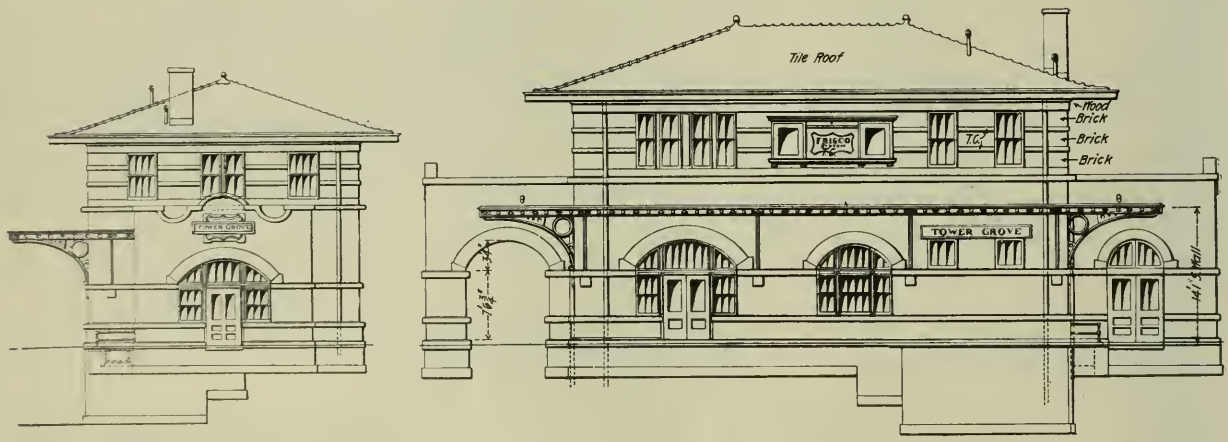
Track Elevation.




End Elevation.




Plan and Elevations of 'Frisco Station at Chickasha, Ind. T.



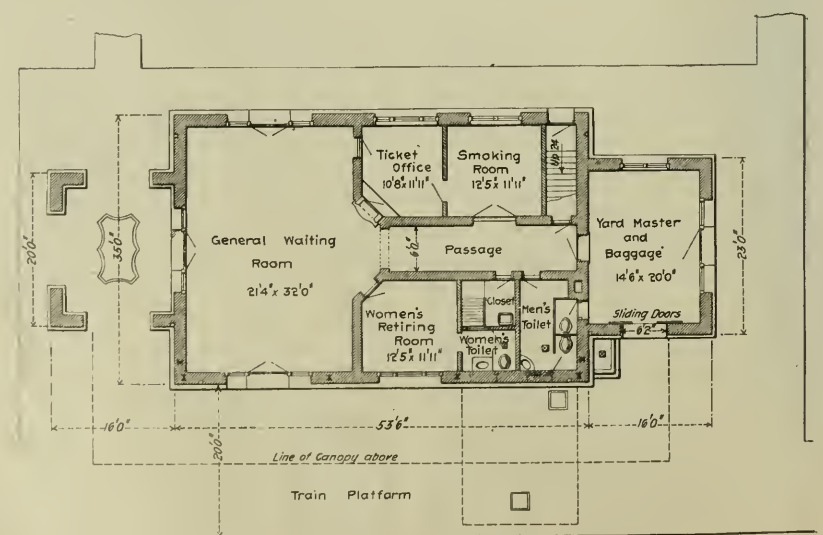

End and Track Elevations of 'Frisco Station at Tower Grove Avenue, St. Louis, Mo.

and the smoking room and men's and women's toilet rooms are along the south wall. The tracks run along the north side of the building and the platform, which is 20 ft. wide, is covered with an awning supported by columns under the gutter. A wide, double door opens from the main waiting room out to the train platform.

The rear of the building is occupied by the colored people's waiting room, baggage and mail room and express room, all opening out on the train platform and also onto a loading platform on the back side, which is protected with an awning supported on wooden brackets. This part of the building is one story high, with a sloping slate roof.

To reduce the expense as much as possible all of the ornamental moldings, caps and other intricate parts were made of Algonite, an artificial concrete stone, made by the Algonite Stone Company, of St. Louis. The pillars are concrete faced with mortar tinted to match the stonework. The interior finish of the building is hard pine and cypress rubbed with oil. A. Anderson & Company, of St. Louis, were the contractors. The station was finished and was put into use about the first of the year.

The Wichita, Kan., station was finished last year and is quite as large and com-




First Floor Plan of Tower Grove Avenue Station.

modious as the Ft. Smith station, although not departing far from other designs in its exterior or interior appearance and arrangement. It is also a two-story building with exterior walls faced with stone and backed with brick. The principal entrance is from Douglas avenue, through a portico under the tower. The main waiting room is 26 ft. x 35 ft. In the center of the building on the first floor are the ticket offices on the track side and a wide hallway on the other, from which two stairways lead up to the offices above. The south end of the building is occupied by the smoking room and women's rest room with the toilet rooms. A passageway 5 ft. wide separates these two rooms and leads into a lobby connecting over a counter with the baggage room, which is a one-story structure built on the station building. A concrete platform runs around the entire building and is protected with a shelter roof supported from the walls on brackets. On the upper floor are the offices of the train despatcher and the district freight and passenger agents.

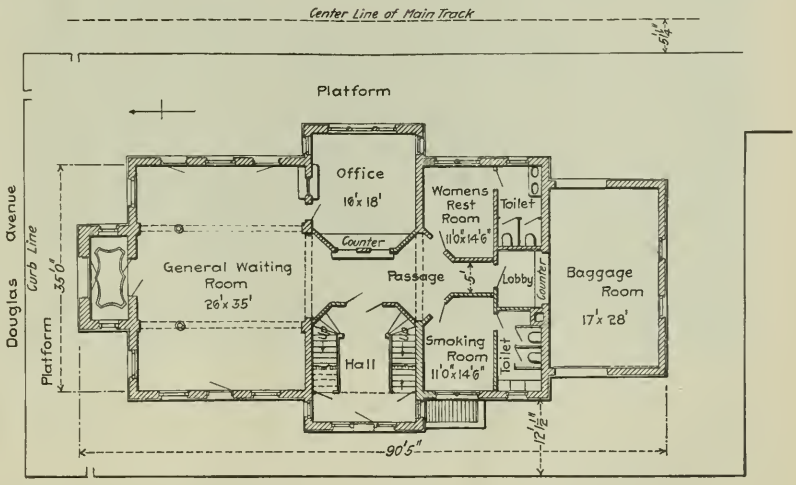
The new station at Tower Grove avenue, St. Louis, has just been completed and is an exceptionally handsome one. It is located at Tower Grove avenue on the north side of the main line tracks of the 'Frisco in the residence district of the city, about three miles from the Union Station and serves a good part of the traveling public in and out of St. Louis. All trains stop at this point to take on and let off passengers. The new building is two stories high, of pressed brick with terra cotta trimmings and tile roof. The entrance is through a portico at the west end, which opens into the main waiting room, 21 ft. 4 in. x 32 ft. Leading off this room is a passage way 6 ft. 4 in. wide, through to the baggage room at the other end of the building. The ticket office and smoking room are on one side of this passage and the women's retiring room and the toilet rooms are on the other. The waiting room and passageway have mosaic tile floors and enameled brick wainscoting 5 ft. high around the walls. All the other rooms have maple floors and plaster finish.

On the second floor are offices for the train despatcher and superintendent of terminals and their clerks. The building is surrounded by a concrete platform and has an ornamental shelter canopy extending out over the platform on the track side. This is held up by iron brackets built into the wall. Suitable tablets of terra cotta with the name of the railroad and the station name are built into the walls over the entrances. Eames & Young, St. Louis, were the architects for this building, but all of the others were designed by C. M. Roquette, the railroad company's architect.

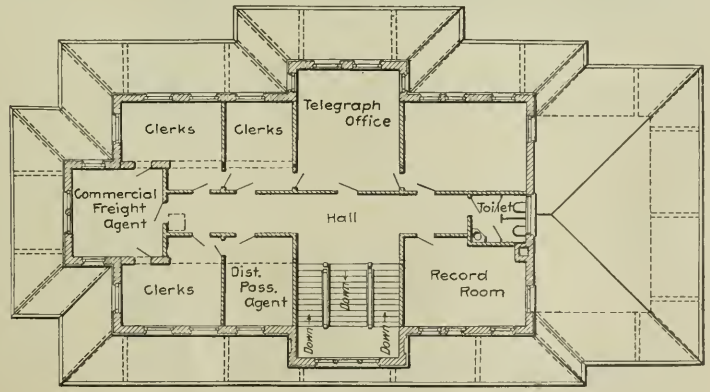
We are indebted to Mr. C. D. Purdon, Chief Engineer, for the drawings.

Track Elevation.

Track Side Elevation of 'Frisco Station at Wichita, Kan.




First Floor Plan of Wichita Station.




Second Floor Plan of Wichita Station.

## Foreign Railroad Notes.

In the Prussian House of Lords the Minister of Public Works reported that the surplus of net earnings of the State railroads for the year ending with April last was $144,704,000, while his estimate at the beginning of the fiscal year was that it would be $118,286,000, and he begged pardon for his error. The returns on the capital invested were 7.3 per cent. The Minister recommended an appropriation of 3,000,000 marks ($714,000) to the employees' sick fund; which was granted.

He spoke of the possibility that the State might soon begin the construction of a new kind of railroad, interurban railroads, between considerable cities, to be worked by electricity at great speed on the open road (38 to 50 miles an hour), but with the cars running over the street railroad at the two termini, and, of course, low speeds, which is certainly the rational way to make such lines convenient to the passengers. Frankfort and Wiesbaden were named as places suitable to be connected by such a line. Wiesbaden has about 60,000 inhabitants, and Frankfort 290,000, and they are 26 miles apart.

The East African Railroad Co. has been formed by a syndicate of German bankers and other capitalists to build the railroad from Dar-es-Salaam, on the coast, westward to Mrogoro, for which the German Empire has guaranteed interest and principal of 21,000,000 marks ($4,998,000). This is expected to make accessible the comparatively healthy interior of German East Africa, by affording quick and comparatively cheap transit through the low country near the coast.

## New Cars for the Boston Elevated.

The Boston Elevated Railroad has recently received from the St. Louis Car Company 24 cars of a design which embodies a number of changes from the so-called Manhattan type. The equipment now in use on the Boston Elevated has a wide sliding door in the middle of the car on each side, and open-end platforms enclosed by gates, which swing back against the platform railing of the car when operated by levers handled by the brakemen standing on the platforms between the two cars. During the rush hours, when the platforms are crowded, these gates are opened and closed only after much pushing and crowding on the part of passengers and delay to the train at the station. The doors in the end of the car also form a restricted passage, which impedes the easy access and egress of passengers. Side doors in the cars assist somewhat in taking on and letting off passengers at busy stations, but they require a guard for each car on each station platform to open and close them, besides the regular guards on car platforms. The new cars for the Subway in New York are built with an enclosed end platform and sliding doors, but the narrow door in the end of the car has been preserved and no side doors in the middle of the car have been provided.

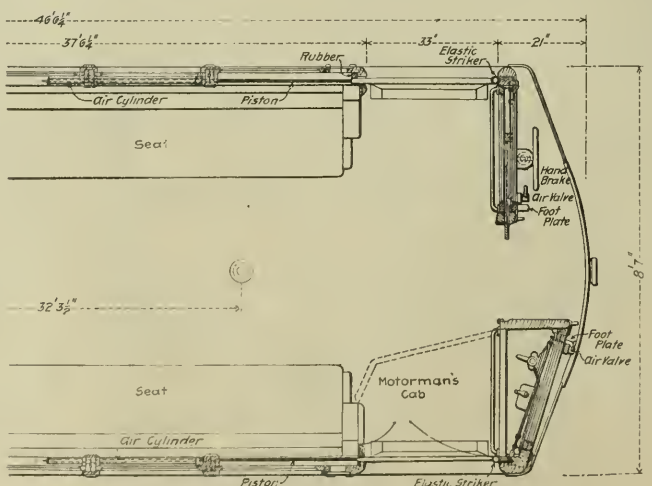
The new cars of the Boston Elevated have been built without platforms at the end; that is, the platform has been enclosed and the end bulkhead of the car body has been removed, making the platform practically a part of the car. Sliding doors instead of gates are provided and a narrow sliding end door has been built in the end of each platform, so as to give access from one car to another, but these doors are intended to be kept closed and to be used only by the brakemen. The end side doors are operated by compressed air drawn from the air-brake system. An air cylinder which has a stroke equal to the width of the door opening is placed in the side of the car just under the side plate. The piston which works in this cylinder is attached to the top of the door and a spring latch is provided to hold the door in place. The foot lever controlling this latch and the valve controlling the door operating cylinder are mounted on the outside of the end of the car. To open the door the brakeman presses on the foot lever, which unlocks the spring latch; then, by operating the air valve he admits air in front of the piston, which forces the door open. When the door is opened fully the valve handle is returned to its mid-position and the air is exhausted from the cylinder. To close the door the valve is turned in the opposite direction, and air is admitted back of the piston. In order to prevent passengers from being injured by the door when it closes, or from having their clothing caught between the door and the jamb, a pneumatic cushion 1 11/16 in. in diameter is fastened along the edge of the door, and this forms a waterproof joint when the door is closed. Any clothing which is caught can be easily removed. A rubber cushion is also fastened along the back edge of the door to take up the shock of the door's closing.

New Type of Car for the Boston Elevated.

Interior View of End of New Cars for the Boston Elevated.

This arrangement of enclosed platform and sliding doors permits a considerable increase in speed of handling passengers in and out of the cars and adds greatly to their comfort by providing a space wide enough for two lines of people to enter the body of the car without crowding or crushing. The interior carrying capacity of the car is also largely increased. Instead of having to cross over both platforms, the brakeman can make station announcements without leaving his place between the two cars. The motorman's cab is formed by two folding doors, one of which folds back against the end of the platform and encloses the brake and controlling apparatus when the car is not in the head end of the train. The other door folds back against the end of the car body.

We are indebted to Mr. C. S. Sergeant, Vice-President of the Boston Elevated Railroad Company, for the illustrations and details of the description.




Plan of End of New Cars for the Boston Elevated.

## The Tropical Fruit Traffic.

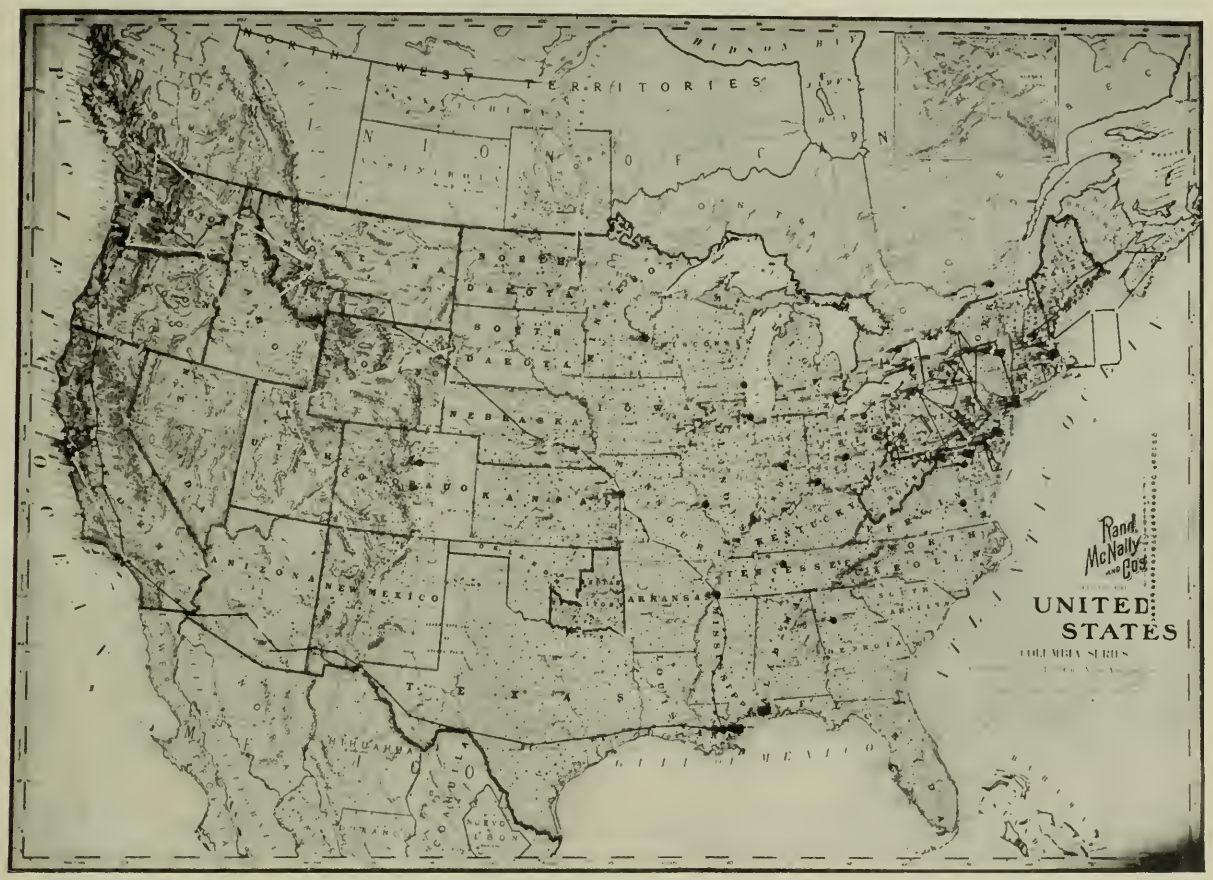
Within the last few years the United Fruit Company, which is now in control of probably 75 per cent. of the banana business in this country, has built up so important an industry and one of so unusual a character that it is of special interest to the rail transportation lines. It is only a short time, relatively speaking, since bananas were scarce everywhere except in the cities along the Atlantic and Gulf ports, and were to be classed rather as a tropical luxury than as a staple article. Although shipped green, it was of the utmost importance that they should be handled with great care and with great rapidity, and until the plantation methods, the shipments and the rail connections were thoroughly harmonized the loss of the fruit in transit greatly restricted the territory to which they could be delivered at a low price.

The United Fruit Company was organized in March, 1899, and in the year following approximately 15,000,000 bunches of bananas were shipped from Jamaica, Costa Rica and the plantations in Cuba, Honduras, etc., a quantity which at that time was looked upon as being extremely great. Yet in four years the business was so developed that in 1903 it amounted to 23,413,892 bunches, while preliminary estimates for the year ending September 30, 1904, indicate that the total shipments will aggregate about 26,000,000 bunches. The company now works a fleet of 83 steamers, collecting fruit from a number of points in Central America, from Cuba, Jamaica, Haiti and Santo Domingo, and delivering it at New Orleans, Mobile, Charleston, Norfolk, Baltimore, Philadelphia, New York and Boston by direct lines. Some of the newer steamers in the company's fleet are provided with air blast ventilation, but in the majority of cases the ship's ventilators supply all that is necessary. On the smaller vessels, the hold as a rule contains only two layers of bunches, which are set on end, one above the other. This is the ordinary method of packing the fruit, although in some cases, where the lower deck is also used, the top layer of bunches is laid flat on those standing.

In either case a considerable air space is left between the top of the fruit and the deck overhead. The care with which this kind of a cargo must be handled, precludes even the use of steam winches or of any kind of labor-saving device, so that a large force of men is required to load and unload the ships. Five gangs of 25 men each are about what is required on one of the smaller vessels, and the bunches are handed up from the hold to a man standing on the 'tween decks, and so on to the deck, and on the car or truck. Since the first of July the fruit has been sold by the hundredweight. Prior to that time it was sold by the bunch; the bunches, or stems, being classified according to the number of "hands" of bananas they contained. Most of the fruit which commands the best market price is on stems of eight hands, each hand containing about 12 bananas, so that a bunch consists of from 90 to 100 bananas, and weighs some 45 or 50 lbs. With the quality of the fruit the same, the full-sized bunches of eight or nine hands command a higher price than the smaller bunches, per hundredweight.

Great care is taken in accounting the cargo, and each stem as it leaves the hold is tallied on a street car cash register of the familiar type. Besides this, bunches are similarly tallied as they are placed on board the fruit car or truck at the dock, and the tally and the invoice are audited together, after the fruit has been delivered. As the cargo unit is always the same—the stem, or bunch—it will be seen that this cash register system affords a very quick and easy system of tallying any loss or fraud.

Green fruit alone is shipped to any distance from the steamer port. There are always some ripe bananas in the cargo, and these, together with the bunches of green fruit which are rejected because of defect in size, or in the number of fruit on the stem, are sold to local dealers or consigned to short-haul points. The capacity of the larger vessels of the company, one of which is shown in the accompanying illustration, is from 25,000 to 30,000 stems, equivalent to some 2,750,000 bananas. The capacity of the smaller vessels, constituting the majority of the fleet, ranges in the neighborhood of 18,000 stems.

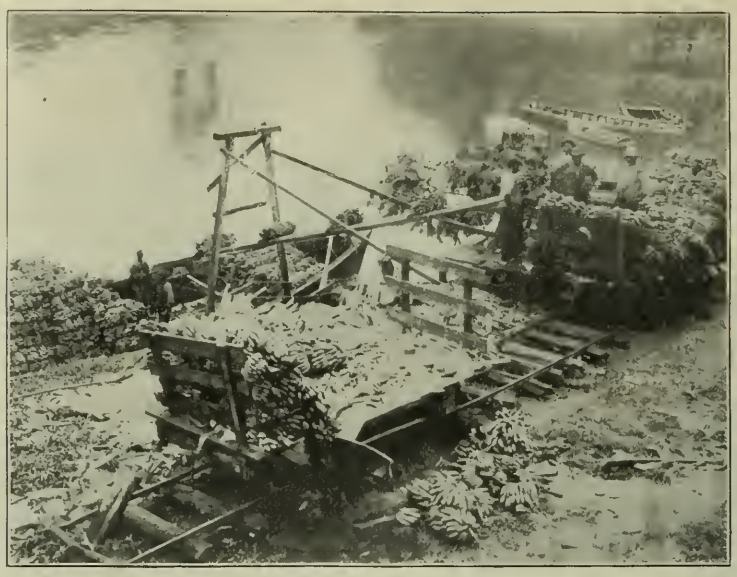



Route Map, Fruit Despatch Co. (United Fruit Co.).

The report last issued, that for the year ending September 30, 1903, showed that the company owned an improved plantation acreage of 92,523 acres and an unimproved acreage of 172,996 acres, giving a total acreage of 265,519. The largest holdings are in Costa Rica, where 108,902 acres are owned, of which 32,060 are improved. In Cuba 75,761 acres are owned, and the aggregate holdings in Jamaica, Santo Domingo, and the Republic of Colombia amount to over 80,000 acres, besides which 500 acres of improved plantation land were owned in Honduras. The company has recently been increasing its holding of sugar-cane plantations in Cuba, and now owns some 10,000 acres, in addition to some considerable acreage of cocoanuts and oranges, but the center and heart of the

industry at present is the production and transportation of bananas. It has its own railroad facilities, in whole or in part, in each of the main territories where it works, amounting in 1900 to a total of 124 miles. The accompanying illustrations show the shipment of fruit by rail and by boat in Costa Rica. In addition to the American business, shipments of bananas and other tropical products have been made regularly by the company from the West Indies and Central America to England during the last year or so, and the results have been so satisfactory that three additional steamers are now being built especially for the European trade. The business is handled by a company organized under the laws of the United Kingdom, in which the United Fruit Company owns half the capital stock.

With the fruit landed at the dock, however, there still remains the problem of rail transportation, for it is imperative that the enormous traffic be handled without delays, with great care, and in a thoroughly systematic manner. A reproduction of the company's route map is shown with this article. The entire land business is handled by a subsidiary organization known as the Fruit Despatch Company, which was formed in December, 1898, to be the medium of distribution for the Boston Fruit Company. The main divisions of the Fruit Despatch organization are indicated on the route map by octagonal brass checks, which can be seen in the illustration. Each of these divisions controls several branch houses, indicated by the small, black stations on the map, and each branch house is in charge of a large number of agencies. On the actual route map, these agencies are marked by white thumb tacks with a number on the head, which classifies them according to the branch house to which they report, but the facsimile is so greatly reduced that they scarcely show.



Loading Bananas at Cricamola, Costa Rica.

Banana Farm in Costa Rica.

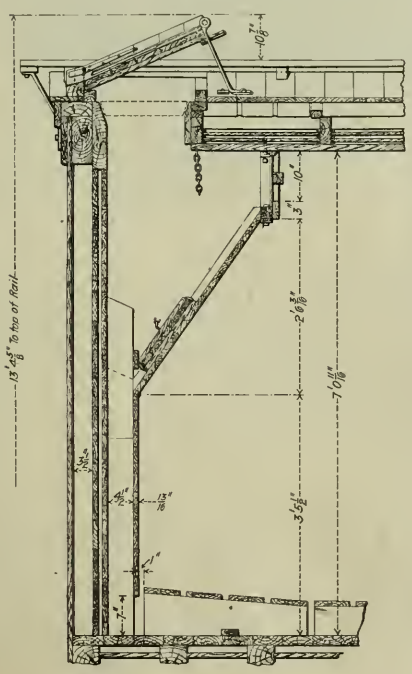
The lines on the map are strings of different colors, stretched to show the routes and the connections made for shipments to long-haul points over several lines of railroad. Thus, the way in which the fruit is sent from New Orleans to Denver is graphically indicated. In general terms, about half of the fruit is received at ports on the Gulf of Mexico and about half at ports on the Atlantic, and the division of territory is made according to this basis. Shipments to the New England States, to Montreal, to the greater part of Pennsylvania and Ohio, and as far south as Richmond, would commonly be made from New York, Philadelphia, Baltimore or Boston. Detroit, Cleveland and Columbus are on the borderland between the main eastern and southern divisions, and may receive shipments from either. But the territory east of this irregular boundary line is such a consumer of fruit that the business done in this section, geographically unequal, is approximately the same as that done by the company in all the rest of the country together. Shipments to the southern Atlantic cities can be more readily made from Norfolk or Charleston, but the entire West is served from New Orleans and Mobile. There are regular stations for the receipt of fruit as far away as Vancouver and Winnipeg, the time of shipment from New Orleans to these points being 15 or 16 days.

Free circulation of air is the only satisfactory agent for preserving the fruit in good condition en route during hot weather, and no ice is used. The drawing of the car built by the American Car & Foundry Co. specially for this traffic, for use on the New York Central, illustrates what has been found to be the best type of ventilation for the service. The air enters the rear end of the car by means of the roof ventilator, and is deflected under a grating, on which the fruit rests, to the forward end of the car. The ventilator on this end serves as an up-take and even a slight motion of the car creates a strong draft, which drives the cold air in underneath the fruit and removes the hot air on top. Whichever way the car is moving, forward or backward, the draft is of equal force, although changing its direction.

Solid Train of 15 Fruit Cars, New York to Montreal.

The Delaware, Lackawanna & Western also has some extremely satisfactory cars in service built especially for the trade, in which the ventilation works on the same plan, although the air chamber is of a different shape, and there are arrangements for carrying ice in case the cars are used for other kinds of produce. Out of Mobile and New Orleans the fruit is chiefly handled by the Fruit Growers' Express and by the refrigerator cars on the Southern Pacific. At times the shipments are made on special trains; otherwise on the regular fast freight service. The Illinois Central banana expresses, which run solid from New Orleans to Chicago in 33 hrs., when required, have been described in a previous issue of the *Railroad Gazette*, [August 28, 1903]. An insulated fruit house has been built on this line at Mounds, Ill., holding 80 cars, and another is now building at Springfield, Mo. The house at Mounds has a heater, but no cooling plant. The house at Springfield will have both. A special banana train of 15 cars, bound from New York to Montreal, is also illustrated herewith, and it is an interesting commentary on the growth of the business that a point so isolated should require so large a shipment at one time.

In loading the bananas on cars as they are taken from the ships, great care is taken to have them properly classified according to the number of hands on the stem. To provide for this, a flag is placed by the door of each fruit car, numbered 8, 7, etc., according as the car is to receive stems of 8 hands or 7 hands. In order to provide against the stupidity or ignorance of the gang of laborers who carry the fruit, each kind of flag is made a different color. One car commonly is marked with a yellow flag, bearing the letters "RIP" and a green flag bearing the letters "REJ." This indicates that this car is to receive the ripe fruit and also the broken or rejected bunches of green fruit, which, as previously stated, are classed together and sold to local jobbers. Each car is carefully weighed by the Fruit Despatch Company before it is sent out, and a card is placed on it giving the number of the car, the marked weight and the actual weight. As for example, car 6,706, marked weight, 42,000; actual weight, 41,900. This facilitates selling the fruit by the hundredweight in carload lots. A ventilated fruit car of the kind in common service contains about 450 bunches, which are laid in two layers, the lower one of stems standing on end and another one laid across on top of them. This leaves approximately half of the car free for the circulation of air on top of the fruit, and enables the bananas to be kept cool, while the hot air is thrown off the upper part of the car.



Ventilating Apparatus for Fruit Car.

Sales by the Fruit Despatch Co. during 1903, representing what might be called the gross operating earnings of the United Fruit Co., aggregated over $8,000,000, and the company disposed of nearly 25,000 carloads of tropical fruit.

Steamer Admiral Sampson Leaving Port Antonio, Jamaica.

## Single Phase Electric Traction in Europe.

That long-distance heavy electric traction problems call for a system using high-tension alternating currents is now quite generally recognized. But the question whether three-phase or single-phase alternating currents are best suited for this purpose has not yet been definitely decided. The three-phase system has been successfully employed for a number of years on several European roads. But the modern demand is for a single-phase system on account of its alleged greater simplicity and greater efficiency of regulation. There are three completely worked out single-phase systems now on the market, the one of the Westinghouse Co., with a motor brought out by Lamme, the General Electric system with a motor originally designed by Eickemeyer and greatly perfected by Steinmetz, and the Finzi system, using the Finzi motor. The Finzi system has already been tried successfully on the street car lines of Milan, Italy, and the two American systems have been experimented with for some time past in the yards of the two manufacturing companies and are now being installed on different interurban electric railways in this country. We may thus expect to hear comparatively soon of the results obtained with them in regular service.

In the meantime Europe is going in for regular trunk-line work on a single-phase basis and a real competitive test between three-phase and single-phase systems is now being prepared there. The Societá Italiana per le Strade Ferrate Meridionali, already operating its well-known Valtellina Railroad by means of the three-phase system, has just decided to make extensive experiments with the Finzi single-phase system with a view to obtain results which would guide it in its future policy in regard to electric traction matters. The Valtellina Railroad is a normal gage line operated distinctly under steam railroad conditions and connecting Como with Lecco, Colico, Sondrio and Chiavenna in the northern part of Italy. For the last few years this road has been operated as a three-phase alternating current road. Its power station is situated in the Alps and generates 20,000 volts at 15 cycles per second. Twelve transformer substations distributed along the line reduce this tension to 3,000 volts, which is directly fed to the overhead contact line. The rolling stock consists of passenger motor cars and freight locomotives, both of the double-truck type and both equipped with one three-phase induction motor on each of the four driving axles. The passenger motor cars usually haul two or more trailers, and the locomotives are coupled to the ordinary freight trains in the manner customary on steam roads.

The administration of this road, naturally greatly interested in all electrical progress, has for some time been anxious to compare the merits of the three-phase and the single-phase systems, and it has now ordered a series of impartial tests, which will undoubtedly furnish a great amount of valuable information in this respect. After careful consideration of the merits of the various single-phase systems a Finzi single-phase equipment was ordered to be installed in one of the standard Valtellina motor cars, the equipment to consist of four single-phase alternating-current motors, each rated for a normal output of 100 h.-p. at 200-400 volts, together with the necessary controlling apparatus. The car is to be controlled electrically from either end, but no rheostat will be used, thus making the regulation very efficient. The current will be taken direct from the 3,000-volt overhead contact line by means of the standard type of Valtellina roller trolley. Each of the four motors will drive one of the four axles of the double-truck car by means of an intermediate gear. This car, as well as the three-phase cars now in use, will be called upon to haul a 100-ton train from Lecco to Sondrio at a speed up to 45 miles per hour. Further details regarding these tests are not at present available, but they will undoubtedly be watched carefully by all interested in electric traction matters. The Finzi system is represented in this country by Muralt & Co., of 25 Pine street, New York.

## Accident Bulletin No. 11.*

The Interstate Commerce Commission has issued Bulletin No. 11, showing railroad accidents in the United States during the three months ending March 31, 1904. The number of persons killed in train accidents was 221, and of injured 2,797. Accidents of other kinds, including those sustained by employees while at work, and by passengers in getting on or off the cars, etc., bring the total number of casualties up to 919 killed and 12,444 injured. These reports deal only with (a) passengers and (b) employees on duty.

*Table No. 1.—Summary of Casualties to Persons.*

| | Passengers. | | Employees. | |
|---|---|---|---|---|
| | Killed. | Inj'd. | Killed. | Inj'd. |
| Collisions | 33 | 661 | 99 | 1,006 |
| Derailments | 7 | 313 | 55 | 391 |
| Miscellaneous train accidents (excluding the above), including locomotive boiler explosions | .. | 21 | 27 | 405 |
| Total train accidents | 40 | 995 | 181 | 1,802 |
| Coupling or uncoupling | .. | ... | 70 | 857 |
| While doing other work about trains or while attending switches | .. | ... | 65 | 2,826 |
| Coming in contact with overhead bridges, structures outside of track, etc. | .. | 2 | 37 | 317 |
| Falling from cars or engines or while getting on or off | 25 | 295 | 143 | 2,453 |
| Other causes | 14 | 298 | 344 | 2,599 |
| Total (other than train accidents) | 39 | 595 | 639 | 9,052 |
| Total all classes | 79 | 1,590 | 840 | 10,854 |

The most prominent items in the foregoing table show a gratifying falling off, both from the figures of the preceding quarter (Bulletin No. 10) and from those of this quarter a year ago (Bulletin No. 7), though, of course, it is only in making such a comparison that any gratification can be found in a record of deaths averaging 10 persons a day. The number of employees killed by falling off cars, etc. (143), is 32 per cent. less than the record in Bulletin No. 10. This, very likely, may be due to the increased use of air-brakes on freight trains, diminishing the necessity for the men in charge of such trains to ride on the tops of box cars. The diminution in the figures as a whole is made in spite of a record of passengers killed in one class—collisions—which is large. Of the 33 fatalities in this class, 18 are chargeable to one collision (No. 18 in Class A).

Of the total in the table below, 294 collisions and 144 derailments affected passenger trains.

*Table No. 2.—Collisions and Derailments.*

| | Number. | Damage to Road and Equip. | Kill. | Inj. |
|---|---|---|---|---|
| Collisions, rear | 526 | $536,656 | 40 | 527 |
| Collisions, butting | 217 | 390,213 | 56 | 546 |
| Collisions, trains separating | 238 | 102,038 | 1 | 96 |
| Collisions, miscellaneous | 678 | 331,506 | 35 | 498 |
| Totals | 1,659 | $1,362,813 | 132 | 1,667 |
| Derailments. | | | | |
| Defects of roadway | 222 | $172,900 | 11 | 217 |
| Defects of equipment | 530 | 411,625 | 10 | 124 |
| Negligence | 74 | 80,423 | 9 | 66 |
| Unforeseen obstruction | 93 | 82,148 | 15 | 110 |
| Malicious obstruction | 9 | 11,964 | .. | 23 |
| Miscellaneous causes | 212 | 134,604 | 17 | 164 |
| Total | 1,149 | $893,664 | 62 | 704 |
| Total collisions and derailments | 2,799 | $2,256,477 | 194 | 2,371 |

In collision No. 18, shown in the double column table, 18 passengers were killed. The circumstances of this case are typical of those features of train management which give rise to the charge, often repeated in various public prints, that American railroad management is reckless. The men in charge of the passenger train in this case had positive written orders to look out for (and meet) a freight train, with an engine of a certain number, at a certain place. This order was delivered to and read by both the conductor and the engineman. The freight train had not reached the appointed meeting place, and the only thing to be done by the men in charge of the passenger train—the regular and usual thing—was to stop their train and wait until the freight train should arrive. But another freight train was there on the side track, and it was *assumed* that that was the one specified in the meeting order. The conductor, apparently, made no effort to identify the freight engine, trusting that his engineman would do so; and the engineman, evidently, was willing to take the risk of passing on (at full speed, no stop being required at that station for leaving or taking passengers), knowing that if his assumption proved wrong he would in all probability cause much damage to property, if not great loss of life. In point of fact, he caused both.

The other cases in the list which are most prominent, on account of being fatal to passengers, are collisions 15 and 20. The last named appears to have been occasioned by the very severe weather which prevailed in January. Two other accidents, both costly, were due, in part, to the unusually low temperature which was so widespread in that month—collision No. 13 and derailment No.

*The *Railroad Gazette* train accident record for January, February and March will be found in the issues of February 26, March 25 and April 29.

Causes of Twenty-six Prominent Train Accidents (Class A).

[Note.—R. stands for rear collision; B., butting collision; M., miscellaneous collisions; D., derailment; P., passenger train; F., freight and miscellaneous trains.]

COLLISIONS.

| No. | Class. | Kind. | Kill'd. | Inj'd. | Damage to Road and Equip. | Record. No. | Cause. |
|---|---|---|---|---|---|---|---|
| 1 | B | F. and F... | 0 | 3 | $2,300 | 59 | Despatcher (experienced and with good record) overlooked orders; his age 32 years. |
| 2 | B | F. and F... | 1 | 0 | 2,400 | 55 | Engineman (who was killed) fell asleep 3 or 4 minutes before reaching meeting point. |
| 3 | B | F. and F... | 0 | 16 | 3,160 | 15 | Sixteen employees, who were injured, were riding in caboose, which was the leading car of a work train moving westward; engineman of eastbound passenger train misread name of station in order. |
| 4 | B | P. and F... | 0 | 6 | 3,600 | 54 | Wrong signal given; back wire of signal had been frozen and was disconnected; front wire probably pinned down by a piece of iron dropped from a train. |
| 5 | B | F. and F... | 0 | 4 | 3,900 | 40 | Butting collision of extra freight trains; despatcher failed to make meeting point; his experience 13 months as despatcher, 12 years as operator. |
| 6 | B | P. and P... | 0 | 14 | 4,941 | 52 | Conductor neglected to deliver meeting order to engineman. |
| 7 | B | F. and F... | 0 | 3 | 5,000 | 14 | Operator, 8 months' experience, failed to deliver order. |
| 8 | B | F. and F... | 1 | 0 | 5,900 | 41 | Flagman, who had been ordered to hold one of the trains, went into caboose to get red light; sat down to warm himself and dry his clothes; fell asleep; had been on duty 16½ hours. |
| 9 | B | P. and F... | 1 | 2 | 7,298 | 11 | Engineman and fireman of empty engine misread telegraphic order; engineman in handing order to fireman told him what it read, but did not tell him correctly; order read "2d No. 1;" these men read it No. 1. |
| 10 | B | F. and F... | 1 | 8 | 7,400 | 57 | Operator failed to notify southbound train that a northbound train, first section, had brought to that point signals for a second section. |
| 11 | B | F. and F... | 2 | 1 | 8,730 | 60 | Operator signed conductor's name to order, but then failed to deliver it; expected conductor to come into office for clearance card, but conductor neglected this duty; both experienced men. |
| 12 | R | P. and P... | 0 | 11 | 10,242 | 2 | Collision within yard limits; foggy; failure to flag. |
| 13 | R | F. and F... | 0 | 4 | 10,400 | 7 | Air-brakes frozen and would not work; conductor and brakeman in caboose did not hear whistle signal for hand-brakes. |
| 14 | B | P. and P... | 2 | 8 | 12,526 | 33 | Misplaced switch (10 p. m.); brakeman, for some unaccountable reason, turned switch in face of train. |
| 15 | M | P and F... | 3 | 3 | 14,500 | 30 | Passenger train ran past station; in setting back, ran over a switch, which had meantime been turned, and crushed caboose of freight train on side track; 3 passengers in caboose killed; freight brakeman, in charge of switch, 22 years old; on duty 14 hours 58 minutes. |
| 16 | B | P. and F... | 5 | 8 | 17,100 | 53 | Engineman of northbound train neglected to examine register, and so was ignorant of non-arrival of southbound train; proceeded and collided with it at 30 miles an hour. Engineman depended on conductor to check southbound train, but conductor failed to check correctly. |
| 17 | B | P. and F... | 0 | 9 | 19,000 | 13 | Northbound passenger ordered to wait for 4 southbound freights; waited only for 3; operator also at fault for clearing signal. |
| 18 | B | P. and F... | 18 | 37 | 26,500 | 3 | Occurred 1 a. m.; passenger train passed a meeting station without stopping; conductor and engineman did not correctly identify freight met at station. |
| 19 | M | P..... | 0 | 11 | 27,180 | 61 | Passenger train entered siding at night at high speed; misplaced switch; some evidence that it had been maliciously misplaced. |
| 20 | R | P. and P... | 4 | 9 | 29,400 | 1 | Foremost train standing at water tank; second train following too closely; furious snowstorm and wind, and very low temperature. |
| | | Total..... | 38 | 157 | 211,477 | .. | |

DERAILMENTS.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | D | P..... | 0 | 7 | $10,300 | 29 | Unknown. |
| 2 | D | P..... | 0 | 0 | 10,400 | 65 | Broken wheel. |
| 3 | D | F..... | 0 | 0 | 11,500 | 24 | On 1½ per cent. grade; air-brakes failed; extremely cold weather; packing leather in air-brake cylinders frozen, allowing air to leak out; engineman, 3½ years' experience, failed to call for hand-brakes in season. |
| 4 | D | F..... | 0 | 0 | 11,901 | 48 | Broken flange; wheel cast-iron, 33 inches, 600 lbs., made in 1893; chill was too deep and wheel was not bored true. |
| 5 | D | P..... | 0 | 0 | 14,121 | 44 | Track distorted by solar heat. |
| 6 | D | P..... | 0 | 0 | 23,260 | 49 | Misplaced switch; wreck burned by fire starting in oil which ran out of the tender. |
| | | Total..... | 0 | 7 | $81,482 | .. | |
| Total col. and derail... | | | 38 | 164 | $292,959 | .. | |

3. A brake failure due to freezing of packing leather has never before appeared in these records.

Misconduct or negligence of telegraph operators is given as the chief or principal cause of 4 collisions costing $40,130 in damage to cars and engines and the loss of 3 lives. These are Nos. 7, 10, 11, and 17. One operator failed to deliver an order; one failed to give an oral notice, or notice by flag or signal, and one signed a conductor's name to an order without having been authorized to do so; and in the fourth case, although the conductor and engineman were primarily to blame, the wrongful clearing of a train-order signal by the operator was the final act which made the collision possible. Two collisions, Nos. 1 and 5, were due to mistakes of despatchers—and despatchers are presumed to be men who have made good records as operators.

Collision No. 9 is notable as being the fourth case recorded recently as due to precisely the same error in reading a written order—the overlooking of "2d," or "Second." Two such cases appeared in Bulletin No. 8, and a third in Bulletin No. 9. This would seem to point, obviously, to the need of a change in the scheme of numbering or naming trains, or in writing the numbers or names in despatchers' orders. Collision No. 3 was also due to misreading, no explanation being given except that the name which was written and the name which the reader assumed both begin with "St."

## The Mexican Central Shops at Aguascalientes.

A preliminary description of these shops, with a general plan of the proposed layout of the yard and buildings, was printed in the *Railroad Gazette*, April 6, 1900. The plant has been completed and in operation for some time now. The following description has been sent us by Mr. C. T. Bayless, Mechanical Engineer of the road, through the courtesy of Mr. Ben Johnson, Superintendent of Machinery:

The consolidation of the Mexico City and San Luis Potosi shops of the Mexican Central into one general repair shop at Aguascalientes has practically been accomplished, and the headquarters of the mechanical department have been moved from Mexico City to the latter place. Aguascalientes, being at the junction of the Mexico and San Luis divisions, is the ideal location for a general shop and a center for material distribution to the entire system. The two old shops had been found insufficient to handle the repairs incident to a greatly increased equipment, and their consolidation has been brought about for the purpose of securing a better economy, together with increased facilities and greater capacity. Very few new machine tools have been purchased, but a much larger output from the old ones has been secured by their judicious arrangement and the provision of better facilities for handling the work.

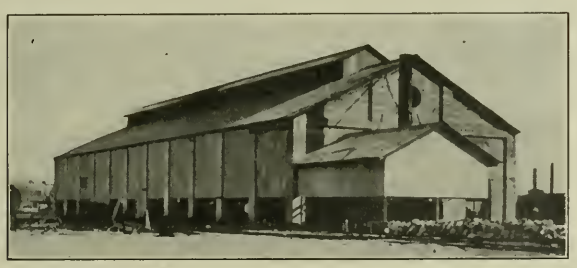
List of Tools in Hammer and Smith Shop.

| Tool No. | Description. | Method of Driving. | Motor No. | H.-P. of Motor. |
|---|---|---|---|---|
| | INDIVIDUAL MOTORS. | | | |
| 140. | No. 9 Sturtevant blower | Motor belted to a. c. s. | 55 | 20 |
| 142. | Axle cut-off and centering lathe | Motor belted to a. c. s. | 56 | M. V. 5 |
| 143. | Double punch and shear | Motor geared to machine | 54 | 20 |
| 145. | Bulldozer | Motor belted to a. c. s. | 53 | 20 |
| 158. | No. 7 Sturtevant blower | Motor belted to a. c. s. | 62 | 10 |
| | GROUP DRIVEN. | | | |
| | Group "A." | | | |
| 134. | 4-ft. grindstone | Motor belted to lineshaft "A" | 61 | 5 |
| 135. | 36-in. drill press | | | |
| 289. | 18-in. shaper | | | |
| | Group "B." | | | |
| 136. | Switch and frog planer | Motor belted to lineshaft "B" | 59 | 15 |
| 117. | Switch and frog planer | | | |
| | Group "C." | | | |
| 146. | Bolt header | Motor belted to lineshaft "C" | 91 | 20 |
| 150. | Washer machine | | | |
| 151. | Bolt headers | | | |
| 152. | Nut tapper | | | |
| | Group "D." | | | |
| 155. | Upsetting machine | Motor belted to lineshaft "D" | 52 | 20 |
| 157. | Rivet machine | | | |
| 1. | 3-in. bolt cutter | | | |
| | Total electrical horse-power in this shop | | | 135 |

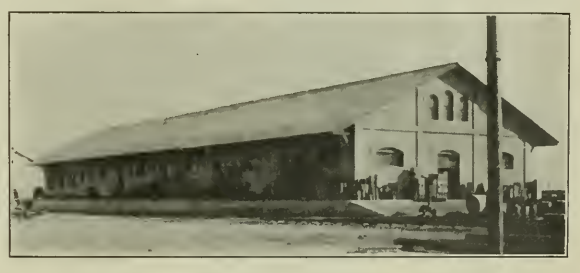
The design and construction of the buildings has been under the care of Mr. Lewis Kingman, Chief Engineer, and Mr. H. Bentele, Assistant Chief Engineer. Mr. Ben Johnson, Superintendent of Machinery, assisted by the writer and Mr. R. M. Henderson, Electrical Engineer, has had complete charge of the design and installation of the power plant and the equipment of the shops. The actual work of installation of the power house machinery and cranes, and the wiring for power distribution was done by contract by the D'Olier Engineering Company, Philadelphia, under the supervision of the mechanical department of the railroad.

*General Plan.*—The general plan of the yard and buildings is shown in the accompanying illustration, in which all buildings actually completed are shown by full lines, while future buildings and additions to the present ones are shown dotted. To the north of the shop yard is the yard of the timber preserving plant for treating cross ties, bridge timbers and telegraph poles by the Wellhouse or the zinc-chloride-glue-tannin process. Both of these yards are enclosed by a 10-ft. adobe wall with stone foundation, brick pilasters and brick coping. The adobe is plastered and whitewashed, giving the appearance of stone. These walls are necessary to prevent thieving, which is one of the greatest sources of loss to the railroads in Mexico. Outside and to the west of the shop yard is the general freight yard, water tanks, cinder pits and coal chute, as Aguascalientes is both a freight and passenger division terminal. To the east and south of the yard are the company cottages for employees and the general hospital of the system, where the headquarters of the Chief Surgeon, Dr. H. S. Squires, are located.

The buildings for locomotive repairs, viz.: machine, boiler and erecting shop, hammer and smith shop (and in the future a tank shop), are grouped together with the roundhouse and oil house at the south end of the yard. The car repair buildings, consisting of a truck, wheel and axle shop, planing mill and coach shop are grouped at the north end, while the material buildings, consisting of iron and brass foundries, rolling mill and storehouse, are in the center. Owing to the mild and equable climate such material as boiler and tank steel, iron castings, couplers, wheels, tires, etc., are stored in the material yard not under cover. The storehouse proper is reserved for small articles and such material as is easily perishable or liable to be stolen. The power house is located with reference to the center of power distribution, and cables strung on iron poles carry the current to the different buildings. All the water for the shops, hospital and company houses is supplied at present by two dug wells, one outside the wall near the office building, and the other at the timber treating plant. Water from the shop well is pumped up into a 100,000-gal. steel tank and that from the timber plant well into a 33,000-gal. tank. Both tanks connect with the water main, which also runs off northeasterly to a reservoir of about 350,000,000-gal. capacity, which it is hoped will be filled during the rainy season that lasts from about June to October.



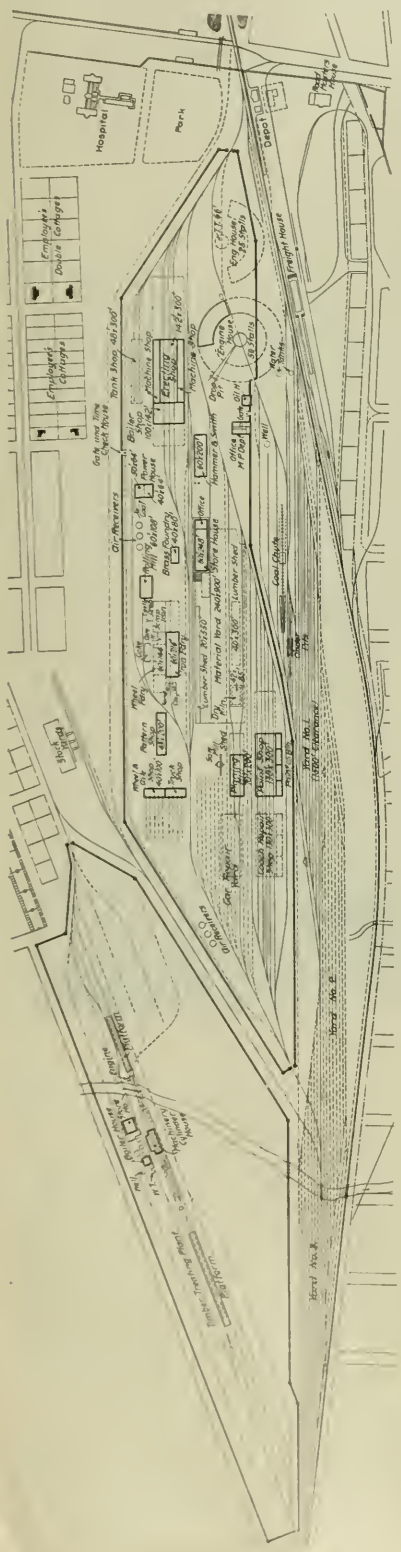
Hammer and Smith Shop.



Material Storehouse.

*Hammer and Smith Shop.*—The hammer and smith shop, located near the north end of the machine erecting and boiler shop, is 63 ft. wide by 201 ft. long. The rolling mill, iron foundry and planing mill are similar. The end walls and side columns are of concrete, roof trusses are of yellow pine, and side walls and roof are of galvanized corrugated iron. The side walls are open for a height of 6 ft. 9 in. above the ground and the corrugated iron sheets are fastened to old rails, the ends of which are set into the columns. The floor is dirt, tamped hard. In the extreme south end the frogs and switches for the entire system are made. For this purpose two double-head planers, a shaper and drill press are employed. The rails are heated in the furnace and cut or bent under the hammer so that only a finishing cut is necessary on the planers, thus saving considerable time overdoing all the work on the planers. Under the 6,000-lb. steam hammer, near the other end of the

building, are forged all the axles for the system, and such forgings as are too heavy for the 1,500-lb. hammer. A large bulldozer, double punch and shear, bolt headers and an upsetting machine complete the equipment at the north end.




General Layout of the Mexican Central Shops at Aguascalientes.

The table on page 217 gives a list of the electrically operated tools and the sizes of motors used:

*Brass Foundry.*—The brass foundry is 80 ft. by 40 ft., closed in from floor to eaves and provided with a large number of windows for lighting. Ventilation is accomplished by an ordinary roof ventilator extending the full length of the building. This building is closed in at the sides for the sole purpose of preventing theft. The roof trusses are yellow pine, and the roof galvanized iron. There are six Morgan brass furnaces for melting brass in crucibles. Blast for these furnaces is supplied by a No. 7 Buffalo blower driven by a 5-h.p. motor, No. 75, and the furnaces are served by a steel jib crane. Two furnaces are also provided for melting lead and babbitt, and one Tabor pneumatic molding machine for making journal bearings. In one corner of the building a 10-h.p. motor, No. 76, runs a magnetic separator, a small rattler, a double emery grinder and a journal bearing boring machine.

All brass castings, battery zincs, babbitt and solder for the system are made here and all cast-iron journal bearing shells are fitted with brass crowns and lined with babbitt. As before stated, these are for freight service. The total power used in this shop is 15-h.p.

*Iron Foundry.*—The iron foundry is 216 ft. by 60 ft., with a "lean-to" on the east side to form charging platforms for cupolas, and a core house. The building is the same construction as the hammer and smith shop. The core house is 42 ft. wide by 54 ft. long and contains in addition to the necessary benches two core ovens, one of which is 18 ft. by 24 ft., with a push car track for handling large cores, and the other 60 in. wide by 24 ft. long for small cores. This latter oven has a cast-iron front in six sections, each of which has two 10½ in. by 30 in. doors and four 6¾ in. x 30 in. doors. To each of these doors is riveted a light cast-iron shelf in the form of a quarter circle with a sheet iron back so that when the shelf is pulled out the back closes the door opening and prevents escape of heat. All the iron castings used on the system are made in this foundry and the average run is about 10 tons of castings per day.

The foundry is furnished with a 10-ton Colliau cupola for general use, and an old 5-ton McKenzie cupola for emergency. The blast for the Colliau cupola is furnished by a No. 8 Sturtevant blower and for the McKenzie cupola by a McKenzie blower. Both are driven from a short shaft by a 20-h.p. motor, No. 22, arranged so that by shifting a belt either can be put into operation. The charging platform is served by an electric elevator made by Darien & Co. The motor driving this is located in the blower room and is a 10-h.p. motor, No. 77.

At the north end of the building a 20-h.p. motor, No. 66, drives a shaft to which are belted a grinder for sand, clay, etc., two emery grinders and two castings rattlers. The foundry is also equipped with three pneumatic Tabor molding machines for making brake shoes and other small work.

The total electric horse power in the shop is 50-h.p.

*Rolling Mill.*—This building is of the same construction as the iron foundry, is 60 ft. by 108 ft., and contains a 9 in. three-high train of rolls driven by a vertical engine, two heating furnaces with locomotive boilers above them to furnish steam for the engine, and a 2,500-lb. steam hammer. These rolls are used to roll scrap iron into round and flat bar iron, it first being hammered into billets under the steam hammer. The experience of this road has been that a much better grade of iron can be secured by hammering the billets than by rolling them.

A 10-h.p. motor, No. 16, drives a No. 6 Sturtevant blower to furnish blast for the furnaces and a 10-h.p. motor, No. 84, is geared to a large No. 10 Robinson-Rhae Manufacturing Co. alligator shear located near the cooling beds, and used to cut the bar iron.

The total electric horse power in this shop is 20 h.p.

*Pattern Shop.*—The pattern shop is 43 ft. by 200 ft., made of adobe with brick pilasters, and brick trimmings around doors and windows. The adobe is plastered both inside and outside, the former being given a smooth finish and the latter a rough one, lined to imitate stone. At the south end of the building for 60 ft. is the work-room where the patterns are made, and the remainder of the building is divided into seven pattern storerooms by firewalls which extend up through the roof and isolate the storerooms. Each of these rooms is provided with two windows on the east side closed by shutters which are sheathed with galvanized iron and a door on the west side similarly sheathed. These storerooms are also provided with shelving for storage of patterns.

In the work-room a 10-h.p. motor, No. 79, drives a pattern-makers' lathe, a core-box machine, small band saw, surfacer, rip saw and grindstone. An electric heater for the glue pot is also provided.

*Truck, Wheel and Axle Shop.*—This at present is a temporary structure built of wooden posts and trusses, with galvanized iron sides and roof. It was moved to Aguascalientes from Mexico City and will be replaced by a building of the same construction as the rolling mill and hammer and smith shop. It is 40 ft. wide and 200 ft. long and will be used exclusively for the truck, wheel and axle work for coaches and freight cars. Small forgings for car repair work will also be made there, and a compressed air line is brought into the shop for riveting machines, hoists, and machines for the manufacture of brake-beams.

The following table gives a list of the electrically driven tools, and sizes of motors used:

| Tool No. | Description. | Method of Driving. | Motor No. | H.-P. of Motor. |
|---|---|---|---|---|
| 171. | No. 7 Buffalo blower | Motor belted to blower | 69 | 5 |
| | | Group "A." | | |
| 170. | 40 in. drill press | Motor belted to short lineshaft | 71 | 10 |
| 282. | 27 in. drill press | | | |
| 169. | 27-in. drill press | | | |
| 139. | Spring hammer | | | |
| | | Group "B." | | |
| 188. | Car wheel borer | Motor belted to short lineshaft | 60 | 5 |
| | Emery grinder | | | |
| 288. | Bolt cutter | | | |
| | | Group "C." | | |
| 181. | Hydraulic wheel press | Motor belted to short lineshaft | 72 | 5 |
| 182. | Hydraulic wheel press | | | |
| | | Group "D." | | |
| 112. | Axle lathe | Motor belted to short lineshaft | 70 | 10 |
| 183. | Axle lathe | | | |
| 178. | Car wheel lathe | | | |
| 291. | Pipe cutter | | | |
| | Total electric horse power in shop | | | 35 |

*Planing Mill.*—This building also is of the same design and construction as the hammer and smith shop except that it has skylights in the roof made of heavy ribbed glass. It is 70 ft. by 200 ft. and has two tracks longitudinally through the building. These connect at the north end with the yard tracks, and at the south end will be extended to pass on each side of the dry kiln when that is built. The floor is vitrified brick laid on edge on a layer of sand as in the machine shop and the motors are placed on supports located against the columns of the building.

To the east of this mill is a small saw mill consisting of a 44 in. circular saw and common log carriage. This saw is driven by a 30-h.p. motor, No. 50, belted directly to the pulley on the saw arbor.

All the lumber for extensive car repairs as well as for the construction of new cars at this point is handled in this mill, and car lumber is dressed and finished for shipment to outside points which are not provided with facilities for doing this. On a handle machine are made all the axe, pick, hammer and other handles used on the road.

The following table gives a list of the electrically driven tools and sizes of motors used:

Mechanical Department Headquarters Building.

| Tool No. | Description. | Method of Driving. | Motor No. | H.-P. of Motor. |
|---|---|---|---|---|
| 212. | Dimension planer | Motor belted to planer | 49 | 15 |
| 219. | Cross-cut saw | Motor belted to saw | 51 | 15 |
| | Group "A." | | | |
| 204. | Handle machine | Motor belted to lineshaft | 42 | 15 |
| 199. | Knife grinder | | | |
| 203. | Wet emery grinder | | | |
| 202. | Saw grinder | | | |
| 200. | Bench emery wheel | | | |
| 201. | Bench emery wheel | | | |
| | Group "B." | | | |
| 273. | Rip saw with iron table | Motor belted to lineshaft | 45 | 20 |
| 205. | Rip saw with iron table | | | |
| | Group "C." | | | |
| 285. | Surfacer | Motor belted to lineshaft | 46 | 20 |
| 284. | Rip saw with iron table | | | |
| | Group "D." | | | |
| 213. | Surfacer | Motor belted to lineshaft | 47 | 30 |
| 214. | Frieze and edge moulder | | | |
| 215. | Jig saw | | | |
| 216. | Combination saw and dado machine | | | |
| 218. | Universal wood worker | | | |
| 287. | Mortiser | | | |
| | Group "E." | | | |
| 209. | Jointer | Motor belted to lineshaft | 43 | 15 |
| 220. | Car sill tenoner | | | |
| 222. | Borer and mortiser | | | |
| | Group "F." | | | |
| 223. | Small borer and mortiser | Motor belted to lineshaft | 48 | 15 |
| 224. | Sticker | | | |
| 225. | Small tenoner | | | |
| 286. | Band saw | | | |
| 274. | Band saw | | | |
| 227. | Wood lathe | | | |
| 228. | Grindstone | | | |
| | Total electric horse power, including saw | | | 175 |

*Storehouse.*—The storehouse (Fig. 2) not only serves as a local store for material used in these shops, but also as a general distributing store for the entire system for all departments. As before stated, all of the bulky material that is not harmed by exposure to the mild climate of this place is kept outside in the storehouse yard, while in the house is stored the more valuable perishable stock. At the south end of the building are offices for the local storekeeper and also for the material agent of the system, who makes his headquarters here. On both sides of the building are 8-ft. loading platforms, the edges of which are made by setting four old rails in cement. The four rails are held together by a cast-iron clamp, the two outer ones being set with base of rail up and the two center ones with head up. The cast-iron clamp keeps them from spreading and the spaces between them are filled with cement. The edge of the platform being thus formed by the base of the rail, never chips or breaks off, and wears indefinitely. It is the practice of this road to make the edges of all station platforms in a like manner. On each side of the storehouse is a standard gage track and material is handled to the shops on push cars. All "job orders" for the road are handled through the storehouse and after completion in the shops are shipped to destination.

*Office Building.*—The office building containing the headquarters of the mechanical department is a very neat two-story red brick building, shown in Fig. 23. The first floor is arranged with offices for the superintendent of machinery, superintendent of shops, mechanical and electrical engineers, drafting room, and shop paymaster, while the second floor is occupied by the chief clerk of mechanical department, with the exception of a blue-print room in the southeast corner. Fireproof vaults are furnished to the drafting room, paymaster and chief clerk. The roof and cornices of the building are of galvanized iron, while the window ledges are of concrete. The interior of the building is very neatly finished in yellow pine and varnished.

The power house, machine, erecting, boiler and paint shops and engine terminal facilities will be illustrated and described in subsequent issues of the *Railroad Gazette.*

## A New Speed Record on the Atlantic City Road.

On Wednesday, July 20, train No. 25, of the Atlantic City Railroad, was run from Camden, N. J., to Atlantic City, 55.5 miles, in 43 minutes, equal to 77.4 miles an hour. The record on the train despatcher's sheet shows that this train ran from Winslow Junction to Meadow Tower, 29.3 miles, in 20 minutes, or at a rate of 87.9 miles an hour. The regular engine of the train was disabled, so that the start was made several minutes late, with engine 334; but the train reached Atlantic City three minutes ahead of time. Besides the engine, there were in the train one combination car, three passenger cars and one parlor car. The times at Winslow Junction and at Meadow Tower are recorded in even minutes, so that the rate of speed is probably subject to some slight correction. Accounts have been printed headed "115 miles an hour," referring to the speeds for short distances, but these, for the reason indicated, are of doubtful accuracy. The best previous record that we find over this line is that of August 5, 1898, when the run through was made in 44 minutes 45 seconds (74.4 miles an hour); but in that case there were six cars. On August 20, 1898, a train of seven cars was run through in 46 minutes 45 seconds.

A writer in the *Journal* of the German railroad gives a long and elaborate analysis of the cost of passenger traffic on the Saxon State railroads, the result of which is that he finds it to be something like 5 per cent. more than the passenger earnings. Travel by express trains yields some profit (because express trains run only where there is considerable travel), and perhaps ordinary passenger traffic on main lines; but this profit does not equal the loss on branch lines. The Saxon fares are very much lower than ours; but doubtless a similar result would be shown on many systems here. Mr. Fink's elaborate studies of the cost of transportation on different parts of the Louisville & Nashville, made 30 years ago, showed how costly transportation is on some branch lines, and the average passenger train load of 46, in this country, indicates that on the average there is little profit in passenger traffic.

### The Glenwood Collision.

The coroner's jury, at Chicago, which investigated the rear collision on the Chicago & Eastern Illinois, at Glenwood, on July 13, when 18 passengers were killed, has returned a verdict recommending that the conductor, one brakeman, the engineman and the fireman of the freight train be held for trial before the Grand Jury; and that the train despatcher, F. O. Whiteman, be also held, on the ground that he was criminally negligent in omitting to give orders, which he might have given, to prevent the collision. The verdict also censures the railroad company for using old and dilapidated cars and for requiring freight trainmen to work too many hours. The reports contain no evidence to warrant the censure of the despatcher and none concerning the quality or condition of the cars; and the only statement that we have seen concerning hours is to the effect that the freight fireman had been on duty 17 hours.

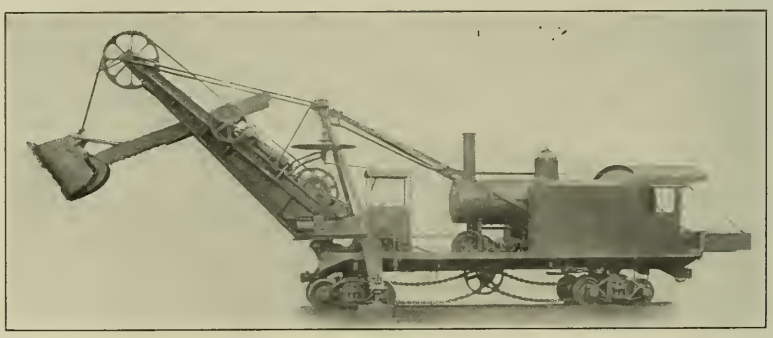
The evidence given at the inquest indicates that Engineman Hoxie, of the freight, is the principal person at fault, and he has disappeared. The testimony of the other trainmen at the inquest throws no light on the reasons for Hoxie's misconduct.

The report of the collision given in the *Railroad Gazette* of July 22, page 179, is substantially confirmed. The conductor of the freight, Frank Cooper, alighted from the front portion of his train (engine and 30 cars) as soon as it reached Thornton, and it appears that while he was in the station office the engineman backed the cars southward. When Cooper came out he said to the station agent: "What is that fool engineer trying to do with that train?" He and the agent then went back into the office to telegraph to Glenwood to order Hoxie back to Thornton. Brakeman Charles H. Wright was on the leading car of the string of cars as Hoxie pushed them southward. The intention of the conductor was to have the cars backed from the east (northbound) track across the southbound track, to a siding still further west, the crossover being south of the entrance to the siding, so that it was necessary to set the cars back southward and then pull them north in order to enter the siding; but Hoxie continued backing southward. Conductor Cooper says that the engineman disregarded three signals given by him, and Brakeman Wright also says that he tried to stop Hoxie; but the facts concerning these hand-motion signals and about Cooper's going north to flag are not clearly reported. By the time the cars had reached Glenwood the train despatcher had been advised of what was going on; and although Operator Smoot, at Glenwood, was off duty, he came into the office and the despatcher gave him an order to stop the cars which were coming from Thornton. To do this, Operator Smoot ran out and climbed a car and told Brakeman Wrignt to stop, as the passenger train was coming on that track; Smoot then jumped off, waited until the engine reached him and then notified the engineman. Smoot returned to the office to advise the despatcher; and on coming out, a moment afterward, found the train stopped and Hoxie and Wright disputing about the responsibility for having run the cars to Glenwood. They had talked only a minute or two when the collision occurred.

One or two interesting points were brought out which, while not bearing directly on the main cause of the collision, show how collateral circumstances frequently have a vital bearing in cases of this kind. Brakeman Wright admitted that if he had remained on top of the leading car he probably could have given a signal which could have been seen from the engine of the passenger train in time to prevent the collision. On the other hand, it looks as though the engineman of the passenger train was not keeping a good lookout. He did not see the freight cars until he got within 300 ft. to 500 ft. of them; but the line curved to the left and he, no doubt, could have seen much farther if he had looked across the top of his boiler. One statement is to the effect that the fireman could have seen 1,700 ft. ahead, but he says that he was blinded by the glare of the fire-box. Without suggesting any suspicion of this particular fireman, railroad men will at once be reminded of the frequency with which they have heard this explanation given by a fireman who simply was not taking an interest in the lookout. The testimony of the men in the baggage car indicates that the conductor came into that car and gave the stop signal, on the whistle cord, before the engineman had shut off steam or applied brakes. The conductor, after pulling the cord, immediately jumped off.

### The Atlantic Steam Shovel.

The accompanying illustration shows a new design of steam shovel which is being sold by the Atlantic Equipment Co., New York. It was designed by A. W. Robinson, and is built by the American Locomotive Company. In quality of workmanship it is fully up to standard practice for locomotive construc-



The Atlantic Steam Shovel.

tion, and while it has a number of radical departures from the usual form of shovels it still retains the best features of the older designs. In actual service it has proved to be a machine of great speed, power and capacity. The shovel shown is now in use on the New York Central and is designated as Class 38-16-2½, that is, a shovel having a pull on the dipper of 38,000 lbs., a clear height of lift of 16 ft. and dipper of 2½ cubic yards capacity.

The distinguishing feature of this shovel is the direct wire-rope hoist. In the chain hoist the friction loss is often as high as 40 per cent., while in a direct wire-rope hoist the friction loss is less than 10 per cent. A single sheave of large diameter is used for hoisting, which besides reducing friction, also increases the angle of lead of the bucket. A heavy pull on the bucket by the hoisting chain has little effect other than to strain the machine if the angle formed by the chains and the dipper handle is acute. In this shovel the angle is increased to such an extent that the digging effect is practically doubled. The whole arrangement of boom and dipper gives a high lift to the bucket; as compared with other shovels with the same length of boom, about 4 ft. to 6 ft. more lift can be obtained. Machines of this type can be built with a clear lift of 20 ft., which will work at as high speeds as the old type of shovels with a low lift. The hoisting engines are incorporated in the base of the boom so that the whole hoisting machinery revolves together. The hoisting machinery is compact and at the same time strong and easy of access. The drum is short and of large diameter and fits between the sides of the boom which constitute the frame. The gearing is steel and the hoisting friction is quick and sensitive, doing its work without heating. It is operated by steam so that the operator exerts no effort.

The A frame is formed of solid steel bars, having solid forged pin connections at the feet and a cast steel head. It is stepped upon the ends of the jack-arm truss in such a way that it forms a continuation of the jack-arms, giving additional stability and relieving the car frame from strains. The A frame head is arranged so that the three strains intersect in a point, thus doing away with all lateral bending strains.

When required the A frame can be lowered for transportation over the road to 15 ft. (or lower) above the rail. The pin-connections at foot of the frame permit of this movement and the back guys are shifted forward to a connection provided for the purpose. The raising and lowering of the A frame is done by power.

The boom is a departure from the usual practice, being made with a straight taper deepest at the inner end. This form is simple and gives the greatest strength where it is needed and the least weight at the outer end where there is greatest motion. The most severe strains in a boom are those due to twisting when swinging rapidly and in irregular work caused by the leverage of the dipper handle. To give the lower flange of the boom strength in a horizontal or lateral direction the upper members of the boom are made of steel channels set vertically and the lower members are made of channels set horizontally, while the web is a solid steel plate. The turntable is built solid with the boom, being made of stiffened steel plates and a rolled rim. The hoisting machinery is mounted directly upon the boom so that no guide sheaves are necessary, and the power is applied directly with the least possible loss. A pair of engines with drum and gearing are mounted on the base of the boom. They take up very little room and can pull the required amount on the dipper at a speed of five to six dipper loads per minute. All of the parts are adequate for continuous heavy work and are easily accessible. The frame of the engines is cast steel in one piece and forms the foot of the boom and center of the turntable as well. The engines and gearing are located on the axis of rotation of the boom and therefore do not appreciably increase the power required for swinging nor interfere with the speed.

The main engines are of the locomotive

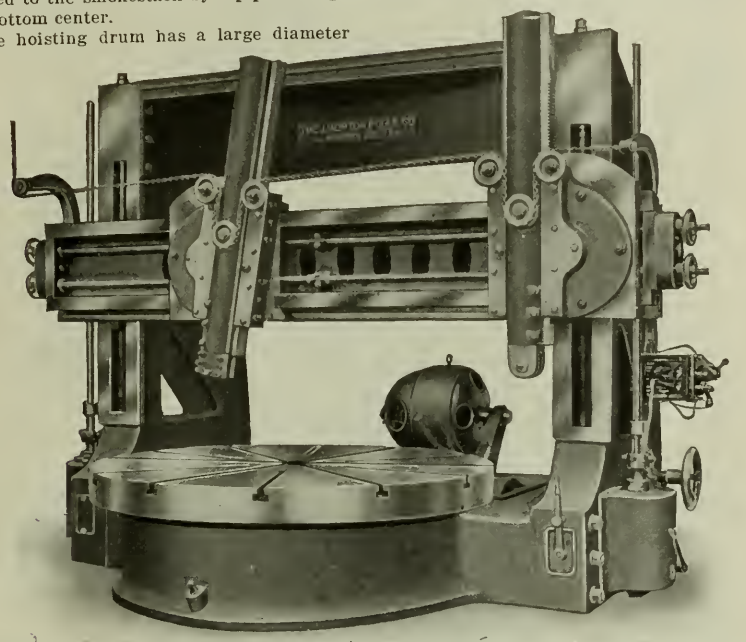
type, with outside cylinders and are enclosed in a sheet steel casing for protection. They have a solid cast steel frame for both engines cast in one piece, and steel cross-heads. All parts are easy of access. Steam is carried by a pipe having a double ball and socket joint on the top center, and the exhaust is carried to the smokestack by a pipe through the bottom center.

The hoisting drum has a large diameter and is grooved for steel wire rope. There are two parallel ropes, each bearing half the load, equalized around a small sheave or thimble at the dipper. The two ends of the rope are tied by clips at the drum and are attached in such a way that the rope can be removed and replaced without delay. The cost of renewal of a steel rope 1½ in. in diameter and 108 ft. long is about $40. An equivalent chain would be 1⅜ in. and 125 ft. long and would cost about $134. The rope will last fully as long as the chain, since there is but one sheave over which it runs and there is the added advantage that a rope will give warning of weakness due to wear before it breaks, while a chain snaps without warning. The hoisting drum is driven by two steel gears and two band friction clutches operated by steam, and the clutch and throttle are controlled from the runner's stand on the car.

Instead of attaching the double hoisting rope to a bail and sheave it is attached directly to the back of the dipper in such a way that the lines of force meet in a point situated in the plane of the resistance or in line with the strain applied to the teeth. The entire back of the dipper is one piece of cast steel with lugs formed upon it to receive the dipper-arm, hinges for door, etc. The lip and teeth of the dipper are amply strong and are attached so as to be easily renewable.

Independent thrusting engines are used to feed the dipper to its work. These engines are solidly built with bed plate cast in one piece and securely bolted to the boom. The gearing is steel and the engines are reversing by means of a central valve. They are completely enclosed and have no rocker arms, valve spindles, etc., exposed in any way so as to be injured by flying fragments from blasting.

Independent reversible engines are employed for swinging being duplicates of those on the boom for thrusting. They are double-geared to a drum which carries double steel wire ropes on each side, which are connected to the turntable. The shovel is propelled by the swinging engines, power being transmitted to a cross shaft underneath the car. This shaft is connected with the forward and rear axles by two chains of sufficient strength to slip the wheels. The swinging and propelling shafts are all short and strong and are attached to the main center sills of the car.



The Poole 10-ft. Boring Mill.*

The boiler is of the locomotive type and is made large enough for engines of twice the cylinder capacity of those used. It is built to carry 140 lbs. pressure and is lagged with magnesia and planished iron. All of the other parts of the machine are either housed in casings or built to stand exposure. With the exception of a steel cab for the fireman and a shelter for the craneman, the usual box covering has been omitted, and this gives the shovel a peculiar appearance. If it were necessary the whole machine could of course be enclosed.

The shovel is mounted on diamond arch-bar trucks of extra heavy design and hand brakes are applied to the rear truck. Large water tanks are supplied and a hinged coal platform on the back end carries the coal supply. This is made of steel and when not in use it folds up against the back of the cab.

One of these shovels at work on the New York Central frequently loads ten cars (100 cubic yards) in eight minutes. Another machine is now at work on the terminal site of the Pennsylvania in New York and one is also on exhibition at St. Louis by the American Locomotive Company.

*This illustration should have appeared as Fig. 1 in last week's issue, instead of the illustration which was shown.

## Railroad Shop Tools.

(*Continued.*)

BORING MILLS.

The 54-in. car wheel boring mill shown in Fig. 1 is made by William Sellers & Company, Philadelphia, Pa. The table has a self-closing and self-centering chuck, which will take wheels up to 42 in. in diameter. The table is 54 in. in diameter and can be started or stopped instantly by lever, without moving the belt shifter. The feed is operated by friction discs with automatic hold-fast. The crane is stopped automatically at the upper and lower limits of its travel. All the hoisting mechanism is placed on the outside of the machine and is easily accessible. A slide rest is provided for facing the wheel hubs. A boring bar 3½ in. in diameter, fitted with a set of double cutters which give four cutting surfaces, is furnished with each machine. The countershaft has two sets of fast and loose pulleys, one set 24 in. x 4 in. and the other set 18 in. x 6 in. These should run at 134 r.p.m. and 290 r.p.m., respectively.

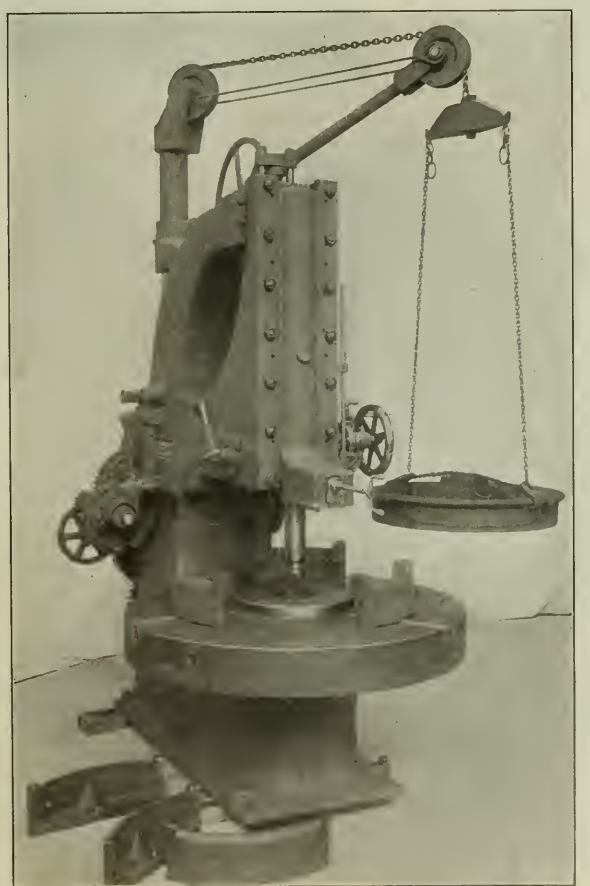


Fig. 1—The Sellers 54-in. Wheel Boring Mill.

The 52-in. vertical boring and turning mill shown in Fig. 2 is made by the Rogers Machine Tool Company, Alfred, New York. This machine will take work 52 in. in diameter and 40 in. high. The table is 50 in. in diameter and has sixteen ⅞-in. T slots.

The table can be stopped at any desired position by a foot brake. The spindle has a V-shaped lateral bearing, 35¼ in. in diameter. The housings are 88 in. high and 37 in. wide at the bottom; they are the box type and have a 6¾-in. bearing on the cross rail. They are fastened to the base by bolts and keys. The cross rail is the box type and is 91¾ in. long and 17¾ in. wide. It is 6 in. thick and has an 18⅞-in. bearing on each housing. It is fitted with a belt lift, applied to the center of the lift shaft and transmitted equally to each screw. The counterbalance weight lifts on the cross rail, instead of the rail carrying the weight. The heads are independent in regard to amount and direction of the feeds. Either may be brought to the center for boring, or they may be run tandem. The feeds are positive geared, and are separated by levers. There are 12 changes, ranging from 1/36 in. to ¾ in. horizontally and 1/54 in. to ½ in. vertically, per revolution of the table. The saddles are 18 in. wide, and have a bearing of 2¼ in. on the top and bottom of the cross rail. The cross rail has a 17¾-in. face, and the swivels have 21⅞ in. bearing on the tool stakes. The swivels are graduated and can be set at any angle. The tool stakes are 41½ in. long and 7¼ in. wide. They have a travel of 27 in., and are fitted with clamps to grip the toolholders. The toolholders are forged from machine steel and are 15 in. long and 3 in. in diameter. The driving mechanism is placed between the housings. It is direct geared and has 24 changes of speed, ranging from 1.04 to 52.47 r.p.m. of table. It is supplied with a friction clutch for locking the drive gear. The driving gear is independent of the table. The racks and gears in the heads are steel. The worm wheels are bronze. The countershaft should run at 220 r.p.m. and has a friction clutch pulley mounted on a shaft 2¼ in. in diameter, running in ring oiling bearings. The floor space required for this mill is 106 in. wide by 108½ in. long. The weight of this machine is about 19,000 lbs.

The 37-in. boring and turning mill, Fig. 3, is made by the Niles-Bement-Pond Company, New York City. This mill will swing work 37 in. in diameter and the tool bars have a traverse of 18 in. The boring bars are steel forgings octagonal in section, having four sides scraped to bearings in the swings. Clamp screws are provided in the lower boxes.

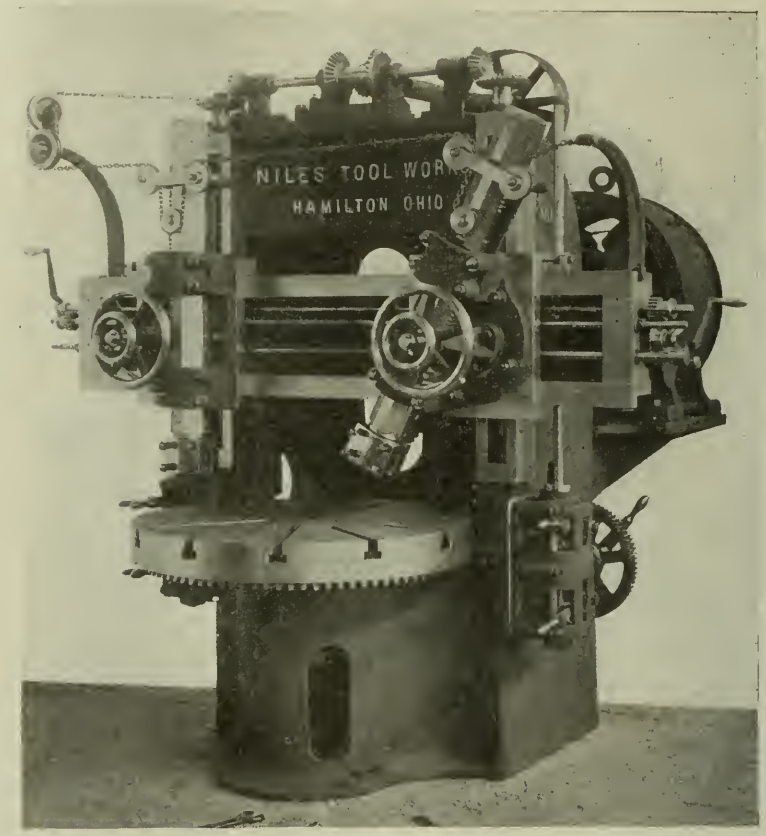



Fig. 3—The Niles-Bement-Pond 37-in. Boring and Turbine Mill.

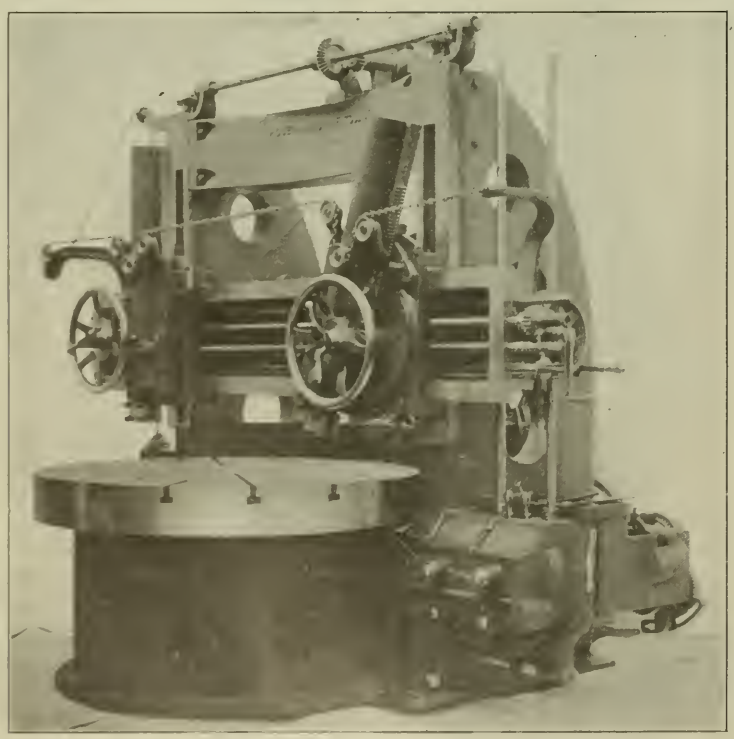


Fig. 2.—The Rogers 52-in. Boring and Turning Mill.

The toolholders are solid steel forgings keyed into the bars by taper-sockets. They are readily removed for the insertion of double-end cutter-bars or other tools. The heads can be set to any angle. Only one counterweight is used. This is half the weight of one bar and acts in a line with the bar at all angles. This does not tend to pull the swing over or interfere with easy movement of the saddles along the rail. The cross rail has a power elevating gear and is of the box-girder form made double between the housings. The table is driven by cut bevel gearing; the table spindle has a taper-bush at the top for taking up wear. The lower step runs in oil. The feeds are positive driven by gearing. The feeds for the heads are independent and reversed or changed from a fine to a coarse feed by levers at each side of the mill. There are eight changes of feed, four for roughing and four for finishing. All the changes of a given set are obtained by sliding gears at the ends of the cross rail. The bed, housings, back and top brace of this mill are cast in one solid piece. No part of the machine extends below the floor. The motor for driving the mill is a 5-h.p. Westinghouse Type S., designed for the three-wire system, using 110 to 220 volts, and it has a speed variation from 310 to 1,240 r.p.m.

The 60-in. boring and turning mill shown in Fig. 4 is also made by the Niles-Bement-Pond Company. This machine will take work 60 in. in diameter and 36 in. high. The diameter of the table is 54 in. and the tool bars have a traverse of 30 in. The rim of the table runs in an annular grove cut in the

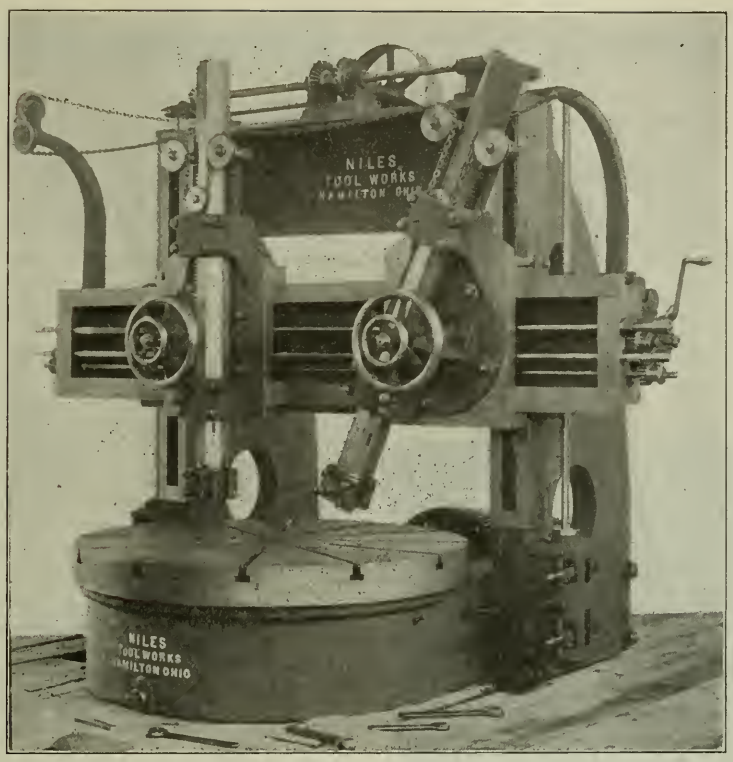



Fig. 4.—The Niles-Bement-Pond 60-in. Boring and Turning Mill.

bed and flooded with oil. The table spindle has a taper bush at the top for taking up the wear. The lower step runs in oil and rests on a wedge, which has a screw adjustment for slightly raising the table from the annular bearing when running at high speeds.

*(To be continued.)*

## Costs and Profits of Electric Railways in Germany.*

The enforced publication of corporate finances and the exhaustive methods by which municipal accounts are kept and made public in Germany have enabled the Association of Electrical Engineers to collect and formulate some highly interesting statistics on the financial results which have followed the change from horse to electrical traction in street railways in this country. Although this transformation began later here than in Belgium and the United States, it was made with such promptness and energy that within a period of four or five years the horse car practically disappeared from Germany and was replaced by electrical tramway systems, which traverse all the cities and larger towns and connect each of them with practically every village and hamlet in a large and constantly extending radius. These systems have now been in operation long enough to supply some definite data as to the profits of such enterprises under existing conditions in Germany, which, measured by average street railway dividends and the market values of their shares, have been in general somewhat disappointing. The net fact, which has been known to investors for some time, and which these newly formulated statistics confirm and explain, is that electric street-car lines, while serving the public infinitely better than any other method of city and suburban transportation yet devised, have proved in many if not most cases less lucrative to shareholders than the horse-car lines which they replaced.

There are several tangible reasons for this, some of which are more or less peculiar to Germany. Among these may be cited the fact that most German municipalities refused at the outset to permit overhead conductors to be used in important or centrally located streets, and the companies were therefore forced to use a costly type of car which would take its current in the suburban streets from an overhead wire carrying a voltage sufficient to charge at the same time storage batteries of sufficient capacity to run the car through the central districts where the trolley wire was forbidden. These storage batteries were heavy and expensive, they deteriorated steadily and were difficult to keep in order, and when the snow and ice of winter encumbered the tracks they failed so utterly in Berlin, Hanover, and other cities that thousands of cars equipped with them had to be thrown ont and their storage batteries removed. It was only at this heavy cost that the overhead trolley wire secured admission to the central districts of several German cities, and there are even yet in Berlin and elsewhere long stretches on important avenues where it is tabooed and underground conductors are insisted upon as indispensable.

A second important fact in this connection is that German municipalities are very exacting with tramway companies in respect to rates of fare, paving, and all the other specifications of their franchises. Every step in the process of construction is subject to the inspection and control of the city engineers. Most franchises involve the responsibility of the company of laying and keeping in repair the pavement on all space between the two outer rails, a breadth, in case of double tracks, of 12 to 15 ft. or more, and where, as in Berlin, the pavement is asphalt laid on deep foundations of rubble and cement, this becomes a heavy item in the cost of construction and maintenance, for no skill and experience seem able to avert the necessity of frequent upheavals for purposes of repair, in which asphalt and cement have to be cut out with cold chisels driven by sledges, a slow and toilsome operation.

Moreover, there are very few municipalities in Germany where electric current can be generated by any other or cheaper power than that of steam or gas engines, and no form of steam fuel is really cheap in this country. Although a very few of the largest central stations produce electric power as low as 1¼ cents per kilowatt-hour, in most others the cost averages from 2¼ to 3¾ cents, and in certain small stations as high as 10 cents per kilowatt-hour. Estimated by the ordinary German standard, the power consumption per car varies with grade, curves, and other conditions from 450 to 700 watt-hours per car-kilometer, equal (in case of the latter figure) to 1,170 watt-bours per car-mile.

Finally, the outlay for track renewal and repair turns out here, as elsewhere, to be unexpectedly heavy. In the days of horse cars a well-laid track in a city of from 150,000 to 200,000 inhabitants would last from a dozen to fifteen years. Now, with the far heavier and more frequent cars, the rails, especially at curves, wear in much less than half that period until the wheel flanges are found running on the bottom of the groove, so that the track has to be taken up and renewed. Another cause of frequent and expensive repairs lay in the fact that the surface resistance of the copper bonds with which the rail ends were united increased rapidly under certain conditions, until their use was largely superseded by the better system of welding the rail joints by means of electrical heat or thermite.

Still another increased item of expense has been that of labor. The motormen are naturally employees of a higher grade than horse-car drivers, and being well organized, they have been able to compel increased wages and to shorten working hours until the net labor cost per car-kilometer is more than 50 per cent. greater than in former years.

To all this is to be added the fact that the rates of fare in most if not all German cities are rigidly restricted by the authority granting the concession. From the latest published statistics it appears that the average street railway fares paid in eleven principal German cities during the year 1903 varied from 2.2 cents each at Frankfort to 2.72 cents at Hamburg, the mean average for Berlin and its suburbs being 2.35 cents, or less than half the usual 5-cent fare that prevails generally in the United States. To complete the restrictions under which street railways operate in this country, most of their charters contain clauses providing that from a prescribed date the company shall pay to the municipality a portion of its surplus after disbursing a stipulated percentage as dividends. Many charters further provide that after being operated by the companies for a specified term of years the whole installation, tracks, power plant, and equipment, shall revert in fee simple to the municipality which has granted to the corporation for a term of years the use of its streets.

The total length of German street railways at the close of 1902 was 1,906 miles, of which 346 miles, or about 18 per cent., were under municipal ownership. Of the latter, 65 miles were leased to individuals, leaving 281 miles of lines operated directly by the municipalities. The four longest municipal lines are at Frankfort, 26½ miles; Düsseldorf, 25 miles; Munich, 29 miles, and Co-

*Government report from Consul-General Mason, Berlin, Germany.

logne, 40 miles. It does not appear that fares over these lines are lower, but, on the contrary, that they are rather higher than those charged on similar lines worked by individuals or corporations. On the whole, it cannot be said that experience has increased public sentiment in Germany in favor of municipal management of street railways, and several cities—among which is Barmen—which built their own lines are now considering the plan of leasing them to private companies.

By far the largest and most important corporation of this kind in Germany is the Great Berlin Street Railway Company, which, with its various branches, operates 200 miles of track, of which 144 miles are owned and the remainder are controlled by the company. On its own lines the "Grosse Berliner" ran last year 40,400,000 car-miles and carried 295,000,000 passengers, whose fares aggregated $7,025,000. The total capital of the company is 100,082,400 marks ($23,918,611); its shares are to-day worth 184, and its 3½ per cent. bonds are quoted at 99.40. This, however, is the status of an exceptionally powerful and ably managed company in a large, level city, and is quite above the average financial condition of street railway companies elsewhere in Germany, most of which have to be satisfied with 4 and 5 per cent. net earnings on their stock.

The one all-controlling fact which has enabled street railways in Berlin and other German cities to make head against the exacting requirements of municipalities and the enormous cost of conversion from horse to electric traction, with the increased outlay for labor, workmen's insurance, paving, and other expenditures, has been the phenomenal increase in business, particularly in the suburban traffic in all the larger towns, which has come with the increased speed, the greater frequency of service, the better ventilation, space, and comfort of electric cars. Whole suburbs have been built up within a few years by the influence of a single well-managed tramway line, which carries a legion of men and women to and from their daily toil in the city more quickly and cheaply than the horse car could transport them half the same distance. And although the electric street railways of Germany under the conditions above described are but moderately remunerative to shareholders, they hold a high place among the potent influences of modern civilization.

## The Sturtevant Fuel Economizer.

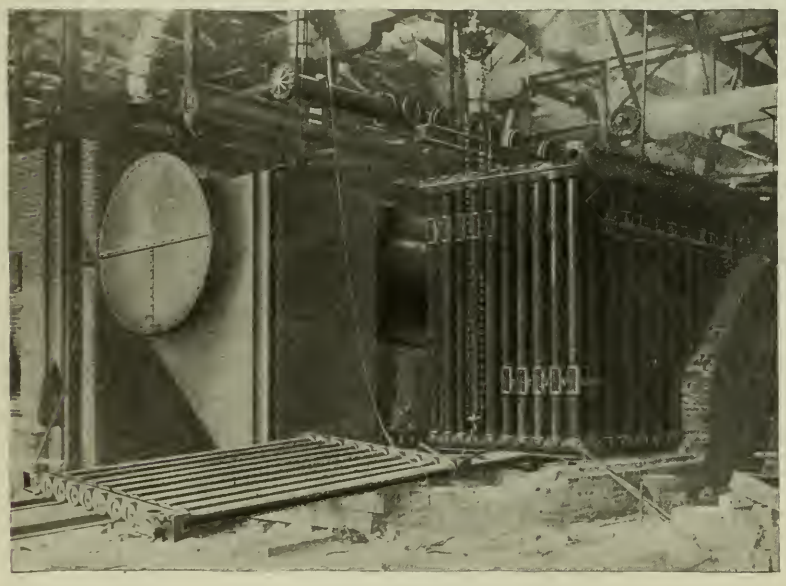
Two essential qualities of a fuel economizer are, the ability to utilize for heating water a maximum amount of heat (otherwise wasted) from the escaping gases, and the accessibility of all surfaces for cleaning, repairing and renewals. The Sturtevant "Standard" and "Pony" type economizers shown herewith were designed to utilize the waste heat from the gases by a patent system of staggered pipes. This system compels all the hot gases to encircle the pipes, thus giving much effective heating surface.

The joints of the Sturtevant economizer are made taper, metal to metal, and are designed so that any pipe can be taken out and a duplicate substituted without disturbing any other pipe, section or side walls. This would not be possible if packing, cement or rusting were used to make tight joints. Any header can be withdrawn and a duplicate substituted without disturbing any other header, section or side walls. Any section can be withdrawn and a duplicate replaced without disturbing any other section or side walls. There are no connection pipes to remove and all water surfaces are rendered accessible by the removal of the caps. The taper metal to metal joints make these economizers especially valuable for high pressures.

The scrapers are interchangeable and the driving mechanism is positive. A guide-plate for the scrapers is used which prevents them from sticking and breaking. The driving pulley can be belted up parallel or perpendicular to the length of the economizer. The economizers are not designed for forced circulation, but the connections are made in such a way that the flow of water is started in the proper direction, so that the flow up and down the consecutive sections will take place without making undue work for the pump. The machines are constructed so that the parts have the rigidity otherwise required in the foundations. The fact that taper metal to metal joints are used also eliminates the necessity of building more rigid foundations, as there are no gaskets to loosen and leak if the foundations spring slightly.

The "Standard" type is built in sections containing pipes from four to twelve wide, the staggered system of pipes making it possible to build sections of an odd as well as an even number of pipes. The "Standard" is adapted to power plants of almost any size, but is more commonly used for boiler capacities of 350 h.-p. and over. The "Pony" type is smaller than the "Standard" and is better adapted to power plants of 350 h.-p. or less. All machines are made of cast iron and are tested to 350 lbs. pressure.

These economizers are made by the B. F. Sturtevant Company, Hyde Park, Mass.



Sturtevant Standard Economizer with 1,500 H. P. Babcock and Wilcox Boiler.

The Sturtevant Pony Economizer.

## THE GRAIN EXPORT SITUATION.

The advance sheets from the Monthly Summary of Commerce and Finance, issued by the United States Government, for the month of June, and for the twelve months ending with the first of July, 1904, show a great decrease in the exports of wheat from this country. Figures for a fiscal year ending June 30 are, of course, somewhat misleading for grain shipments, since they tend to divide the crop arbitrarily, and the exports of each summer and fall after the first of July are carried over into the figures for the succeeding year. Nevertheless, it is interesting to note that exports in the year under review aggregated only 44,230,169 bushels, as against 114,181,420 bushels for the twelve months ending June 30, 1903, and 154,856,102 bushels for the year ending June 30, 1902 The difference in the month of June taken by itself is even more interesting, for in June, 1903, over 5,000,000 bushels of wheat were exported, as against less than 500,000 bushels in June, 1904. The question of where the wheat goes is particularly interesting at this time. The fact that the 1903 wheat crop was smaller than any crop since 1900 only answers the question in part, for in 1900, with a crop more than 100 million bushels smaller than in 1903, the exports of wheat were some 25 millions greater; and in 1897, when the crop amounted to only 530 millions, as against nearly 638 millions last year, almost 110 millions were exported, as against 73,372,255 bushels in the calendar year 1903. It is evident, therefore, that the disproportion between crop and amount exported was in the year under review unusually great.

The first difficulty in considering statistics of the grain business lies in the unreliable method employed by the Government in obtaining these statistics. The Government receives reports through a large number of local agents; for example, postmasters in small towns in the wheat country. These agents know the gossip of the locality and are able to express an opinion as to the crop of the territory they report chiefly from more or less accurate statements received from their neighbors. They hear what Smith thinks his crop is going to amount to; they also hear what Thompson thinks Smith's crop is going to amount to. From this presentation of several points of view they can get up a rough kind of average for the Department of Agriculture; but of course the value of these figures depends to a considerable degree on the personal characteristics of the man who estimates them. It is fair to say that our Government figures do not report the situation as accurately as those issued by many foreign countries. One specific chance of error may be pointed out in the fact that the divisions between the localities reported by the different agents are not always fairly understood or carefully observed. Our Government figures report really about the same kind of a guess at the crop of the country as a whole as that which one can pick up by talking with the natives of each locality at the village stores; but this drawback is partly offset for statistical purposes by the fact that they have always been obtained in the same way; and though the figures may not be accurate for any one year, the comparison between the Government returns of a number of years gives a pretty fair perspective of the situation.

One reason for the small current exports of wheat is found in the fact that the 1903 crop was of rather poor quality, so that a comparatively large amount of it did not grade sufficiently high for export purposes. Rather than sell low grade wheat through an intermediary at a price which seems to him low, although it may be fair enough for the grade, the farmer will often keep the poorer quality of wheat at home to be mixed for feed and sold on the hoof. This, of course, largely depends on the current crop of corn, oats and other grains better adapted than wheat for feeding animals; for, if these are plentiful, they can be used to better advantage, and it is more profitable to sell the low grade wheat for whatever it will bring. Although the corn crop was good last year, it was considerably smaller than in 1902, and the production of oats was rather small, so that the low quality of the wheat kept much of it at home.

But the important fact to be noted in connection with the diminishing grain exports is that the producing capacity of the country at a present average of some 12½ bushels per acre is about taken up. This statement does not include Canada, but refers merely to the wheat-producing area within the boundaries of the United States. There is no doubt that, by the exercise of proper care, the average yield could be brought up considerably higher than 12½ bushels per acre; but the farmers, generally speaking, do not sufficiently appreciate the need of introducing new seed, but allow their old product to deteriorate until both the quality and the quantity of the wheat decrease. At present, it is probably not a serious exaggeration, if it is any exaggeration at all, to say that there is capacity in the mills for twice the wheat produced in the entire United States, without allowing any for export.

There seem to be two ways in which the amount of wheat available for export can be increased; one by more scientific planting, so as to improve the crop, and the other by further development of the great Canadian Northwest. The Canadian trans-continental lines say they are building an empire, and at present the possibilities of this great Northwest country as a wheat producer appear almost boundless. As soon as Canadian wheat enters into discussion, however, a number of other questions arise. With the present high prices in mind, the American farmers want Canadian wheat kept out, but are opposed in this by the millers, who need the grain very much, and desire legislation permitting it to be milled in transit. Of course, the millers want flour to be kept out.

As regards the competition of Montreal as an export point for Canadian wheat, it is necessary to remember that in spite of the direct rail and lake connections, and in spite of the Canadian canal system, with which the new barge canal will evidently be quite unable to compete, owing to its greater length of restricted channel and less depth, the port which has the greatest amount of miscellaneous shipping has great advantages over the smaller port like Montreal, which must, for the most part, depend on a single class of traffic. The consolation of the New York railroads in the face of the evident trend of the northwestern wheat business to Canada lies in the berth-rate business. The steamer carrying a general cargo is extremely glad to be able to supplement it with grain to obtain full tonnage, and can naturally make lower rates for this class of traffic than a steamer which depends on grain for its entire cargo. To the general freighter, grain is really a profitable kind of ballast, and the ocean rate on it might be considered pure profit as a supplement to the rest of the cargo. So it seems evident that New York, with its great general freight business, will always secure a large volume of grain, despite the competition of Montreal. It must be borne in mind in this connection that it is the berth-rate business and not the barge canal which is likely to bring the grain to New York. This point was fully discussed in the *Railroad Gazette* last fall, and need not be further elaborated at this time.

So far as wheat exports from the current crop are concerned, the recent returns from the Northwest of damage because of the wet season are rather discouraging; but the Government reports that the general quality is considerably better than last year, and it may reasonably be assumed that a greater proportion of the crop will therefore find its way to the sea ports, and less be used as feed for cattle. This view is considerably strengthened by the fact that the hay crop is extremely good this year; and this, together with the good showing made by the other grains, makes it unlikely that much of the wheat will stay at home. Even with the predicted small yield, under these circumstances it is quite likely that the exports next year will be considerably greater than they have been this summer.

But the rapid growth of the country, with its accompanying increase in home consumption, and the natural limitation of subsequent crops by the possibilities of acreage, make it seem wholly likely that exports of American, as distinguished from Canadian wheat, will tend gradually to diminish rather than increase, unless genuine improvement is made in the methods of planting. The exporters have also a potential competitor in the enormous Argentine country, as yet quite strikingly undeveloped, in view of its evident possibilities. With American energy and industrial methods Argentina could tremendously increase its wheat output, and when the development of the great South American prairies is accomplished, and they raise an amount of grain vastly in excess of the small domestic consumption, this competition will undoubtedly tend still further to keep at home the wheat raised in the United States.

## THE RAILROAD TELEGRAPH OPERATOR.

A railroad officer well acquainted with conditions in the West said recently before the St. Louis Railway Club that the telegraph department of the railroads had seriously deteriorated in the last ten years. (*Railroad Gazette*, March 4, pages 153 and 163.) A prominent railroad telegraph superintendent expressed pretty nearly the same thing at the recent Indianapolis convention; he said

that good operators, being where they can readily get acquainted with the business men of their town, and well enough acquainted to accurately classify them—good, better and best—soon secure employment outside the railroad service at better salaries than the railroads pay. Unless there is a good hope of promotion on the railroad many operators stay but a year or two; and it must be admitted that this hope is not at present so bright as it was in the youthful days of those numerous operators who now occupy high positions in the railroad world. Then, the operator who was competent to act as despatcher soon filled a position of that kind and the despatcher soon became an important adviser and helper to the superintendent, in line for further promotion. The increase in business per mile of road has alone put a great obstacle in the operator's path upward, by requiring a larger number of men in other departments who are fit for promotion; and when by reason of the increase a road is changed from single track to double, the telegraph department at once loses a large part of its importance. The telephone has an influence in the same direction by reducing the importance of the operator's long term of education. A telephone operator needs but little training, and it is increasingly easy to get along without the telegraph for a day or a week, or permanently, according to the nature of the business. The telegraph being of less importance, has received less attention; less effort has been put forth to secure the best men for it and salaries have suffered.

But whatever may be the cause of the real or alleged deterioration, the telegraph superintendent who wishes to bring his department to the highest efficiency can only take the situation as he finds it. As long as operators are required to receive and deliver train orders according to the standard code, the service needs as high a standard as ever it did. If operators resign too rapidly, the head of the department is bound to demand the money to pay them better salaries; unless he is able to find another kind of man—one who is fully competent to fill the telegraph position, but does not possess the knowledge or ambition to get a better place in some other business. If the telegraph superintendent's demand for increased salary appropriations is "turned down" what shall be the next step? Surely, the telegraph department cannot wash its hands and wait for the general manager to make the next mention of the subject. The demand must be repeated. The tact necessary to do this at the right time and with the right degree of urgency is not taught in editorials—or in any other specific place—but it is up to the telegraph superintendent to acquire it, nevertheless. How else can he have a clear conscience when some dull-witted or inexperienced operator lets a couple of trains run together and kill some passengers? Perhaps one of the best ways to keep your general manager fully alive to this question is to see that he knows all about the collisions which are reported in the public press every month as due to operators' mistakes and negligence—and is reminded how many operators of that same kind he has on his own road!

Where the block system is in use and is rightly managed, the duty of handling despatchers' orders at once becomes less exacting, as a mistake in sending or receiving, or a failure to deliver, is not sure death to two or three trainmen, as so often is the case under the old plan; but is there, then, no call for improvement in the telegraph department? It must be admitted that at hundreds of stations the business appears to be accomplished, in some way or other, by operators who are poor senders, who make mistakes in receiving, though they take at a snail's pace; who do not understand the switchboard, and who make little intelligent effort to please the public. If a general manager is satisfied with that kind of service, or with the work of boys who, though bright, have a great deal ot the knowledge of their business yet to learn, he will of course be hard to deal with; but the telegraph superintendent still is bound to preach to the management his ideal telegraph service, in season and out of season. As long as operators have to deal with the public it seems incongruous to take less pains to make them courteous and attentive to patrons' wishes than is taken with brakemen or gatemen. As long as they handle officers' telegrams why should not they be as alert and well trained as the stenographer or the private secretary?

In short, the telegraph department needs to be brought to a higher standard, not simply from the standpoint of the scientific or mechanical requirements which are peculiar to it, but because all of the functions of the station operator (who so often is the sole or most intelligent representative of the road in his town) are important. His work has to do with profits directly; with attracting custom, which, well or ill done increases or decreases income, and with the safety of lives, limbs and property. If the telegraph were abandoned to-morrow and all orders were to be sent by telephone, an equally good grade of intelligence would be needed. If written and repeated orders were abolished and collisions were prevented by the block system, the most active person at the small station would still have to be a high-grade man, to do the work of such a station properly. A specific complaint, both in the St. Louis paper and at the Indianapolis Convention, was that operators cannot patch wires. Such a deficiency, where it exists, indicates, probably, both neglect on the part of the superintendent or lineman who ought to teach the operator, and lack of ambition and enterprise on the operator's part. Whatever the cause, the means of cure is plain; and it is to be observed that this particular detail of the problem would not be materially changed by abandoning the telegraph and dismissing the telegraph operators, for the telephone would need the same kind of attention. Electrical communication would be an important feature of the railroad service, even if meeting points were made automatically.

The telegraph department of most American railroads holds a rather inconspicuous position. As with the signaling department, it may be that this lack of rightful importance is in some cases due to the modesty of the man at the head of the department, but the result is the same whether a man hides himself or is hidden by some one else. In the early period of the telegraph—say, from 1844 to 1874—the problems of invention, organization and expansion attracted many strong men to the service, but in the quiet times since then not so many of that class take to the telegraph. They find more congenial work elsewhere, and the department is overshadowed by others. Separating the railroad work from that of the telegraph company seems to have helped to produce this result. But whatever the relative position of the department, its work is important and should be made as perfect as possible.

Most of what we have said in the foregoing paragraphs will be taken, perhaps, as an argument for the improvement of the telegraph for the benefit of other departments; telegraph operators ought to be improved because better talent is required for the non-telegraphic duties which they perform. But if any telegraph superintendent feels aggrieved at this, we reply that this is our way of trying to aid him to increase his own importance!

## THE COLORADO DISASTER.

The disaster by flood, at Eden, Col., last Sunday night, seems likely to prove the worst passenger train wreck that ever occurred in the United States, measuring by the number of lives lost, for the largest number of deaths ever before recorded was 85, at Chatsworth, Ill., in August, 1887. But there were over 200 injured in that wreck, whereas the number injured at Eden was very small. At Ashtabula, in 1876, there were 80 killed and 60 injured; at Laurel Run, last December, 65 killed and only 4 injured. At Armagh, Ireland, in 1889, the killed numbered 80 and the injured 262. In the Tay Bridge disaster in Scotland, in 1879, every one of the 73 persons on the train was lost. Larger losses have been reported from Mexico (1881, bridge disaster, 214 killed); Salvador (1894, 200 killed); Japan (1895, 140 killed), and Switzerland (1891, 130 killed). In circumstances the Colorado disaster is much like those at Thaxton's, Va., in 1889, and at McDonough, Ga., in 1900, in both of which cases passenger trains were wrecked as a result of sudden rains of great violence. At Thaxton's a roadmaster was on the engine, and the superintendent was in the baggage car, but the surface of the embankment gave no hint of its inner weakness. At McDonough every person on the train, except those in the rear car, was killed, and those parts of the wreck above the flood were burnt up so quickly that no help could reach the victims.

Whether or not there was any error of judgment at Eden cannot be discussed without a full account of the circumstances; and important details may never be known. The lesson for the future, so far as any lesson is discernible, is not so much one of judgment as one of courage. Cases will arise where an engineman, or the conductor and the engineman together, having no civil engineer or bridge expert at hand, must decide whether or not to cross a bridge of doubtful stability; and the practical question in such cases is quite likely to be, Have we the firmness of will to detain a train load of passengers an hour, or a night, when by minimizing the grounds for suspicion, or by trusting to the vigilance of trackmen whose whereabouts is not known, the train could in all probability be taken through on time? We are not saying that conductors and en-

ginemen consciously and designedly run into danger, even slight danger; but flood disasters which would have been prevented by the rigid caution which the rules require, do occur occasionally, calling attention to the need of consideration of the subject. Such a disaster occurred in Ohio a few months ago, not, however, to a passenger train.

The daily newspapers will call for the employment of track walkers every hour on every railroad. It seems heartless to answer that such a remedy would be too costly, and yet cost is the final arbiter. The wages of a track walker may be only a straw, but a straw may break a camel's back. Restriction of speeds at all times to 10 or 15 miles an hour would prevent a large share of the fatalities from bridge disasters, but the public would reject such a remedy; the people themselves would be glad to step in and deliberately risk their own lives if the railroad company were too cautious. Moreover, some cases would occur even if conductors stopped and examined every threatened bridge. Another demand that will be made will be that railroad tracks always be built high enough and waterways be made wide enough to provide for any possible rainfall or thaw. Here again we encounter the cold argument of cost. If we waited for perfect safety many railroads would never be built. The utmost provision against floods that can reasonably be taken in laying out and building a railroad is to carefully and intelligently provide against those which are liable to occur; and if the engineer puts an extreme construction on the word "liable" he may easily make unreasonable expenditures to guard against dangers that will never happen.

What can be accomplished by skilful retrenchment in the face of decreasing gross earnings is well shown by the comparison of earnings and expenses of the Pennsylvania system for the month of June, 1904, as compared with June, 1903. Taking as the five principal divisions the lines directly operated by the Pennsylvania Railroad Co., the Philadelphia, Baltimore & Washington, the Northern Central, the West Jersey & Seashore and the Lines West of Pittsburg and Erie; in two of the cases, that of the P. R. R. and of the Lines West, gross earnings decreased to a total of over one and a half millions, while on the three lesser divisions, although gross earnings increased as compared with June, 1903, the aggregate increase amounted to only about $76,000. But in place of the increases in operating expenses which were so alarming all last winter and spring, the cost of working was so materially reduced that the aggregate net earnings of the system for the month were $440,300 greater than in June, 1903. This is good railroading.

## The Marienfelde-Zossen Electric High-Speed Trials.

Mr. Alexander Siemens on May 26 read a paper before the London Institution of Electrical Engineers on the high-speed electric railway experiments on the Marienfelde-Zossen line. The paper, in abstract, is printed elsewhere in this issue. In introducing the subject he gave an account of the work of Siemens & Halske since 1886, which led up to the Gross Lichterfelde experiments with a three-phase railway working with overhead conductors in 1898, and eventually to the work of the Studiengesellschaft on the military line between Zossen and Marienfelde in 1901, 1902 and 1903. He gave the rules and regulations which had to be observed during the trials, and having detailed the real object of the investigations, proceeded to bring out the chief results which are of value, by means of comments upon the reports issued by the Studiengesellschaft, together with some interesting curves of speeds, air resistance, energy consumption, etc. Mr. Siemens said that the construction of the conductors and collectors has solved the problem of how large quantities of electrical energy can be transferred from a standing conductor to a rapidly moving car, for the cars ran "steadier at a speed of 120 to 130 k.m. per hour than an ordinary corridor train carriage at 90 k.m. per hour." One of the cars had its ends with the corners well rounded, while the other had ends truncated cone shape. In the first trials the syndicate could not determine which of these was the better, but in the second trials they came to the conclusion that the front of the car should be a rather steep paraboloid. Owing, however, to the necessity of arranging the cabin of the driver in front and providing buffers and drawbars, it is not possible to carry this out in practice, but the nearest approach to the correct form is suggested to be a cylindrical front extending for 86 deg., then plain surfaces which join the sides of the car by easy curves.

When the trial runs of the high-speed cars were completed, some further experiments were made with a Siemens & Halske three-phase locomotive, and these are commented upon in a separate report of the syndicate. Here it is said that the high-speed cars have proved suitable for their work as far as their mechanical and electrical outfit is concerned, but their weight is too great and the proportion of the dead weight to the paying load is not favorable. This weight caused permanent way troubles, and also necessitated very high power during the acceleration period, and for economical high-speed traffic it should, if possible, be diminished so as to load the axles only sufficiently for the necessary adhesion. Mr. Siemens said further that it would not be possible to effect this object by altering the construction of the car, or by lightening its mechanical outfit, without endangering its safety; it is therefore necessary to try to diminish the weight of the electrical apparatus. This may be done by removing the transformers from the car and placing them along the line, or by dispensing with them altogether. In the first case a double set of conductors is required, increasing the losses and the capital expenditure. "It is therefore preferable to employ motors which are capable of utilizing high-tension currents." In order to try the possibility of using such motors on the high-speed cars, Messrs. Siemens & Halske built two motors of approximately the same outside dimensions, but suitable for working with 10,000-volt currents, and fitted them each to a four wheel track with a wheel base of 3.25 in. The car body, 12.5 m. long, was of the usual type for electric locomotives. It was found that the efficiency of this locomotive was much greater than that of the cars at the earlier trials, for the reason that its motors were working nearer to their rated output. Another reason was the absence of a transformer. The losses in the conductors along the line are given as 2 k.w. in the case of the locomotive, and 17 k.w. in the case of cars. It is contended that the experiments have afforded proof of the possibility of building motors for three-phase currents of 10,000 volts, used direct without transformers.

## Railroad Gross Earnings for June.

Notwithstanding the fact that railroad gross earnings for June show a decrease over the same month last year, the returns as a whole are encouraging. For the month of June, 88 railroads report a decrease in gross of only $1,410,787. In May the decrease shown by 81 railroads was $2,811,823, and in April 72 roads reported a decrease of $2,771,810. This shows that gross earnings are slowly picking up, while at the same time operating expenses have been materially reduced. Of 60 of the more important railroads reporting gross earnings for June, 29 show increases and 31 decreases. Moreover, the decreases are confined to certain sections, and are not general throughout the country. Returns from the south, southwest and middle west all appear quite favorable. In the middle west the gains are due largely to the extra travel arising from the St. Louis Exposition, which has not been felt until now, as the fair was opened too late to affect the May earnings.

The factors which have worked toward the decrease of gross earnings in June are mainly the same as those which operated in May, i.e., the coming presidential election making trade very quiet, labor troubles in Colorado and heavy rains in certain sections of the west. The only difference lies in the fact that whereas in May the weather was bad in the Southwest, in June the effect of the inclement weather was felt mainly in the Northwest. Gross earnings when divided geographically clearly show the effect of the rains, as the greatest decreases have been among the Northwest and North Pacific railroads. In this group 14 roads report a decrease of $1,246,483 for the month of June. Earnings of the trunk lines have also been unsatisfactory, seven railroads in this group reporting a decrease of $1,412,883. On the other hand fairly heavy gains were scored during the month in the other groups. These may be summarized as follows: Southwest and South Pacific group (nine railroads), increase $1,053,469; Middle and Middle West group (15 railroads), increase $107,844; Southern group (14 railroads), increase $196,309. Owing to the fact that several of the railroads belonging to the Anthracite group have not reported their earnings for June, the showing may yet be materially bettered.

Among the separate railroads reporting earnings for the month, several show considerable gains. The most noteworthy of these are as follows: Atchison, Topeka & Santa Fe, increase $629,861; Wabash, increase $323,383; Missouri, Kansas & Texas, increase $312,741; Missouri Pacific, increase $265,000; and Illinois Central, increase $260,354. In contrast, the following important railroads show losses: Baltimore & Ohio, decrease $455,538; Great Northern, decrease $427,304; Chicago & North Western, decrease $416,172; New York Central, decrease $354,718; and Northern Pacific, decrease $204,180. As noted elsewhere in this issue, the Pennsylvania also shows a considerable decrease in gross earnings, amounting on its lines east to $1,050,300, and on the lines west, to $574,500 but the curtailment of operating expenses has been so successful that net earnings for the month show an increase of $440,300 for the entire system.

## NEW PUBLICATIONS.

*American Trade Index*, 1904. 703 pages 5½ x8½ in. Printed by the National Association of Manufacturers. 170 Broadway, New York. Price in the United States, $5. The present volume is the sixth edition of the American Trade Index first published in

1899, and contains the names of about three thousand American manufacturers. The book is printed in English, German, Spanish and French, and its prime object is to acquaint the importer and dealer in foreign countries with the manufacturers in the United States of all classes of goods suitable for the export trade. The present edition comprises 12,000 copies, of which 7,500 are for foreign distribution, and this distribution is gratuitous to prominent importers, mostly dealers and manufacturers in countries outside of the United States who are interested in purchasing or handling American goods. The companies included in the book are indexed in four languages in the back according to the class of goods they manufacture.

*Train Rules and Train Despatching*, by H. A. Dalby. New York: The Derry-Collard Company. 221 pages, 4 in. x 6 in., flexible leather. $1.50.

This little book is called "A Practical Guide for Train Despatchers, enginemen, trainmen and all who have to do with the movement of trains." Mr. Dalby is a despatcher of long experience, and he always deals with his subject in a practical manner. About 100 pages contain the substance of the work, the rest being taken up with the standard code and illustrations, etc. Among the chapter headings are: Work Trains; Change of Timetable; Train Registers; Clearance Cards; Identification of Trains; Words to Operators; The Despatcher, Engineman and Trainman; Suggestions to Young Despatchers, etc. The author notices the electric train staff and gives colored illustrations of various kinds of signals, including the right-angle semaphore used on the Lake Shore & Michigan Southern. The book contains a reprint of the standard code, a list of dividing points for standard time, and some original illustrations showing the colored flag and lamp signals used on the front and rear ends of trains. The style of the book can best be shown by an extract. Giving "suggestions to young despatchers" the author says:

"On the average road, I believe the hours of the night, when only a few telegraph offices are open, are the hardest for the despatcher. A freight train leaves an open telegraph office and cannot be expected at the next one for several hours. The despatcher should provide such a train with help on superior trains, not only to cover the time it may reasonably be expected to 'come out of the dark,' but to provide for probable or possible delays. Suppose an extra leaves a station at 1 a.m. and should have plenty of time to make the next open telegraph office for No. 6, which is due at 2:45 a.m. If he knows that No. 6 is to be 30 minutes late it is wise to give the extra that 30 minutes. He may 'fall down' and the 30 minutes may save him two hours. Under the same conditions, if our extra is not important and an extra in the opposite direction is of such a character that we do not want to run the risk of a serious delay, our second named extra should have right over the first with 'wait' orders at such stations as may be of use to the extra of lesser importance. 'Meet' orders between trains of unequal importance should only be given when all telegraph offices are open and conditions are such that, in the event of unexpected delay to the inferior train, it can be reached and the order changed.

"It is very seldom that I should use a 'meet' order between passenger and freight trains, though the freight train may be of so great importance as to warrant taking the risk of holding the passenger train by making the time order three or four minutes longer than the anticipated actual time. Between freight trains, even of varying importance, when all telegraph offices are open, and there is a reasonable certainty of being able to hold the inferior train in case of unexpected delay, I believe the 'meet' order is by far the best. . . . But there are times when the 'meet' order would involve considerable risk of delay to the superior train. An unimportant train reports 'ready in five minutes.' All he has to do is pick up one car. But that car is at the other end of the yard where the train is beyond reach of the despatcher in case an unexpected delay occurs. A 'time' order is the proper thing in this case, if the superior train is of much greater importance."

## TRADE CATALOGUES.

*The Curtain Supply Company*, Chicago, has issued a new catalogue, D, covering car curtains, curtain fixtures and curtain materials. It is 25 per cent. larger than the previous catalogue and is quite complete. The various types of fixtures are shown in the first pages and are described and illustrated in detail. The Forsyth adjustable roller tip fixture, which is widely used by railroads and traction companies, is fully described on pages 11 and 12, two detail sectional views being shown. The various styles of pinch-handle automatic, flap and vestibule door curtains follow, and the last pages show half-tone engravings of a few of each of the different kinds of curtain materials carried in stock, and contain directions relative to the different mechanisms and methods of hanging the curtains.

*The Niles-Bement-Pond Company* are distributing an exceptionally fine number of their *Progress Reporter*. The object of this publication is to keep the employees of the company, and the public generally, informed as to the new machines and devices which are constantly being brought out. The current issue is the Louisiana Purchase Exposition special number, and it illustrates the company's machines which are on exhibition at St. Louis. All of the machines shown are of new design, and a number of the larger machines are shown driven by direct-connected motors.

*The Knowles Steam Pump Works*, 114 Liberty street, New York City, has just issued their bulletin K—73, which describes their recently designed "Express" pump. This pump is of the reciprocating type and is direct connected to a motor. The 250-gallon pump runs at a speed of 300 r.p.m. The details of a test are given in which this pump showed an efficiency of 93 per cent. The pumps are made with capacities of from 200 to 4,000 gals. p.m. and for heads from 100 ft. to 2,000 ft.

*The Standard Paint Company*, New York City, has just issued its July number of "The Exchange." This is published monthly and is devoted to the interest of the Standard Paint Company. The company says that so far this year sales of Ruberoid roofing are largely in excess of those of last year, and that during the last three years the Government has ordered 3,500,000 sq. ft. A great deal of this was used in the Philippines.

The latest number of *The Little Blue Flag*, issued at intervals by The Lowe Brothers Company, Paint Makers, Dayton, Ohio, contains some interesting and instructive information for paint men and good advice on several subjects. There are also some attractive half-tone engravings of exteriors and interiors finished with the products of the publishers.

*The Electric Storage Battery Company*, Philadelphia, Pa., sends its July Bulletin, No. 84, which treats of the installation of the company's "Chloride Accumulator" in residential lighting and power plants. The pamphlet is illustrated throughout with photographs of battery rooms of well-known residences.

*The Cleveland Twist Drill Company*, Cleveland, Ohio, has just issued its 1904 catalogue. This company was established in 1874 and their product includes twist drills, reamers, taps, mills and cutters for all purposes. The catalogue is well illustrated and gives the prices and sizes of the various tools.

*The Blaisdell Machinery Company*, Bradford, Pa., has issued Bulletin No. 12, relating to self-oiling air compressors. A cross-section showing the general design of the compressor is shown. This is followed by a full detailed description of the separate parts and illustrations of the same.

*The Standard Truck and Forging Company*, St. Louis, Mo., sends an illustrated catalogue descriptive of its goods. This company makes a specialty of electric railway trucks, railway truck supplies, blacksmith tools, etc. They also make forgings to order.

## Passenger Terminal at Long Island City.

[WITH AN INSET.]

At the enlarged passenger terminal of the Long Island Railroad, at Long Island City, New York (across the East River from Thirty-fourth street, Manhattan), the Union Switch & Signal Company has erected the largest electro-pneumatic interlocking machine, but one, that has ever been made; and it is in a tower four stories high, the machine being in the fourth story. The Vernon avenue bridge, crossing the tracks above grade, adjoins the tower (on the left in the illustration) and this made it necessary to raise the operating floor to an unusual height. The yard also is very long, the most distant switches being about 1,700 ft. from the tower.

The introduction of power interlocking at this place is part of a general improvement, which includes the entire rebuilding of the tracks in the yard, and the enlargement of the terminus for the accommodation of summer passenger business. The tracks have been increased 50 per cent., and most of them lengthened. The concourse has been doubled in size and the platform space increased in nearly the same proportion. The longest platform will now accommodate trains of 18 cars. The head house, a two-story brick structure, which was badly damaged by fire a year and half ago, has been restored. The building has been made larger, though the waiting room is of the same size as before, the addition being used for express, mail and employees' rooms and other conveniences which before were in outbuildings that have had to be removed to make room for additional tracks. The number of gates is increased to correspond with the increase in the number of tracks and the enlarged concourse. In the old arrangement the switches leading to the platform tracks were worked by hand, the machine in the old interlocking cabin, which stood near the signal marked 26L on the diagram, having control only of those switches within about 600 ft. of the cabin.

The remodeled head house has metal and plaster partitions, metal-sheathed wood work, and, in the first story, a concrete floor. The new part of this building, which is on the south, is so designed that the whole of both old and new can be thrown together for a large waiting room, but this is not at present necessary, for the reason that throughout nine months of the year the en-

tire business of this station is light; the heavy business occurs in the summer wnen the need of indoor facilities is at the minimum. The principal rooms in the addition are, on the first floor, a lamp room, a stationery room, a doctor's room, and rooms for the United States mail service and the Long Island News Co. Figs. 2 and 3 show the old and the new portions of the second story. It will be observed that the two plans of the second story are less in combined area than the first story. This is explained by the fact that a part of the building in the center is only one story high. The conductors' and trainmen's rooms have sheet metal lockers, 90 in the former and 172 in the latter. The racks in the stationery room are of sheet metal and strong wire netting, facilitating ventilation and cleanliness.

The lamp room, for the use of passenger trainmen, has 115 lockers designed especially for lanterns and flags. These lockers, as shown in the illustration, are made wholly of metal and yet are light and not costly. The door of each, a ⊂ shaped skeleton, is fastened by a padlock; and the openings in the skeleton are not large enough to admit of any of the lanterns or other things being taken out without unfastening it.

The sheds over the train platforms are of the inverted umbrella design, with drainage in the center, like those to be built at Washington, D. C., and described in the *Railroad Gazette* of Jan. 15 last, but they are of wood, with wooden supports and frames, and gravel roofs. The cheaper structure is more appropriate in this place, because in a few years the station may need extensive changes, by reason of the completion of the tunnel across the East River, which will take away a large part of its business.

The 185 switches and signals in the yard require 142 levers, as shown on the drawing, Fig. 6. The tower is 21 ft. x 48 ft., and the fourth floor is 35 ft. above the rails. The second and third floors are used for the purposes indicated on the drawing, and the first will probably be used as a shop. The projection, 10 ft. square (on the northwest corner) gives the train director a good view in every direction. The frame of the tower is of steel. The outer covering is of galvanized iron which, it will be seen, had not received its final coat of paint when our photograph was taken. The partitions and floors are so protected by plaster and by the use of metallic lath as to make the building practically fireproof.

There will be indicators in the tower connecting with buttons near the passenger gates at each one of the twenty-three tracks in the station. Conductors of trains about to depart will, by this means, notify the tower, and the man in the tower will in response advise the conductor when the route for his train is being set up.

Fig. 8—Wireless Interlocking.

Fig. 13—Westinghouse Electro-Pneumatic Interlocking Machine, Long Island City.
*The Operators Face South.*

In those cases, in this yard, where switches are very close together, as in the case of No. 6 slips, such as 153 and 155, a single detector bar is used for the two switches, the connection to the bar being arranged so as to be worked in connection with either switch. The movement is arranged on the principle of a floating lever. The movement of either switch moves the bar for half its stroke; the movement of both switches moves the bar a whole stroke. By the use of the motion plate principle in the bar supports, the effect of a half stroke on the bar is practically the same as a whole stroke. With this arrangement, the bar is governed entirely by positive motions, no dependence being placed on gravity.

In consequence of the large number of switches in this yard in proportion to the number of signals, some of the upper levers in the machine are made to serve for switches and it will be seen, therefore, that some of the switches, such as 4 and 6, have even numbers, the usual rule being to use odd numbers for switches.

Since this plan was made, two short spur tracks have been laid to the left of the tower. These join the platform tracks near suspended signal 136R, and that signal has been replaced by one set on the ground at a point beyond the end of the platform.

On the North Shore division, which enters this yard from the northeast, trains are run by the telegraph block system, but from signal No. 30 back to the first block station there will be a continuous track circuit, and this track circuit will give indications in the tower in the yard, so as to automatically announce the approach of incoming trains. These trains, when passing signal 30R automatically set the signal at stop behind them, and by another track circuit they will automatically clear the signal when near signals 30L and 28L.

The new switches, with all parts made to conform in design to 100-lb. rails, were completed and put in use some weeks before the cabin and power house could be made ready. The new rails and frogs being too heavy, to be thrown by hand, they were worked, until the new power and interlocking were in condition to use, by compressed air, but were individually controlled, a man being stationed at each switch, with a key to turn the air valve. The power was furnished by the air pumps of two old locomotives stationed at one side of the yard.

The interlocking during this temporary arrangement was neither mechanical nor electrical, but was wholly psychical, the "machine" being in the top story of the "structure" shown in Fig. 8. This expedient was a marked success. As the reader will readily imagine, from a glance at the diagram of tracks, and from the fact that about 400 trains use this terminal daily, involving two or three times that number of movements, the quiescent attitude in which this train-director here appears was never maintained by him for long at any one time. His job was a "hot", one, not only as measured by the intensity of the rays of the sun, beating down on his very appropriate hat, but also quite "hot" in the language of the caboose.

The design of this yard was largely the work of General Superintendent C. L. Addison, and the signal apparatus has been made and put up under the supervision of Mr. Sidney Johnson on behalf of the Signal Company, and Mr. E. M. Weaver, Signal Engineer, for the railroad company.

## High-Speed Electric Railway Experiments on the Marienfelde-Zossen Line.*

Since September, 1901, three sets of experimental runs have been made with high-speed cars on the military railway between Marienfelde and Zossen, near Berlin, which had been equipped electrically for the purpose, and last autumn speeds of over 200 km. per hr. were attained. The War Office placed their single line between Zossen and Marienfelde at the disposal of a syndicate, and the President of the Imperial Railway office became its chairman. Each year the syndicate has published a report of the trials of the preceding year, and all the data given in this paper are taken from these official reports, unless another source of information is specially mentioned.

The permanent way of the military line consisted of rails weighing 33.4 kg. per m., placed on iron and partly on wooden sleepers, and its condition was such that no greater speed than 80 km. per hr. was allowed on it. In the first instance this was improved by relaying about 800 rails of 12 m. each, increasing the number of sleepers by 4,000 and adding broken stone ballast to the extent of 4,000 cu. m. This work was finished and the line, 23 km. long, ready for the trials on Sept. 3, 1901, when the official inspection was satisfactory. At the same time electric contacts, to be actuated by the wheels, were placed at 500 m. distance from each other all along the line, and a registering apparatus at Mahlow Station was connected to them, so that the speed of the cars could be verified there.

The overhead conductors along the line were constructed by Siemens & Halske, with a device to ground the line in case a conductor should break. At every insulator a metallic loop, about 30 cm. in diameter, extending horizontally toward the pole, is connected to the conductor, and a vertical copper wire passes through the center of the loops, the copper wire being efficiently connected to the running rails and through them to the zero point of the three-phase generators, the rails being in addition connected to metal earth-plates at intervals of 1 km. Any interruption of a conductor brings it, therefore, at once into contact with earth, and prevents any accident by shock from the falling conductor. The efficiency of this arrangement was tested, both intentionally and by accident, when the conductor fell on an official, but in both cases the grounding served as an absolute protection. The line is fitted at every kilometer with means of adjusting the strain, kept at about 1,000 kgs., and with lightning dischargers of the horn pattern. At a distance of about 1 km. from Marienfelde (km. 8.5) the feeding line from the generating station Oberspree, 13 km. distant, and built by the Allgemeine Elektrizitäts-Gesellschaft, is joined to the line along the railway by a main switch.

Two cars were built for the trials by Zypen & Charlier, constructed and fitted as corridor cars in accordance with the rules of the German Railway Union. One of these cars, called "A," was furnished with its electrical outfit by the A. E. G.; the other was fitted out by Siemens & Halske, and in the reports is called "S." There are two groups of three collectors on each car. These cars were delivered on the experimental line in the beginning of September, 1901, and at first were drawn by locomotives, so as to ascertain whether all their parts, especially the brakes and springs, were properly adjusted, and to study the mechanical behavior of the collectors and conductors. Observations were also made as to the relative movements of the bogies and the carriages.

The technical committee of the syndicate decided that the trials should be undertaken in such a manner as to ascertain: (1) The highest safe speed on the line; (2) the proper construction of the permanent way; (3) the most advantageous construction of the car; (4) the most suitable electrical outfit; (5) the amount of energy at the various

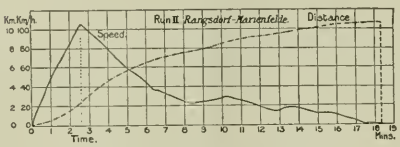
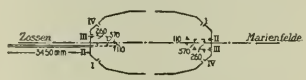



Fig. 1—Curves Showing Retardation of Car "A."

speeds; (6) the cost of working. To obtain the necessary data, each car has been fitted with the following instruments: (1) A speed indicator for the driver; (2) a speed-registering apparatus; (3) an acceleration indicator; (4) a voltmeter; (5) an ammeter; (6) a wattmeter; (7) a phase indicator; (8) a pyrometer; (9) air-pressure indicators.

The speed indicator registers the kilometers per hour, and is checked by the speed-registering apparatus on the car and by the instrument at Mahlow station.




*Location of Tubes in Car.*

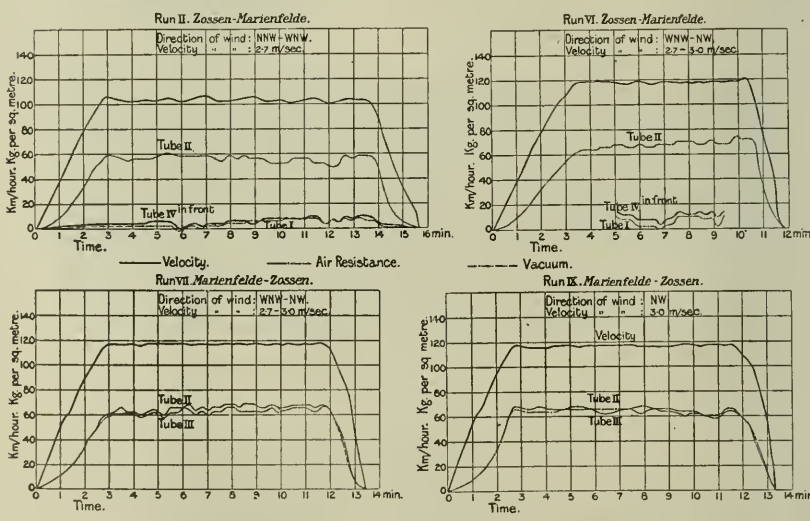



Fig. 2—Curves of Speed and Air Resistance of Car "S."

On October 8, 1901, the "S" car made its first run between the car shed and km. 10.5, but while the current was on the signaling apparatus of the State Railway and of the Military Line were sufficiently affected to require the construction of metallic returns along the whole line. This was finished in time for the regular runs of both cars to commence on October 14.

During these trials the cars ran about 3,000 km., of which 2,200 km. were under current, and for 800 km. the cars were pulled by locomotives before any current was used. The first two sets of experiments were carried out according to programme, and dealt with speeds up to 130 km. per hr., and they were principally utilized to ascertain the rate of acceleration and the data of braking. During the third set the speed was gradually increased until the "S" car reached a speed of 160.2 km. per hr. on November 5, while the railway officials made an inspection of the line in accordance with the regulations governing the trials. Even at a speed of 140 km. the running of the cars became irregular owing to the condition of the permanent way, and at higher speeds the rails were bent and their lever was so much disturbed that the speed of the subsequent runs had to be restricted to 130 km. per hr. It was, however, possible to make valuable measurements of the energy required, and the working of the collectors and conductors could be observed with currents of 48 periods and 13,500 volts.

About the behavior of the various component parts the report of the syndicate enters into great detail, of which a short summary only is given. At the generating station the steam dynamo and transformers worked quite satisfactorily, and supplied current of 25 to 50 periods and 6,000 to 14,000 volts. The feeder consists of four conductors, each of 50 sq. mm. section, the fourth conductor connecting the running rails to the zero point of the two transformers. The conductors along the line, constructed as described above by Siemens & Halske, have given no trouble whatever even in heavy rain or hoar-frost.

One of the most important problems, namely, to ascertain how large quantities of energy can be transferred from a standing conductor to a rapidly moving car, has been successfully solved by the construction of the conductors and of the collectors, both of which were the outcome of the experiment at Gross-Lichterfelde. Both carriages, built by Van der Zypen & Charlier, ran in a very satisfactory manner, and ran steadier at a speed of 120 to 130 km. per hr. than an ordinary corridor train carriage at 90 km. per hr. At higher speeds the irregularities of the permanent way made the running dangerous. In the two articles mentioned above where the position of the car is indicated every 500 meters by the wheel contacts along the line. Of the greatest importance are the observations in connection with the brakes, both as regards the time and the distance taken to bring the car to a standstill after it had attained certain speeds. At the generating station in Oberspree, suitable instruments for registering volts and amperes were connected to the feeder, so as to check the apparatus on the cars.

*From a paper read by Alexander Siemens before the Institution of Electrical Engineers, May 26, 1904.

the electrical arrangements of the two cars are described in detail.

The report of the syndicate makes the following observations:

(*a*) It considers the switching arrangements of the "S" car more complicated than those of the "A" car, and suggests for both cars that it should be possible from either end to set both groups of collectors simultaneously.

(*b*) The transformers in both cars are cooled by air and have worked well during the trials.

In car "S," after running 230 km. in succession, necessitating 14 accelerations to a speed of 120 km. per hr., the temperature of the transformers was only 25 deg. C.; they were, therefore, considered sufficiently large to stand long runs, especially as they worked well with 12,000 to 13,000 volts. On the other car the transformers were much lighter, but they were never overheated, only on November 19 a primary coil was short-circuited by a current of 12,000 volts. After that date currents of no more than 8,000 volts were permitted, so that the point could not be settled whether the transformers on this car could be used for long periods with high voltages.

(*c*) Each of the motors on both cars is designed for 250 h.p., the "A" car motor taking current at 435 volts, and the "S" car motors 1,150 volts, while the pressure in the secondary circuit is 650 volts when standing still and during acceleration. No difference in running was experienced, although the motors on the "S" cars are rigidly fixed to the axles of the wheels, while the motors on the "A" car are carried by the bogie frame and drive by an arrangement of springs. The report prefers the latter arrangement, and suggests trying a third method—driving the wheels by connecting rods.

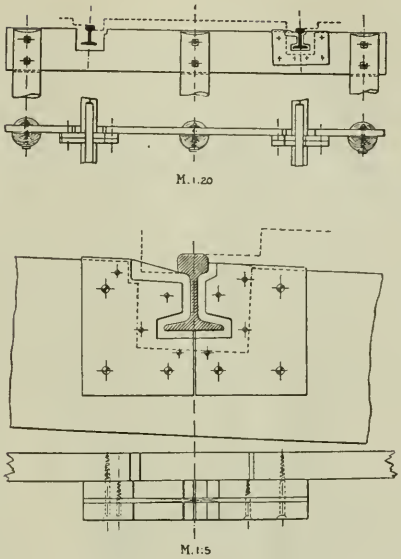



Fig. 3—Apparatus for Indicating the Movement of the Rails.

(*d*) The switches and resistances present another feature in which the electrical arrangements of the two cars differ; on the "A" car liquid resistances were employed, regulated by pumps, while metallic resistances were carried on the "S" car. Both arrangements gave no trouble during these trials. The metallic resistance switches are more complicated than the others, but they work faster. Of great importance are the results obtained while accelerating and during the retardation of the cars. The acceleration varied with the demand on the generating station and the motors, as was to be expected. To obtain a speed of 100 km. per hr. the distances traveled varied from 2,000 to 3,200 meters, and the times from 138 to 220 seconds. These figures correspond to an average acceleration of 0.13 to 0.2 m. per second, and correspond to 700-1,000 h.p. As the motors are capable of exerting up to 3,000 h.p. during acceleration, this might have been increased correspondingly, but the generating set was not powerful enough to supply the necessary current. For trains intended to travel long distances without stops the rate of acceleration is, however, of less importance than the action of the brakes on which the safety of the service depends. Both cars were fitted with a Westinghouse quick-acting brake, hand brakes and an electric brake acting by reversing the currents through the motors. The "A" car had, in addition an accumulator battery, the current from which could be sent through the three-phase motors. In Fig. 1 the decrease of speed is shown when the "A" car was left to itself after attaining a speed of about 106 km. per hr., respectively.

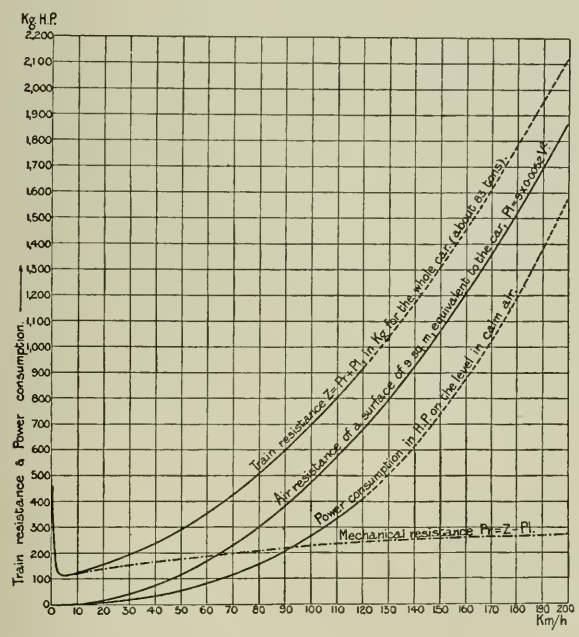

Kg H.P.
Train resistance & Power consumption.
Km/h
Train resistance Z = Pt + Pl in Kg. for the whole car (about 65 tons).
Air resistance of a surface of 9 sq. m. equivalent to the car. Pt = 0.0006 v².
Power consumption in H.P. on the level in calm air.
Mechanical resistance Pm = Z − Pt.

Fig. 5.—Train Resistance and Power Consumption of High-Speed Cars.

Very numerous observations were made about the consumption of energy both in the generating station and on the cars, especially during the last set of runs. For this purpose readings were taken at the switchboard in the generating station every 10 seconds of the volts, amperes and watts, and the periodicity of the current was checked by the number of revolutions of the generating set. On the cars amperes and volts were read at intervals of from 15 to 30 seconds. The measurements at the station were the most accurate, as the instruments there were not exposed to the vibrations unavoidable on the cars. After making the observations they had to be corrected, as the instruments were only correct at a certain periodicity.

Numerous further measurements were taken and Table 1 gives the average result of the power required at a constant speed:

TABLE I.—POWER REQUIRED AT CONSTANT SPEED.

| Car. | Speed, Km. per hour. | B. H. P. Measured at feeding point. | B. H. P. Measured at car collector. | B. H. P. Calculated from speed. | Efficiency of electrical outfit. Car by itself. Per cent. | Efficiency of electrical outfit. Car and conductors. Per cent. | Consumption of steam. Kg. per B. H. P. per hour. At car wheels. | Consumption of steam. Kg. per B. H. P. per hour. At flywheel of steam engine. |
|---|---|---|---|---|---|---|---|---|
| "A" | 118 | 478 | 455 | 397 | 87 | 83 | 5.84 | 4.6 |
| "S" | 115 | 431 | 405 | 341 | 84 | 79 | 6.12 | 4.6 |

The report does not consider these figures reliable enough for commercial deductions, partly because the instruments were not properly calibrated for the varying periodicity of the current, partly because the motors in both cars were working very much below their rated output.

For the purpose of observing the air resistance at the various speeds openings were made in various parts of the car bodies and short brass tubes inserted. These tubes were connected by india rubber tubes to a row of pressure indicators consisting of pairs of communicating glass tubes about 5 mm. in diameter partly filled with water. An adjustable scale was fitted to each indicator divided into millimeters, so that the difference in the water level of the two tubes could be observed at the various speeds. Four such openings were made at each end of either car, two of which were near the center and the other two at the sides, as indicated in the diagrams of Fig. 2.

Preliminary trials proved that the position and the form of the opening of the brass tubes have no influence on the result, and this made it possible to compare the pressure all over the front of the car with the pressure in the center, independent of the varying speed of the car. In addition, straight tubes up to 3.4 m. long, were fitted to explore the pressure of the air in front of the car, and these observations showed that a cone of uniform pressure exists in front and at the back of the car, the apex of which was about 3 m. distant from the car. The "A" car, as the diagram shows, has well-rounded corners, while the "S" car has its ends in the shape of truncated cones. The pressure on these was very much smaller than in the center, and sometimes even negative owing to the influence of the wind. Some openings were also made along the sides of the car and occasional observations showed that speed had very little influence on the

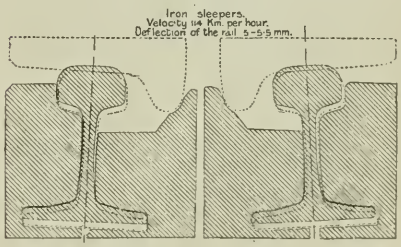



Fig. 4—Diagram Showing Displacement of the Rails at 15.8 Kms.

pressure indicated, when the brass tubes ended flush with the sides of the car, and that the direction of the wind has much more effect.

Combining all the results the report considers that up to a speed of 150 km. per hr. the pressure may be calculated by the equation $p = 0.07\ v^2$, when $v$ is the velocity in meters per second and $p$ is the pressure on a surface of 1 sq. m., at right angles to the direction of the motion. The number of observations were, however, insufficient to determine to best form for the end of the cars. Another set of observations was made to determine the extent of the movement of the rails, when the cars were passing at various speeds. For this purpose measuring apparatus were set up at various points of the line, which are shown in Fig. 3. Each of these consists of three strong posts, about 1½ m. long, rammed into the ground, one in the center and one on each side of the rails, to which a strong board is fastened with its upper edge a little below rail level and with suitable openings cut to permit the rails to pass through. Near each rail two short boards are bolted to the plank, between which a lead plate is supported. This is cut in two and fitted accurately against the rail, the edges touching the rail being sharpened. It is evident that any movement of the rail will bend these edges back and thus leave a permanent record of the greatest movement of the rail. The result on one set of lead plates is shown in Fig. 4,

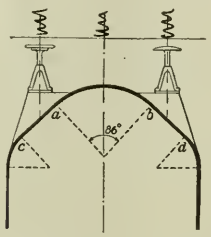



Fig. 6—Shape of Front of Car.

the apparatus is out of order. In addition it is recommended to cut the current off in the sections which a car has just left.

In conclusion, the first report states that, thanks to the care exercised by the firms supplying the cars and outfit, to the cautious and reliable execution of all the electrical work, to the careful maintenance of the permanent way and its appurtenances, and to the conscientious observation of all the precautionary measures, no mishap or damage of any kind has occurred during the trials. No psychological effects on the drivers or passengers, attributable to the high speeds, have been noticed. Although it has not been possible to obtain reliable data for judging the economical aspect of this question, some valuable technical information has been gained. In the first place, the experiments have shown that it is possible to collect high-tension currents even in unfavorable weather can be ascertained whether the cars, their equipment, and all other outfit are suitable for regular traffic on main liues at a speed of 160 km. per hr. and whether still higher speeds are practicable, especially from an economic standpoint.

Originally it had been the intention to resume the experiments in 1902 on the lines laid down at the commencement, and to increase gradually the speed of the cars until a speed of 200 km. per hr. had been attained. It was, however, not possible to relay the permanent way in time, and in consequence of this the authorities would not allow a greater speed than 125 km. per hr. The time was, therefore, utilized for determining more accurately the resistance of the cars at various speeds, the power required for propelling them, and the losses of energy in the feeder and the conductors. In addition to this, further experiments were made with the brakes, and alterations in the structure of the cars were considered to insure steady running at high speeds; the movement of the rails was also observed during the trials.

The second report describes the experiments in great detail, and the following are the principal results ascertained by their help: At first attempts were made to determine the resistance of the cars direct by pulling them at moderate speeds by a locomotive, to which they were attached by a dynamometer. It was found, however, that owing to the great weight of the cars, and owing to the irregular pull of the locomotives,

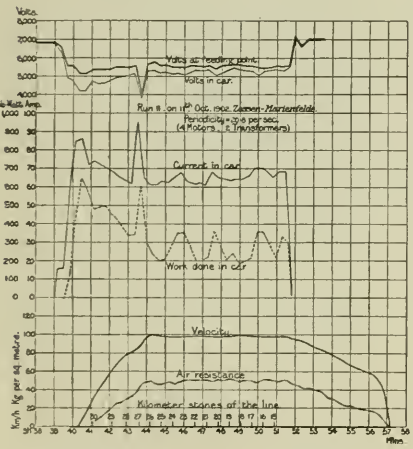



Fig. 7—Runs with Car "A."
*Weight* = 89,500 *Kg.*

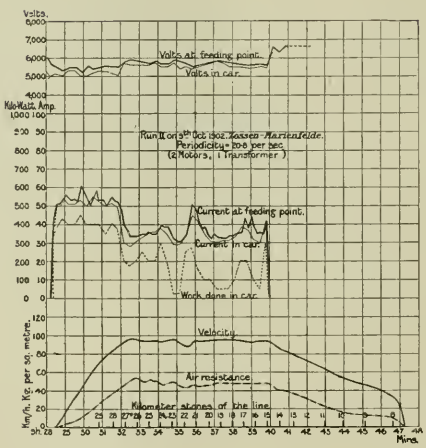



Fig. 8—Runs with Car "S."
*Weight* = 77,900 *Kg.*

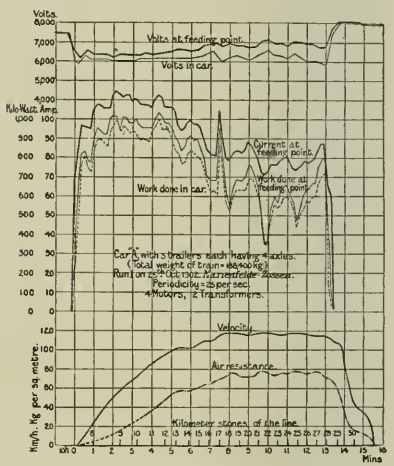



Fig. 9—Runs with Trailers.

and a summary of the principal observations is the following:

| Distance between sleepers. | Material of sleepers. | Ballast Motor Cars. | Speed Km. p. h. | Depression of rails in mm. |
|---|---|---|---|---|
| 800 mm. | wood | sand | 108 | 2.0—2.5 |
| 850 " | wood | sand | 114 | 3.5—5.0 |
| 780 " | wood | stones | 145 | 6.0—6.5 |
| 780 " | iron | sand | 114 | 5.0—5.5 |
| 780 " | iron | sand | 135 | 6.0—6.5 |
| 730 " | iron | sand | 123 | 6.0—7.0 |
| | Military Trains. | | | |
| 850 " | wood | sand | 70—80 | 1.5—2.0 |
| 730 " | iron | sand | 70—80 | 4.0— |

From these experiences the conclusion was drawn that the permanent way had to be thoroughly reconstructed before speeds exceeding 120 km. per hr. could be safely investigated. As the military trains run only at considerable intervals, at a comparatively low speed, the existing signaling apparatus had to be supplemented by distant signals about 2 km. from the stations, and some difficulty was also experienced in seeing sufficiently far ahead in rainy weather. It is, therefore, suggested to repeat the signals on the car by visual and by audible means, which should also indicate when from overhead conductors at double the speed of the present express trains. Both the conductors and the collectors have worked so satisfactorily up to the present that their efficiency at higher speeds may be safely assumed. Three-phase motors have shown themselves reliable, and their overheating has been prevented by suitable ventilation. It has, however, not been possible to decide whether it is preferable to fix the motor on the axle or support it wholly by springs; nor can it be safely said whether fluid or metallic resistances are the more suitable. The brakes have not been powerful enough for the high speeds. An alteration of the existing arrangements, and the adoption of an efficient electric brake appears to be imperative.

Generally speaking, the first year's trials have served principally to find out the best methods of making observations, and to determine which are the most suitable instruments for obtaining trustworthy information. Basing further experiments on the knowledge thus gained, it is certain that it no steady curves could be obtained, nor was the success greater when the cars were attached to a goods train. Somewhat better results were achieved by the employment of a three-phase locomotive, but the curves were still too irregular to be accepted. Nothing remained but to revert to observing the time each car took to come to a standstill after attaining a certain speed, and the distance it covered during that time, due account being taken of all differences in level. The smallest curve on the line has a radius of 2,000 m.; it was therefore not necessary to consider the curvature in the calculations, but very careful measurements of the air resistance were made by means of tubes projected from the cars in the way already described, and in the end a small correction was found necessary in the formula for air resistance, which was altered to $P = .0052\ V^2$, and the resistance of the cars was found to be equal to the resistance of 9 sq. m.

In Fig. 5 the final results of the traction resistance of the cars are represented by four

curves showing the total resistance for a car weighing 83 tons, the air resistance of a surface of 9 sq. m. being the equivalent of the air resistance of a car, the h.-p. required on the level with no wind, and, by the difference of the first and second curves, the resistance due to mechanical friction. It is at once apparent, from this diagram, that at high speeds the air resistance is by far the most important factor, and that the proper shape of the car has to be very carefully determined.

From their experiments the Studiengesellschaft drew the conclusion that the front of the car should be a rather steep paraboloid. Owing to the necessity of arranging the cabin of the driver in front, and providing buffers and drawbars, it is not possible to carry this out in practice, but the nearest approach to the correct form is suggested to be a cylindrical front, extending for 80 deg., then plain surfaces, which join the sides of the car by easy curves, as represented in Fig. 6. Very careful measurements were made as to the amount of energy required, and a measuring station was established at the feeding point, to avoid the calculations of the losses in the feeder. The ammeter and wattmeter at this station were connected direct to the high-tension circuit, to avoid the use of transformers and to make them almost independent of periodicity and of difference in phase. In the cars the instruments were joined to the same phase as at the feeding point. In spite of all precautions, however, the readings were not all reliable, especially in wet weather.

The measurements are divided into two groups: one to determine the energy during acceleration, and the other to measure it at constant speed. In both cases the cars were sometimes running by themselves, and sometimes pulling trailing cars. It will be noticed that the acceleration is not very great, but this was the consequence of the generating set not being powerful enough to supply more energy. Compared with the theoretical amount of energy required to give the cars the same acceleration, the figures of the table show an efficiency of about 45 per cent., due, no doubt, to the losses in the starting resistances; but for long-distance traveling the period of acceleration is almost negligible.

In Tables 2 and 3 the results of these experiments are summarized, and diagrams in Figs. 7, 8 and 9 give some details of runs with and without trailers. An attempt was made to measure the turning moment of a motor direct by fitting on car "A" a special apparatus represented in Fig. 10. Instead of attaching the motor rigidly to the frame, it is held by springs, as shown diagrammatically, and the movement of the springs is transmitted by suitable levers to a registering indicator in the interior of the car.

The instrument was calibrated by weights, and gave useful results when a resistance was inserted in the secondary circuit of the motor, but of course the direct comparison between the indicated turning moment and the electrical readings is thereby prevented. Diagram V., Fig. 11, shows the turning moment during a run of car "A" on November 8. About the measurements made to ascertain the loss in feeders and conductors, nothing need be said, as no novel features with regard to them are disclosed in the report. Nor need the brake experiments be described, as they were again unsatisfactory, and eventually it was considered advisable to alter the whole of the braking arrangements. A good opportunity for doing this was afforded by the reconstruction of the bogies, which became necessary to ensure the steady running of the cars during high speeds.

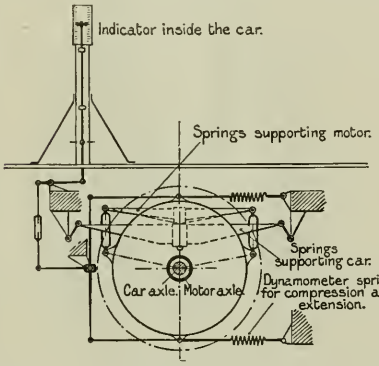



Fig. 10—Apparatus for Measuring Turning Moment.

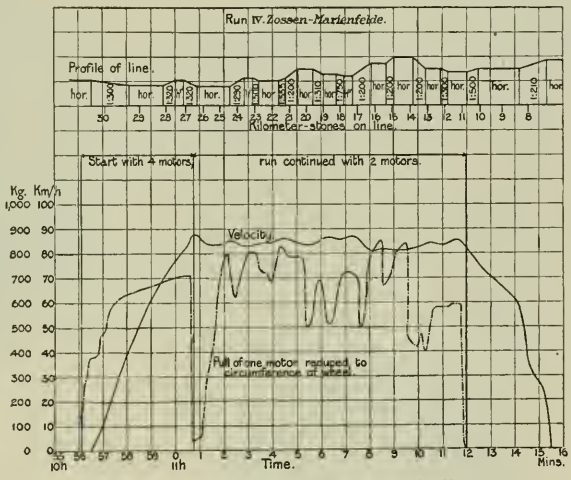



Fig. 11—Trial Runs with Car "A."

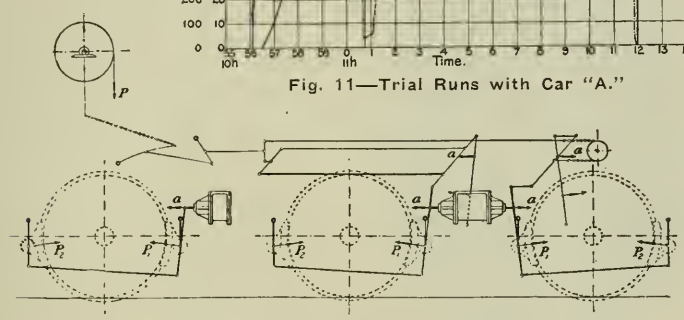


Fig. 12—Proposed Brake Arrangement.

In the new bogies the following points were to be observed: (1) The wheel base is to be increased from 3.8 to 5.0 m.; (2) the bogie frames are to be constructed with simple Z girders; (3) the bearing springs are to be connected by balancing levers, and are to be visible and easily accessible throughout their whole length; (4) the car body is to be supported at four points on each bogie; (5) the center pin of the bogie is to be movable for a distance of 30 mm. in every direction; (6) the motors are to be connected to the axles by springs; (7) the brakes are to be reconstructed as shown in outline by Fig. 12, which explains itself.

During the trials the bending of the rails was measured in the same way as in the previous year; but as the speed of the cars had been restricted, no extraordinary repairs became necessary.

When the trial runs of the high-speed cars had been completed, some further experiments were made with a three-phase locomotive built by Siemens & Halske, and the Studiengesellschaft comments on them in a separate report. In this case they say that the high-speed cars have proved suitable for their work as far as their mechanical and electrical outfit is concerned, but their weight is too great and the proportion of their dead weight to the paying load is not favorable. The trouble with the permanent way and the very high power required during the acceleration period were a consequence of this weight, and for economical high-speed traffic it should, if possible, be diminished so as to load the axles only sufficiently for the necessary adhesion. It would not be possible to effect this object by altering the construction of the car or by lightening its mechanical outfit without endangering its safety. It is, therefore, necessary to try to diminish the weight of the electrical apparatus. This may be done by removing the transformers from the car and placing them along the line, or by dispensing with them altogether. In the first case a double set of conductors is required, increasing the losses and the capital expenditure. It is, therefore, preferable to employ motors which are capable of utilizing high-tension currents.

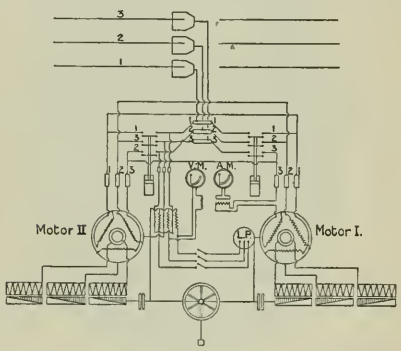



Fig. 13—Diagram of Connections to Air Pumps.

*Pumps are shown at L. P.*

With a view of trying the possibility of using such motors on the high-speed cars, Messrs. Siemens & Halske built two motors of approximately the same outside dimensions, but suitable for working with 10,000-volt currents, and fitted them each to a four-wheeled bogie with a wheel-base of 3.25 m. The car body, 12.5 m. long, is of the usual shape for electric locomotives, and in its center is a driver's cabin 4 m. long by 2.8 m. wide by 2.3 m. high. In the iron boxes on either side of it are the starting switches

and resistances, and on the top it carries the collecting gear, which is like that of car "S." The motors are suspended from the bogie frames after the manner of tram motors, driving the axles by a gearing of 1:2. Between the car body and the wheels are two sets of springs, and provision is made for a slight lateral movement relative to the bogie.

The diagram (Fig. 13) of the connections shows that there are separate switches, moved by compressed air, for each direction of running, a small transformer to supply low-tension current to the air-pump motor, these runs are given in Table No. 4. It is at once apparent that the efficiency of the locomotive is much greater than that of the cars at the trials in 1901, for the reason that its motors were working nearer to their rated output. Another reason is the absence of a transformer, so that a comparison at an output of 400 h.p. shows that the locomotive required for this at 10,800 volts, and an average current of 19 amperes, while the cars at 6,300 volts consumed about 53 amperes. The losses in the conductors along the line are therefore 2 k.w. in the case of the locomotive, and 17 k.w. in the case of the cars. In conclusion, the report considers that the trials have proved the possibility of building motors for three-phase currents of 10,000 volts, used direct without transformers. It is mentioned that the motors and the gearing have worked without giving any trouble.

TABLE II.—AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING ACCELERATION.

| No. of Runs. | Number of Motors Working. | Total Weight of Train in Tons. | Distance in Meters. | Falling Gradient Average P. C. | Average Acceleration m/sec. | Final Speed, km/hour. | No. of Periods per sec. | At Feeding Point. Amp. | At Feeding Point. Volts. | At Feeding Point. K. W. | At Collectors of Car. Amp. | At Collectors of Car. Volts. | At Collectors of Car. K. W. | At Collectors of Car. H.P. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Car A. | | | | | | | | | | | | | | | |
| 12 | 2 | 89.5 | 4,430 | 0.30 | 0.08 | 88.6 | 20.6 | 51.2 | 5,662 | — | 50.0 | 5,376 | 358 | 487 | Car alone. |
| 12 | 4 | 89.5 | 3,950 | 0.84 | 0.12 | 97.5 | 20.8 | — | 5,165 | — | 74.2 | 4,835 | 446 | 606 | Car alone. |
| 12 | 2 | 89.5 | 7,930 | 0.54 | 0.07 | 106.0 | 24.0 | 51.1 | 6,383 | — | 50.1 | 6,024 | 407 | 553 | Car alone. |
| 12 | 4 | 89.5 | 4,550 | 0.57 | 0.11 | 102.5 | 25.0 | — | 6,740 | — | 76.0 | 6,360 | 535 | 727 | Car alone. |
| 3 | 4 | 188.4 | 8,700 | 0.61 | 0.07 | 113.3 | 25.0 | 101.0 | 6,253 | 880 | — | — | 813 | 1,105 | Car drawing three passenger cars. |
| Car S. | | | | | | | | | | | | | | | |
| 9 | 2 | 77.9 | 2,744 | 1.11 | 0.13 | 91.2 | 20.8 | 52.6 | 5,472 | — | 51.8 | 5,257 | 394 | 535 | Car alone. |
| 9 | 2 | 77.9 | 4,294 | 0.68 | 0.12 | 105.6 | 24.0 | 51.1 | 6,290 | — | 50.5 | 5,950 | 434 | 590 | Car alone. |
| 6 | 4 | 159.6 | 5,583 | 0.60 | 0.11 | 116.7 | 25.0 | 108.2 | 6,237 | 1,010 | 105.6 | 5,938 | 928 | 1,261 | Car and two passenger cars. |
| 1 | 4 | 193.4 | 8,300 | — | 0.07 | 115.0 | 25.0 | 110.0 | 6,140 | 988 | 107.0 | 5,450 | 855 | 1,160 | Car and three passenger cars. |

*Observations taken in Autumn*, 1902.

TABLE III.—AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING PERIODS OF RUNNING AT CONSTANT SPEED.

| No. of Runs. | No. of Motors Working. | Total Weight of Train in Tons. | Average Speed km/hour. | No. of periods per second. | At Feeding Point. Amp. | At Feeding Point. Volts. | At Feeding Point. K. W. | At Collectors of Car. Amp. | At Collectors of Car. Volts. | At Collectors of Car. K. W. | At Collectors of Car. H. P. | Efficiency of Electrical Output, P. C. | Power exerted on wheels. H. P. | Power exerted on wheels. Pull in Kg. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Car A. | | | | | | | | | | | | | | | |
| 4 | 2 | 89.5 | 95 | 20.6 | 43.4 | 5,835 | — | 42.1 | 5,543 | 246 | 335 | 82.7 | 277 | 788 | Car alone. |
| 4 | 4 | 89.5 | 96 | 20.8 | — | 5,450 | — | 64.0 | 5,190 | 247 | 336 | 69.7 | 234 | 660 | Car alone. |
| 12 | 2 | 89.5 | 107 | 24.0 | 45.6 | 6,460 | — | 43.8 | 6,089 | 302 | 410 | 86.4 | 354 | 892 | Car alone. |
| 12 | 4 | 89.5 | 113 | 25.0 | — | 6,830 | — | 71.5 | 6,390 | 365 | 496 | 79.1 | 392 | 938 | Car alone. |
| 3 | 4 | 188.4 | 117 | 25.0 | 84.7 | 6,647 | 694 | — | —— | 644 | 875 | 87.1 | 762 | 1,760 | Car and three passenger cars. |
| Car S. | | | | | | | | | | | | | | | |
| 8 | 2 | 77.9 | 92 | 20.8 | 36.7 | 5,781 | — | 34.5 | 5,619 | 197 | 268 | 84.0 | 225 | 660 | |
| 8 | 2 | 77.9 | 106 | 24.0 | 39.2 | 6,447 | — | 36.8 | 6,162 | 283 | 385 | 86.5 | 333 | 850 | |
| 4 | 4 | 159.6 | 117 | 25.0 | 69.2 | 6,937 | 566 | 65.0 | 6,685 | 499 | 679 | 85.5 | 580 | 1,330 | |
| 1 | 4 | 193.4 | 118 | 25.0 | 81.5 | 6,700 | 713 | 75.0 | 6,425 | 680 | 925 | 87.7 | 810 | 1,840 | |

*Observations taken in Autumn*, 1902.

TABLE IV.—RUNS, AT CONSTANT SPEED, OF THREE-PHASE LOCOMOTIVE WITH ONE TRAILER.

| Date—June, 1902. | Run No. | No. of Periods per second. | Weight of Train in Tons. | Time of Measurements in seconds. | Speed in km. per hour. | Average at Feeding Point. Amp. | Average at Feeding Point. Volts. | Average at Feeding Point. K. W. | Average Value of cos ϕ Calculated. | Average Power at Feeding Point. | Weight of Trailer in Kg. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | I. | 30 | 52.25 | 810 | 70 | 10 | 7,250 | 76 | 0.60 | At 70 Km/hour = 91 K. W. = 124 H. P. | 12,250 |
| | II. | 30 | 52.25 | 240 | 70 | 11 | 7,200 | 105 | 0.75 | | |
| 24 | I. | 30 | 57.68 | 390 | 65-70 | 9.5 | 7,200 | 71 | 0.59 | | 17,680 |
| | II. | 30 | 57.68 | 350 | 65-70 | 15 | 7,150 | 137 | 0.74 | | |
| 25 | I. | 40 | 52.25 | 790 | 86 | 12 | 8,200 | 136 | 0.79 | At 86 Km/hour = 184 K. W. = 250 H. P. | 12,250 |
| | II. | 40 | 52.25 | 800 | 86 | 18 | 8,100 | 222 | 0.86 | | |
| | III. | 40 | 52.25 | 760 | 86-88 | 13 | 8,250 | 150 | 0.81 | | |
| | IV. | 40 | 52.25 | 820 | 86 | 18.6 | 8,150 | 226 | 0.86 | | |
| 26 | I. | 47 | 70.75 | 410 | 101-102 | 20.5 | 10,650 | 322 | 0.84 | At 102 Km/hour = 293 K. W. = 398 H. P. | 30750 |
| | II. | 47 | 70.75 | 390 | 102 | 18.5 | 10,850 | 286 | 0.285 | | |
| | III. | 47 | 70.75 | 340 | 101.5-102 | 18 | 10,770 | 270 | 0.81 | | |
| | IV. | 47 | 70.75 | 360 | 101.5-103 | 19 | 10,770 | 290 | 0.82 | | |

The German Railroad Union announces the prizes awarded as offered in 1902, for improvements in appliances, and valuable treatises on subjects relating to railroads. Three prizes of 3,000 marks ($714) each are awarded as follows: To Prof. Barkhausen, of Hanover, privy government councillor, for an improved water tank for water stations; to Prof. Von Borries, of Berlin, likewise a privy government councillor, for steam valves for compound locomotives to secure increased supply to the low-pressure cylinder; to Dr. Uebelacker, of Eger, railroad assessor on the Bavarian State Railroads, for a treatise on the movement on curves of locomotives with trucks. Prizes of 1,500 marks each are awarded to Railroad Inspector Leyffert, of Halle, for an apparatus for moving switches; and mechanical switches for the resistances which are actuated by a hand wheel in the driver's cabin, geared to a horizontal shaft.

Some difficulties were experienced in obtaining readings of the measuring instruments on the locomotive of sufficient accuracy, so that finally only the measurements at the feeding point were taken into consideration. The trial runs were started on June 23, 1902, with 7,250 volts, and this voltage was gradually raised until the locomotive successfully pulled a trailer on June 26 with just over 10,000 volts. Some of the details of the measurements taken during

to Dr. Wiedenfeld, a university instructor in Posen, for his treatise on the economic importance of the Siberian Railroad (a summary of which was published in the *Railroad Gazette*); to Baron Rinaldini, of Vienna, for a commentary on the regulations for railroad operation of the countries represented in the Council of the Empire, and to Dr. Hilscher, of Vienna, for a work on the Austrian-Hungarian and international transportation law. Four of these seven prizes are for books, while two of the others, for inventions, to Professors Barkhausen and von Borries, are to men who are authors of important engineering works.

### Four Officers of the International Railway Congress.

The coming of the International Railway Congress to this country for its seventh session, which is to be held at Washington next May, will doubtless bring to our shores many European railroad men with whose faces we are not familiar; and by way of introducing to our readers two of these gentlemen we give herewith the portraits of the President and the Secretary of the Permanent International Commission, Messrs. Dubois and Weissenbruch. Along with these we show the portraits of the President and the Secretary of the American section of the Congress.

Mr. Arthur Dubois, President of the Permanent International Commission of Railroads (The International Railway Congress), is 66 years old, and has all his life, until a year ago, been connected with the state railroads of Belgium. He was made an Honorary Engineer of bridges and roads in 1859, and for a time was an instructor in the School of Civil Engineering connected with the University of Ghent. His first railroad service was as Engineer in the bridge and roadway department, and his first official position in the administration

Arthur Dubois.

of the state railroads was as Chief Engineer in the roadway department. He was for a time Director of Works and then was a member of the Committee of Direction for 20 years. He was put on the retired list on the first of last October. For ten years (1869-79) he taught the course of railroading at the University of Ghent.

Mr. Dubois is President of the Council of Administration of the Prince Henry Railroad of Luxemburg, and is interested in other commercial enterprises, including the International Sleeping Car Company, in which he is a member of the Finance Committee. He has been a member of the International Railway Congress since its organization, and President since 1893.

Mr. Louis Weissenbruch, Secretary General of the Permanent International Commission of Railroads (The International Railway Congress) is 47 years old, and was born at Liege, Belgium. He was graduated from Brussels University and from the military school of Brussels and was Brevetted Sub-Lieutenant of Engineering in 1879. He served three years with the artificers of engineering at Antwerp, and in July, 1882, was appointed to a position with the ministry of railroads at Brussels. In a short time he was appointed Railroad Engineer and Private Secretary to the Minister, and thence was successively promoted to be Engineer, Chief Engineer in the traction department; specialist in the department of commercial administration, chief of section in the railroad department, and (1901) Director of the safety appliances department. Mr. Weissenbruch has been with the International Railway Congress from its origin, having begun as Private Secretary. He has been "Reporter" on various technical subjects,

Louis Weissenbruch.

having presented papers to the Congresses of 1885, 1887, 1889 and 1892. He is also the author of numerous technical articles in the Bulletin of the Congress and in other publications. He was one of the editors of the French edition of the History of Russian Railroads down to 1892, which was published by the Russian Government.

Mr. Stuyvesant Fish, President of the American section, is the President of the Illinois Central Railroad and of the American Railway Association, having been elected to the latter position last April. Mr. Fish's career is already well known to our

Stuyvesant Fish.

readers, and at the time of his election a sketch of his life was published in the *Railroad Gazette* (April 29, page 328).

Mr. William F. Allen, Secretary of the American section, probably stands as little in need of an introduction to our readers as any railroad man who could be named, his long service as Secretary of the American Railway Association having made his face familiar to operating officers throughout the country. Mr. Allen was born at Bordentown, N. J., Oct. 9, 1846, the son of Col. Joseph Allen, C. E., who lost his life in the Civil War. Mr. Allen was Assistant Engineer on the Camden & Amboy at the age of 14, and in 1868, at the age of 22, was appointed Resident Engineer of the West Jersey Railroad. He was made Editor of the *Official Railway Guide* in 1873, and later became Manager of the company which publishes it, the National Railway Publication Company. He has been Secretary of the American Railway Association from its birth in 1886, having been Secretary of its constituent organizations, the General and Southern Time conventions for a dozen years before that. The distinction which has made Mr. Allen best known to the world is that of having prepared the plan which finally resulted, in November, 1883, in the adoption of our present standards of time, based on even-hour divisions from the meridian of Greenwich. This quiet but far-reaching reform did away with a diversity of time standards which can hardly be appreciated by those whose experience dates from 1883 or later. Standards conforming in this way to Greenwich time have since been adopted by other nations in all parts of the world, and he has been a prominent figure in all public discussions in this branch of science.

William F. Allen.

Mr. Allen is best known to the younger generation of railroad men by reason of the intimate relations that they have with him in connection with his activities in the American Railway Association. He takes an active part in the work of the Committees, and no other officer of the Association has served so many years as he. The American Railway Association has been connected with the International Railway Congress since 1895, and Mr. Allen was a delegate to the London and the Paris meetings. He is a member of the American Society of Civil Engineers and of numerous other scientific societies.

June 23 was the 100th anniversary of the birth of August Borsig, who may be called the Matthew Baldwin of Germany. Beginning as a carpenter, he as a man learned drawing and mechanics in a trade school; became foreman of a foundry; started one himself; developed it into a machine shop; turned out his first locomotive in 1841 and his 500th in 1854, and died a few months later; his son Albert completed the 1,000th engine in the works founded by his father in 1858, and his grandsons, Ernst and Conrad, the 5,000th in 1902. Some of the most accomplished engineers of his time have testified to the extraordinary capacity of August Borsig.

## The Mexican Central Shops at Aguascalientes.—II.

BY C. T. BAYLESS.

*The Power House.*—The theoretical center of distribution from the standpoint of electrical power consumption was taken for the location of the generating plant, which has ample power capacity both for motors and the future lighting system. The current is carried by overhead conductors to the different shop buildings. Steam is delivered to the smith and hammer shop and the rolling mill through a pipe line in underground conduits, and compressed air is delivered to all the shops through an underground pipe system with reservoirs above ground at such intervals as to afford little chance of the local pressure being materially diminished by a sudden or unusual demand at any place on the line.

Power House.

The power house is built of concrete and rubble masonry. Unlike most of the other buildings, the walls are carried down to the ground. In this locality the ground never freezes, the average temperature being about 55 deg. F. throughout the year, and the rainfall is confined to a short season. The soil is of a peculiar formation. There is a surface stratum of loose structure which varies in thickness from 1 in. to 3 ft. Below this is "tepetate" to a great depth. This tepetate is extremely solid, and in digging an ordinary pick makes almost no impression. A bar and heavy sledge is the regular equipment, and blasting is often resorted to. The three factors which rendered solid walls necessary for the power house are the sand storms which prevail from January till June, the rains from June till October, and stealing. This last is fully as important as either of the former.

A skeleton structure of solid concrete piers supports the roof trusses and forms the framework of the building. Where solid walls were desired they were made by filling in between these piers with lime concrete. The north wall is temporary to allow for future extension, and is built of adobe, faced with cement in imitation of cut stone, and reinforced by brick piers. In the boiler room, the entire east side is open between the piers clear to the roof, except in one bay which has since been closed in with corrugated galvanized iron, to protect the belting of the mechanical draft apparatus from rain.

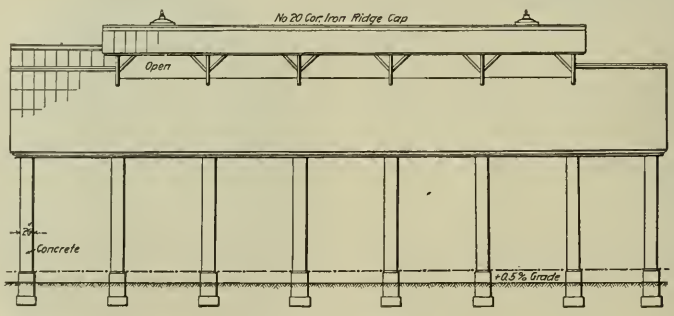
The foundations for the outside engine room walls and the north and south boiler room walls extend 2 ft. below the grade line and rest on hard tepetate. The concrete piers, composed of one part Alsen Portland cement and eight parts fine broken stone, are 26 in. square and are set on a base 32 in. square and 24 in. deep. These piers rise to the roof, the lower chord of the engine room trusses being 29 ft. 3 in. and of the boiler room 22 ft. 6 in. above the ground. The piers between the boiler and engine rooms are heavier and their foundations are deeper, as they support the roof trusses of both rooms and reinforce the steel columns which carry the engine room crane.

Between the concrete piers the walls of lime concrete are carried to the same depth as the piers, and after the forms were removed the entire surface, inside and out, was finished with a cement wash. All the walls are 16 in. thick, except the temporary adobe wall, which is 20 in. thick. Between the piers on the open side of the boiler room a 16 in. rubble wall is carried up to within 6 in. of the floor level, and a coping of cement concrete finishes it even with the floor.

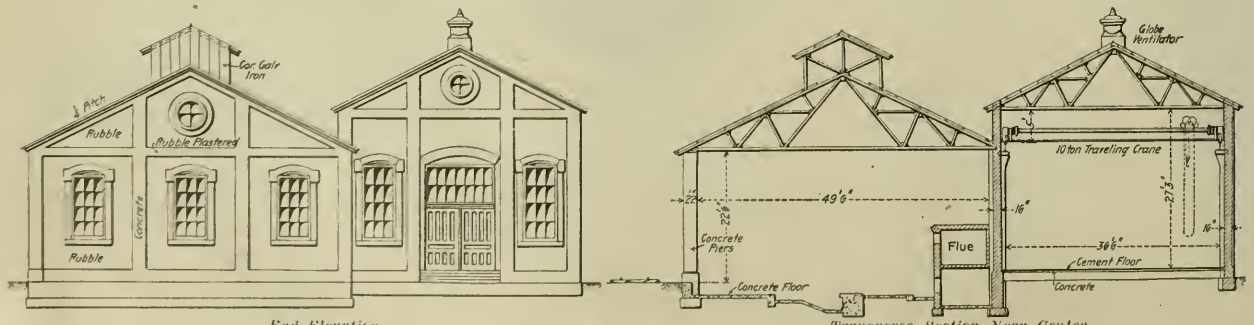
The surface drainage is excellent, and as water is not found in the region of the shop yard at less than 175 ft. deep, no special preparation for a floor to protect it from moisture from below is necessary. The loose surface loam was cleared off to the tepetate, and more tepetate filled in and tamped wet to within 12 in. of floor level. Above this is concrete, in the proportion of one part Alsen Portland cement, three parts clean, sharp sand, and six parts of broken stone. A cement finish 1 in. thick, of one part cement and one part sand completed the floor. This floor is used throughout the power house, except in front of the boilers. Here tepetate was filled in and tamped wet to within 6 in. of floor level. The same mixture of concrete extends 5½ in. Twelve hours was allowed for partial drying and then ½ in. cast-iron plates 36 in. square were laid and set with a slight filling of neat cement.

The condenser pit is 35 ft. x 15 ft. x 15 ft. deep, and is in the northeast corner of the engine room, and in the boiler room is a pit of the same depth, for the main boiler feed pump and the centrifugal pump of the boiler test apparatus. A door in the partition wall between engine and boiler rooms connects the two pits. The floors are of concrete 6 in. thick on the tepetate in its natural state. In one corner of the condenser pit is the hot well, a cement-lined pit 10 ft. x 5 ft. x 5 ft. deep. Another small pit in the center of the condenser pit, directly under the condenser, is for a small pump, belonging to the condensing plant.

Except in the power house and the coach paint shop there are no structural steel roofs. In these two buildings the higher fire risk made it advisable to use incombustible material. The trusses are of light tri-.

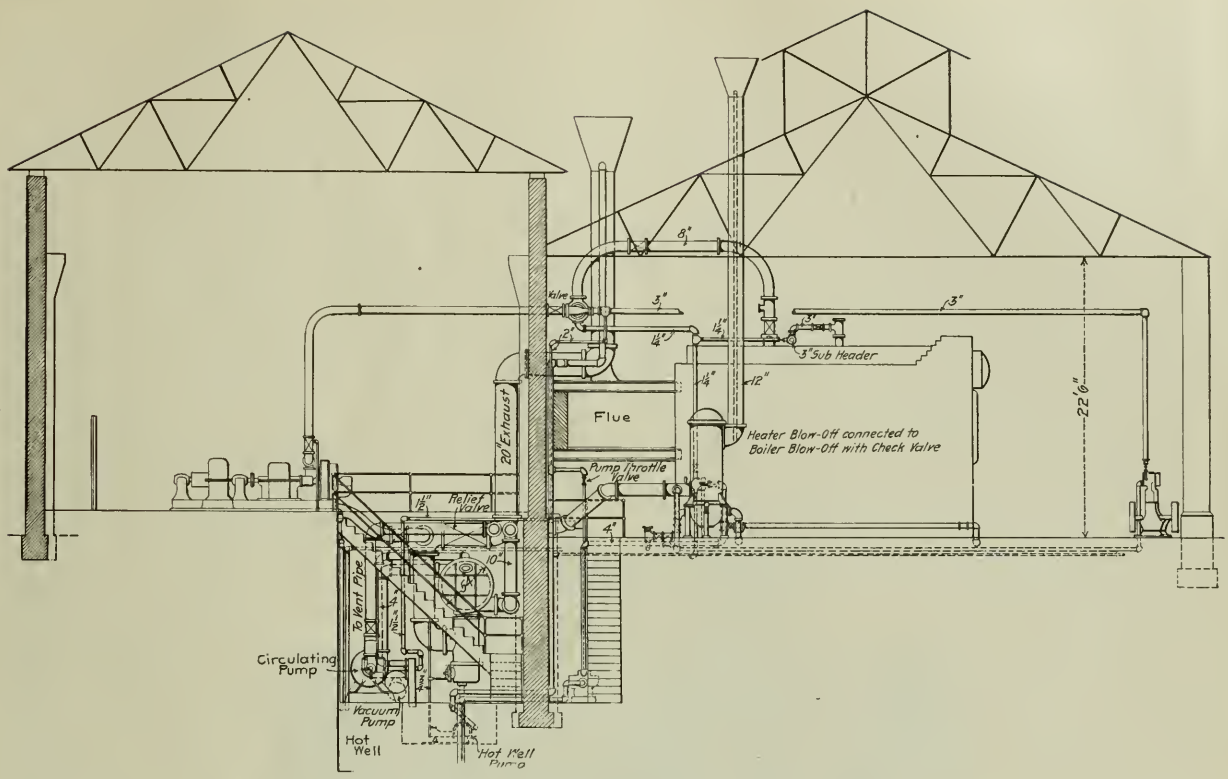



*Rear Elevation.*

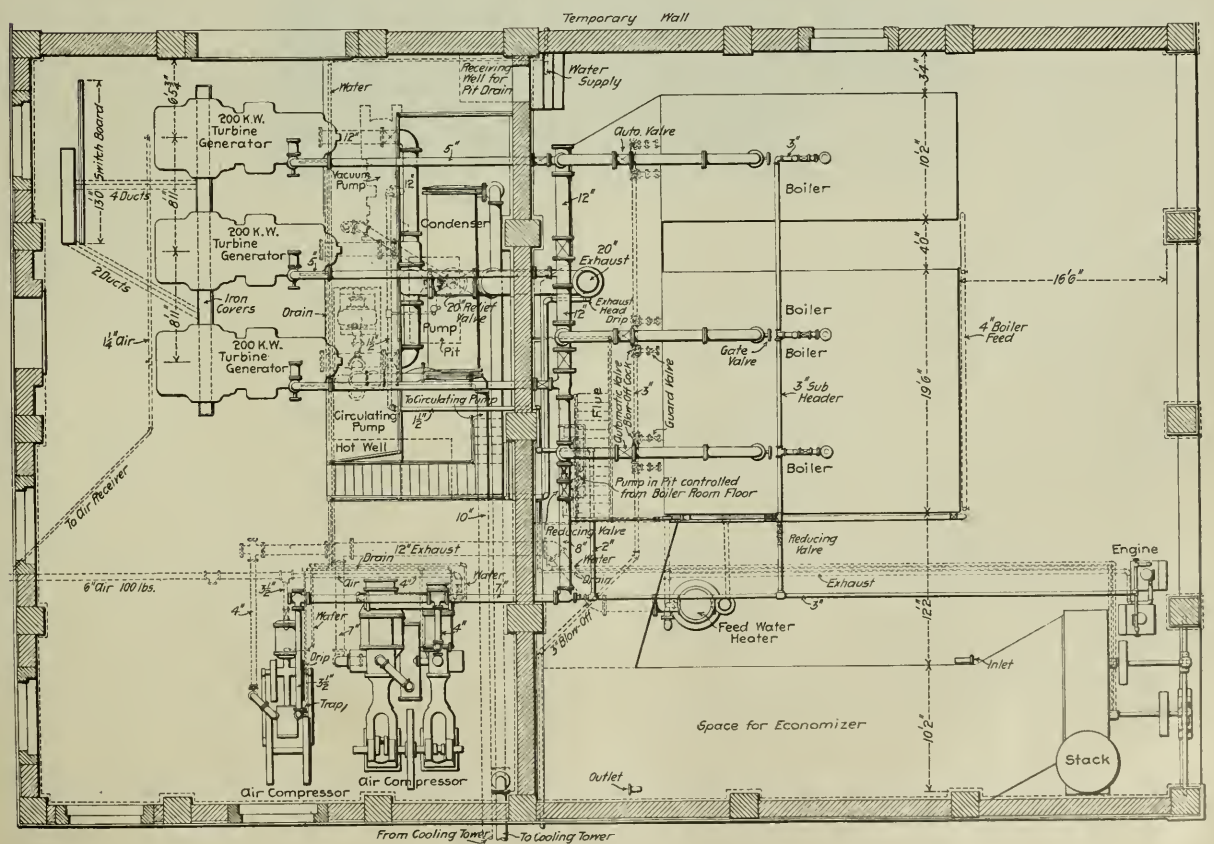



*End Elevation.* *Transverse Section Near Center.*

Power House—Aguascalientes Shops, Mexican Central Railroad.




Section and Part Elevation of Engine and Boiler Room.




Plan of Engine and Boiler Room.

angular form, one-quarter pitch, built up of steel angles. The purlins are Z bars. Corrugated galvanized iron, fastened to the purlins with special galvanized clips, completes the roof.

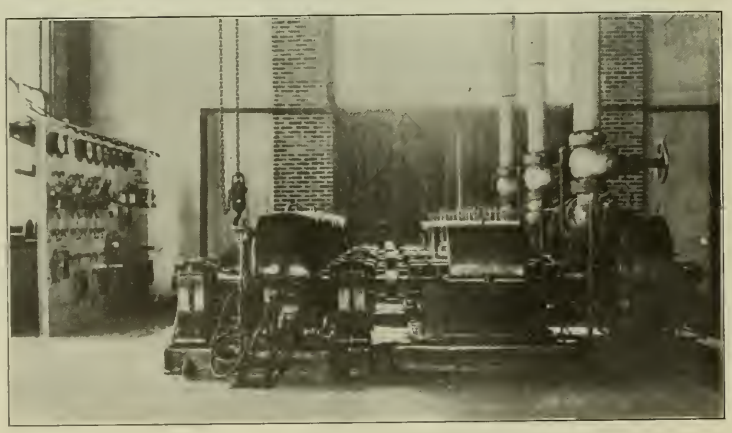
The boilers are hand fired and the coal and ashes are handled manually. The coal and ash handlers in the boiler room are paid 50 cents Mexican currency (22 cents U. S.) per day; firemen, 75 cents Mexican (34 cents U. S.); and head firemen, $1 Mexican (44 cents U. S.). Coal is unloaded from the cars at $1.50 per car and ashes loaded at the same cost. At the present shop load of about 175 k.w., all the coal used is handled from the car, through the bin, boiler, ash pits, and back to the ash car for $2.50 Mexican ($1.14 U. S.) per day, which is equal to $0.00143 Mexican ($0.00065 U. S.) per kilowatt hour. Thus, it is exceedingly doubtful if there would be any economy in installing coal-conveying machinery and mechanical stokers, or even elevated coal bunkers. Accordingly, a coal bin was built on the ground abutting the north wall of the boiler room and fronting the track east of the building. An arched door leads directly from the bin to the front of the boilers. The walls of the bin are of heavy masonry 8 ft. high, and the capacity of the bin is 200 tons.

Water is never over-plentiful, and during the latter part of the dry season is exceedingly scarce at times, so that every possible means and mechanical device has been utilized for reclaiming every available pound of water. The steam plant consists of three 250-h.p. Babcock & Wilcox wrought-steel sectional water-tube boilers, set in one and one-half batteries. Each boiler is equipped with a Babcock & Wilcox superheater with 264 sq. ft. heating surface, which superheats the steam 100 to 120 deg. Fahr. The water columns, also Babcock & Wilcox, are fitted with automatic closing valves and safety gage-glass valves which may be closed from the floor. The total heating surface of each boiler is 2,690 sq. ft. and the grate area 52 sq. ft., giving 51.7 sq. ft. of heating surface and 5.08 sq. ft. of superheating surface per square foot of grate area. The two south boilers are equipped with thermometers, thermometer wells, draft gages, pyrometers, etc., for coal tests. A test is run nearly every working day on one boiler. In the north boiler, the shavings from the planing mill are burned.

The flue, which is of sufficient capacity for 1,500 boiler horse-power, takes the gases of all the boilers. The present flue will be a by-pass to a future economizer, so that access may be had to the economizer without interfering with the operation of the plant. Space has been left for the economizer, and outlets have been left in the feed piping for the connections. At present the by-pass connection constitutes the only flue and leads directly through the fans of the induced draft apparatus to the stack, which is 5 ft. in diameter and 27 ft. long from the top of the fan housing.

The induced draft equipment, which is Sturtevant, consists of two steel-plate fans arranged in a vertical tandem manner, the lower fan is three-quarters housed and the upper one full housed. The wheels are of the overhung type on 4 in. shafts, and each fan is capable of maintaining a draft pressure in the flue connection of each boiler equal to ¾ in. of water, when handling all the gases of combustion from the burning of 3,500 lbs. of coal per hour, with a flue temperature of 600 deg. Fahr., and running at a peripheral speed of fan wheel not exceeding 7,000 linear feet per minute. The ring-oiled fan bearings are water jacketed, except the outboard bearings, which are not subjected to external heat. A counterbalanced sliding damper enables either fan to be cut off from the flues, or both at the same time. Each fan is operated by a Sturtevant vertical simple engine belted to the fan. These engines will operate on 20 lbs. of steam, and as the natural draft is always sufficient to develop this pressure, the draft can always be started and maintained independent of the electrical apparatus, or the compressors run and steam supplied for outside purposes without running the dynamos.

There are three independent systems of supplying feed water to the boilers. The main feed pump is a Knowles simple duplex 7½ in. x 5 in. x 6 in., with outside-packed plungers and heavy pot valves, and can handle 2,500 gals. of water per hour against 200 lbs. boiler pressure. The suction is supplied from the hot well, and the discharge is passed through the feed water heater before entering the boilers. The heater is a Wheeler closed type with straight brass tubes and removable heads; the capacity is 750 h.p. with 250 sq. ft. of heating surface. A by-pass in the feed piping permits the heater being cut out of service if necessary. With the limited amount of exhaust steam from pumps and air compressors available this heater gives an average temperature within forty degrees of the boiling point.



Engine Room (Generator Units and Switchboard).

The second system of feed-water supply is the boiler test system. The piping is independent of the main system and the valves controlling the water of the two systems are located on the front of the boilers. A small motor-driven centrifugal pump takes water from the hot well and delivers it to two measuring tanks of approximately 132 gals. capacity. From these two tanks the water gravitates to a third tank, with a capacity equal to four of the measuring tanks. A 6 in. x 3½ in. x 6 in. Knowles pump, of the same type as the main feed pump, passes this measured water through a smaller Wheeler feed-water heater into the boilers. In emergencies the measuring tanks may also be supplied directly from the water mains. The steam supply for the test feed pump is taken from a reduced-pressure header leading to the fan engines. This header may be fed by either the main steam header or the 3 in. saturated steam header, and it is a continuation of the header which supplies the air compressors.

A third system of feed is by means of a No. 8 Friedman injector, which takes steam from the saturated steam header at full boiler pressure aud takes water directly from the mains.

The generating equipment consists of three 300-h.p. De Laval steam turbines fitted with De Laval centrifugal governors, and each direct-connected by gearing to two 100-k.w. Milwaukee multi-polar direct-current dynamos, the whole forming a 200-k.w. unit. Under the guarantee, the turbines operate with 200 lbs. steam pressure at the governor valve, equivalent to 27 in. of vacuum at this altitude (6,200 ft.), 100 deg. Fahr. of superheat, and at 10,500 r.p.m. with a speed regulation of 2 per cent. from no load to full load. Two spiral-tooth pinions made solid with the flexible turbine shaft, with their teeth set in two rows at an angle of 90 deg. to each other, mesh with gears mounted on the two main shafts, which are connected to the dynamo shafts by flexible couplings and reduce the armature speed to 900 r.p.m. The overload guarantee is 25 per cent.

The steam consumption guarantees per brake horse-power were: Full load, 14.6 lbs.; three-fourths load, 15.1 lbs.; one-half load, 16.1 lbs.; one-fourth load, 19.0 lbs. With such economy on the lower range of loads it was not considered necessary to install a smaller unit to care for the night or lighting loads.

No cylinder oil is used and there is no oil in the exhaust steam, which makes it possible to use a surface condenser. An Alberger condensing plant was installed capable of condensing 20,000 lbs. of steam per hour under the existing atmospheric conditions, with the exception of the cooling tower, which is of sufficient size to cool the condensing water when condensing 40,000 lbs. of steam per hour.

The circulating water is handled by a centrifugal pump with 10 in. supply and discharge pipes, built by the Kingsford Foundry & Machine Company, Oswego, N. Y., and connected by a flexible shaft coupling to a 30-h.p. Crocker-Wheeler shunt-wound motor. Thermometers located in the 10 in. discharge and suction pipes show at a glance whether the circulating water is being properly cooled. The Alberger cooling tower is located just south of the power house. It is 32 ft. high and 19 ft. in diameter, and the walls of a concrete reservoir 5 ft. deep form its foundation. Two 8-ft. fans at the bottom drive a current of air up through the 4-in. square spaces between crossed courses of ¾ in. cypress boards set on edge, which constitute the cooling surface. The 10 in. discharge pipe from the condenser ends in a sprinkler head about 5 ft. below the top of the tower, the force of the water operating this head, which revolves slowly and gives an even distribution of the discharged water over the entire area of the tower. The shaft on which the fans are mounted extends through a wall bearing into the engine room, and is belted to a 30-h.p. Crocker-Wheeler shunt motor mounted on a bracket on the wall above. Both this motor and the one driving the circulating pump have their panel boards on the walls of the engine room, so that they can be started up again

quickly in case the main circuit-breakers are thrown out. The condenser with its auxiliaries make an exceedingly compact group, as the 900 h.p. occupies a floor space 15 ft. x 25 ft., excluding the cooling tower.

The main air compressor is a Laidlow-Dunn-Gordon duplex, two-stage, horizontal, cross-compound, direct-connected, fly-wheel type with separate intercooler and receiver. The steam cylinders are 15 in. and 24 in. x 18 in., and the air cylinders 14 in. and 14 in. x 18 in. With 125 lbs. steam pressure and 120 r.p.m. it has a capacity for compressing to 100 lbs. per sq. in. at an altitude of 6,500 ft., a weight of air equivalent to 800 cu. ft. of free air per minute at sea level. As an auxiliary to the main compressor is a straight-line Class A Ingersoll-Sergeant No. 7 machine. It is a single-stage type with steam cylinder 14 in. x 18 in. and air cylinder 14¼ in. x 18 in., and when running 120 r.p.m. has a capacity for compressing to a pressure of 100 lbs. per sq. in., a weight of air equivalent to 382 cu. ft. of free air per minute at sea level.

All pipes for high-pressure steam is extra-heavy wrought iron of National Tube standard, while the piping for exhaust steam, water, air, oil and drips, unless otherwise specified, is of full-weight black iron pipe of National Tube standard. All water and air pipes which are run underground are cast iron, nowhere less than ½ in. thick, with bell and spigot connections and joints calked with lead.

All fittings for live steam, pressure feed water and the high-pressure drip piping are extra-heavy cast iron, flanged or screwed, as best suited to each case. Fittings for exhaust steam, water and air pipes are of standard weight cast iron, flanged or screwed as required, except where located in the ground. All flanged or screwed fittings and valves are the Eaton, Cole & Burnham Company make. The valves used in live steam, pressure feed and pressure drip return lines are of extra-heavy pattern, with cast-iron bodies and hard bronze seats. Sizes 8 in. and above are fitted with a by-pass and valve. Valves on other lines are of standard weight pattern with cast-iron bodies and hard bronze seats.

Gaskets for live steam and pressure feed flanges are of corrugated copper, in no case less than 24 gage, thoroughly annealed and of proper diameter to come within the bolt circle. Gaskets for exhaust steam, water and air pipe flanges are of "Rainbow" sheet packing, 1/16 in. thick. The underground compressed air piping, which was rated for 100 lbs. air pressure, was tested and made thoroughly tight under 150 lbs. hydraulic pressure.

A full set of gages are mounted on a marble panel in the engine room. The instruments have 8½ in. dials and are mounted in heavy brass cases. Two high-grade Tagliabue angle thermometers are installed in the boiler feed line, and one in each boiler feed pipe just below the check valve. These thermometers are mounted on the two test boilers and give the temperature of the entering water either from the main feed line or the test feed line. A third thermometer is located near the discharge from the test feed pump, so that the actual work done by the feed water heater may be noted at a glance.

All live steam piping is lagged with "fire felt" material made by the H. W. Johns Manufacturing Company. All such piping 6 in. and above has a first covering of fire felt sheets 1 in. thick, closely wired to pipes, and is finished with a coat of asbestos cement ½ in. thick, troweled hard. Pipes less than 6 in. have a sectional covering of fire felt 1 in. thick fitted closely and held with brass bands, all joints being left tight. After all the covering was finished, it was given a coat of glue sizing and two coats of first-class lead and oil paint.

The dynamos are the double armature type built by the Milwaukee Electric Company for direct connection to De Laval steam turbines. A flexible bolted coupling connects the armature shafts to the driving shafts. Each side of the double machine is a compound-wound, four-pole, direct-current 100-k.w. generator, over-compounded 10 per cent., with a working range of e.m.f. from 250 volts at no load to 275 volts at full load. This rather high over-compounding was specified on account of several comparatively long lines to points where there is a considerable cousumption of power. The current output of each generator set is 800 amperes at 250 volts, or 400 amperes at 500 volts, making the maximum output of the station at 25 per cent. overload, 1,500 amperes at 500 volts.

Traversing the entire engine room is a 10-ton crane built by Maris Brothers,, Philadelphia. The span is 36 ft. 5 in. between

Feed-Water Heater and Measuring Tanks for Coal Test.

centers of runway rails and the lift is 22 ft. 3 in. The load is carried on two strands of chain and is held at all points, both in hoisting and lowering, by an automatic friction brake. Hoisting is at two speeds, one double the other, the change being effected by a shackle on the lower block. All the movements are by hand, and the gearing is such that one man can handle the full load at 60 ft. a minute on the trolley, 40 ft. a minute on the bridge, and three men can lift full load 1 ft. a minute, or one-half load 2 ft. a minute.

*Distribution.*—In deciding on the system of electrical disribution and control as related to the driving of machine tools, all due consideration was given to the manifold advantages of multiple voltage with several available voltages. However, to obtain the best results which one has a right to expect from such a highly developed and relatively complex system, it is preferable, if not absolutely essential, that the machinists operating the tools be of as relatively high an order as the apparatus. In a shop where probably 75 per cent. of the men operating machines are necessarily common Mexican laborers—many of whom cannot write their own names and are about the mental equals of the uneducated negro—it is exceedingly doubtful if it would be advisable to install multiple voltage with all its refinement of controlling apparatus. Induction motors in their extreme simplicity seemed ideal and were considered. But their adaptability to crane and other variable speed work was a much mooted and still open question. After carefully balancing the advantages and disadvantages of all the available systems, together with their widely differing costs of installation and maintenance, it was finally decided to adopt the familiar Edison three-wire system with 250 and 500 volts direct current. De Laval turbine generators with their two armatures driven by one turbine shaft are admirably adapted for this work. On all individually-driven tools where variable speed was desired, compound starting and regulating rheostats were used in addition to the two voltages, and the motors were so connected to the tools as to preserve the variable speed features of the machines themselves. For instance, in the case of a 48 in. engine lathe, the motor is geared to the countershaft, whose five-step cone is belted to the lathe. With the two voltages and the five steps of resistance, which can be cut into the field circuit and the five-step cones, this machine has 50 different and easily-available speeds. The change from 250 to 500 volts, or vice versa, is made by means of an ingenious switch designed by Mr. Leslie Griscom and shown in Fig 6. The field resistance is controlled by the regular starting lever.

The smaller machines are driven in groups by constant speed motors. The distance from electrical supply houses rendered it advisable to have the fewest possible sizes of motors consistent, in order that the stock of repair parts be as small as possible.

The switchboard is 2 in. blue Vermont marble. There are six panels of a uniform height of 6 ft. 6 in., surmounting 12 in. marble pasteboard panels. There are three generator panels, 30 in. wide, a voltmeter panel 30 in. wide, and two feeder panels 36 in. wide. The generator panels each carry a 400-ampere double-pole laminated type I-T-E circuit breaker, a 500-amp. triple-pole, quick-break main knife switch, two 500-amp. Weston round-type switchboard ammeters, and two Wirt field rheostats. The voltmeter panel contains two 750-volt Weston round-type voltmeters, and two 12-point voltmeter switches for connecting the voltmeters to any circuit on the ground as desired. Thus no other ground detector is needed. On this panel is also mounted a 2,500-ampere Thompson recording wattmeter for recording the total station output. The next panel is a feeder panel and contains four 500-amp. triple-pole, quick-break switches, and the total load ammeter, a 3,500-amp. Weston round pattern. These four switches control all the shop power circuits and the separate circuit for the 60-ton cranes in the erecting shop. The last, also a feeder panel, was added later and contains two 500-amp. triple-pole, quick-break knife switches, one 75-amp. double-pole, carbon-break knife switch, and a 300-amp. Thompson recording wattmeter for recording the consumption of power by the timber preserving plant. The 75-amp. switch controls the circuit of the two 30-h.p. motors of the condensing plant; one of the 500-amp. switches is for the line to the timber preserving plant, and the other is for the future lighting feeders.

From the switchboard five lines of feeder cables distribute the electrical power. The lighting system, to be installed at some future time, will be controlled by separate feeders leading from the power bus bars. The only exception to this is the timber preserving plant, which has its lighting system,

fed from the power lines; 250-volt enclosed arc lamps and 250-volt incandescent lamps burning singly are to be used throughout. Running the lighting system from the power bus bars will not result in flickering lamps if the turbine regulation continues in its present perfection, for lights have been tried at various points of the system and no flicker was noticeable.

Following is a table covering the feeder system:

| Feeder No. | Size. | From switch board to | Total rated h.p. on line. | Approx. distance from switchboard to entrance board. |
|---|---|---|---|---|
| 1 | 400,000 cm. | Machine shop Hammer and smith shop | 331 | 350 ft. |
| | | | 135 | 200 " |
| 2 | No. 000 B. & S. | Brass foundry | 15 | 300 " |
| | | Rolling mill | 20 | 470 " |
| 3 | 500,000 cm. | Iron foundry | 50 | 720 " |
| | | Pattern shop | 10 | 1,140 " |
| | | Planing mill | 175 | 1,350 " |
| | | Paint shop | 20 | 1,600 " |
| 4 | No. 2 B. & S. | Cranes in machine shop | 302½ | 350 " |
| 5 | 250,000 cm. | Truck, wheel and axle shop | 35 | 1,350 " |
| | | Timber pres. plant | 125 | 3,200 " |

Double-braided weatherproof wire is used for the aerial lines, and for open wiring in the buildings, slow-burning, double-braided weatherproof wire. All conduit wiring is done with double-braided rubber-covered wire, and where run in tile ducts, paper-insulated wire covered with lead is employed. All conduit work is installed on the single tube system with loricated iron conduit. Porcelain wall bushings are used at all entrance points, and the wiring is all in accordance with the rules and requirements of the National Board of Fire Underwriters of the United States. Overhead wires are carried on iron poles at a height of 20 to 25 ft. from the ground. Poles are spaced about 80 ft. apart and are set 5 ft. deep in a bed of cement 18 in. in diameter, which extends above the ground and tapers up from the circumference toward the center till a tight joint is made with the pole at a point about 8 in. above the ground. This was done to prevent the rusting away of the pole at the ground line. Iron brackets and No. 2 Knox glass cable insulators carry the heavy cables. All sizes above No. 2 B. & S. are of stranded wire. Wurts non-arching lightning arresters are used at all entrances to buildings, and a thorough ground was made at all points where needed either on the pipes of the water system or with heavy ground plates well buried in coke.

The wiring on entering the buildings is carried to a fused quick-break knife switch located at a convenient point, and from this switch the branch wiring radiates to the various motors. The machine shop is typical of all the buildings in this respect. The mains are carried to the entrance board and from there the three-wire branch mains are run open in a loop around the shop, being supported by the lower chord of the roof trusses of the side bays. Branches to the machines are carried in conduits down the columns of the building to the motor panel boards. Wires are then run in conduit to the motor.

Group motors are all run at constant speed on 500 volts. Individual motors are in some cases run on either 250 or 500 volts. All motors for machine tools are Crocker-Wheeler, open frame, shunt or compound wound as suited to each case. Starting boxes and compound starting and regulating boxes were made by the Cutler-Hammer Company, and the circuit breakers which are used on all motors above 15 h.p. are of the Cutter Company's 1-T-E street car type. In all cases the motor-controlling apparatus is mounted on a slate panel board. The panel boards for the variable-speed motors carry an auxiliary interlocking switch, by means of which the voltage impressed on the armature may be changed from 250 to 500, or vice versa. A non-inductive resistance is cut into the motor circuit by opening the main switch so that the motor is protected during the change from one voltage to the other.

*(To be continued.)*

## Permanent Way and Structures of the San Pedro, Los Angeles & Salt Lake.

The San Pedro, Los Angeles & Salt Lake Railroad is expected to be ready for operation by January 1st, next. Only 100 miles remain to be laid with rails, 46 miles of which are yet to be graded. The contract for the grading has been awarded and the rails to close the gap are on hand, so that there is little doubt that the road will be finished on time. Considerable equipment has been ordered and should be in readiness for the opening of the completed line.

This road, which will be 777 miles long, joins Salt Lake and Los Angeles, and is of special interest because of its importance as a new transcontinental link. When first talked of, over five years ago, the project was ridiculed as being not at all practicable, and the obstacles confronting the projectors were many. Last year, however, the Oregon Short Line sold to the San Pedro & Salt Lake the trackage rights in Utah and Nevada, which were needed as a valuable part of the new road, and at the same time the company arranged for certain trackage rights in California with the Southern Pacific and the Santa Fe. With matters arranged with competitive lines on this friendly basis, the builders were in a position to proceed with their work.

It was decided at the outset to adopt high standards in building and equipping

Cut Through Stockton Dyke near Stockton, Utah.

Station at Riverside, California.

Typical Stretch of Track Through Southern California.

Fig. 1—Plan of Terminal Passenger Station of the Long Island Railroad at Long Island City, N. Y.

Facts from Contractor at extreme right and Left

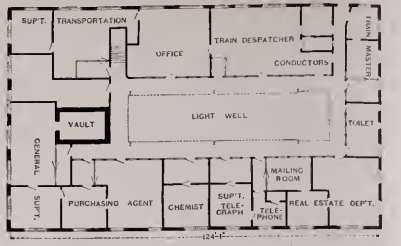



Fig. 2—Second Floor, North End.

Fig. 12—Fourth Floor of Tower.

Fig. 9—First Floor of Signal Tower.

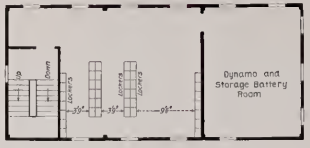



Fig. 10—Second Floor of Tower.

Fig. 11—Third Floor of Tower.

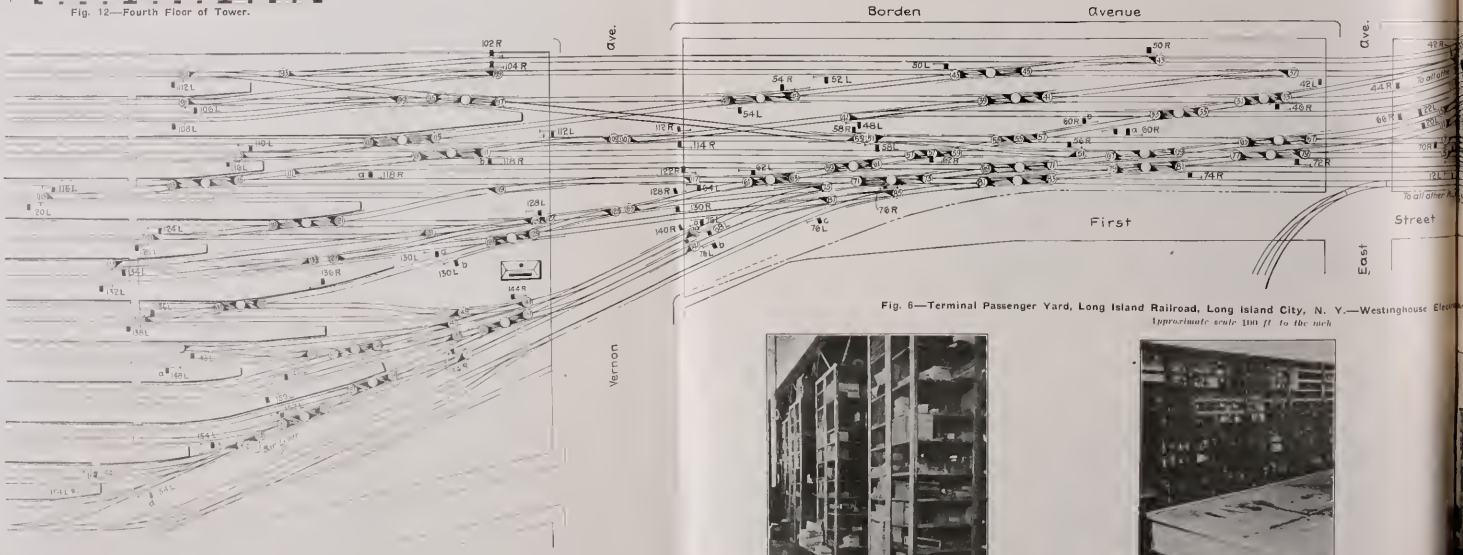
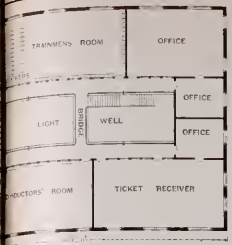



Fig. 6—Terminal Passenger Yard, Long Island Railroad, Long Island City, N. Y.—Westinghouse Electric

Approximate scale 100 ft. to the inch

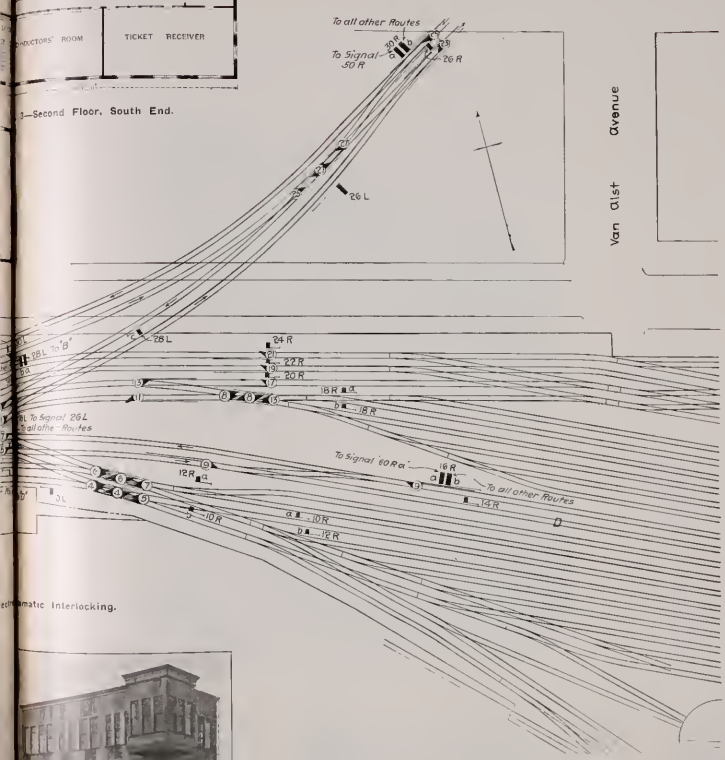
Fig. 4—Stationery Room.

Fig. 5—Trainmen's Lamp Room.




3—Second Floor, South End.

The machine in the tower has spaces for 167 levers. Eighty-six levers work 56 single switches, 28 double slips with movable frogs, three single slips with movable frogs, and one bar; 56 levers work five standard semaphores with two arms each, one semaphore with a single arm, 70 dwart signals, and 11 suspended signals. There are 25 spare spaces.




matic Interlocking.

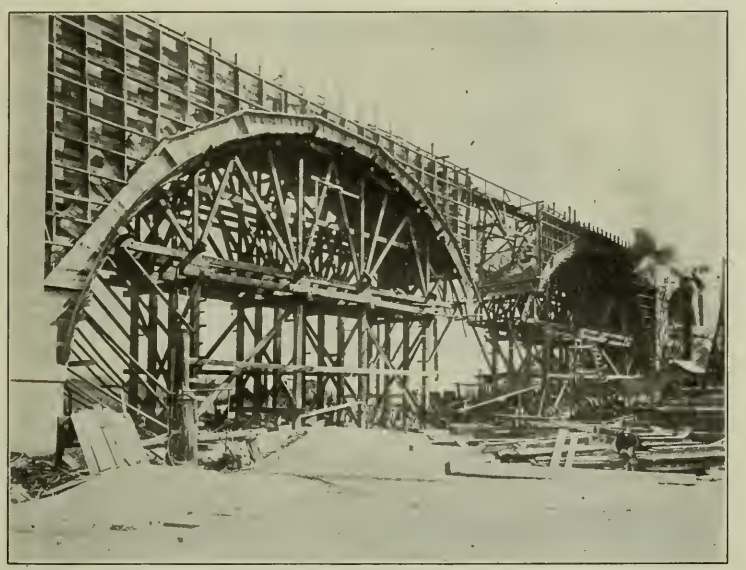
Fig. 7—Signal Tower.

the line, making it first class in every respect possible, rather than to leave this to a subsequent period of rebuilding. The accompanying illustrations from photographs show how well this plan was carried out in the construction. The sub-grade is 18 ft. on fills and 20 ft. in cuts, being even wider in some places where it was necessary. The ties are standard sawed Oregon fir, laid throughout with heavy tie plates. The rails are 75-lb. A. S. C. E. section, and the wooden bridges have solid floors with continuous ballast.

There is a great deal of concrete work along the line, the most notable example being the Santa Ana bridge across the Santa Ana River in California. This structure is probably the largest concrete bridge in the world. It contains 14,000 cu. yds. of Portland cement concrete, and consists of eight main arches of 86 ft. clear span and two approach arches of 40 ft. span. The height is 60 ft. above the ground. Many of the culverts and small building foundations are concrete. The standard water tank used along the line is steel on a solid concrete foundation. One of the illustrations shows the one at Rowland, Cal., which has a capacity of 72,000 gals.

On the new parts of the line there are a number of steel bridges on masonry abutments, the one shown being near Los Angeles. Later, all of the bridges on the old line in Utah are to be rebuilt and this part of the line will be brought up to standard. The artistic features of the stations in California will not, however, be duplicated in the desert sections. Wherever possible, flowers and lawns will surround the stations and all along the right-of-way the permanent structures, crossing signs, mile posts, etc., will be of a standard size and color. The stations in California are of the Mission style, and two typical ones at Riverside and Pomona are shown in the illustrations. A section of standard track in California is also shown, and this gives a good idea of the ballast and string stone work.

There is much attractive and interesting scenery along the route. Leaving Salt Lake City the line skirts the south shore of Great Salt Lake, passing through Stockton dyke, which once held back the waters of the lake, into the region of Stockton and Ophir and thence to Tintic, all great mining camps. At Lynn Junction the new line joins the old line acquired from the Oregon Short Line, which extended to Uvada, on the State line, where new track begins once more. The whole line through the State of Nevada is new construction. Most of the region traversed for 150 miles is a waste, although rich in mineral. After leaving Nevada the road reaches the line of the Santa Fe at Daggett and uses its track to Riverside. San Pedro, the western terminus of the line, is on the Pacific, and has good harbor facilities.



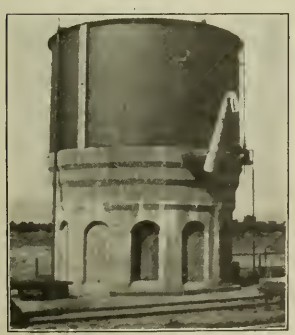
Santa Ana Viaduct During Construction.

Santa Ana Viaduct.

## Foreign Railroad Notes.

Last Whitmonday a train took for the first time a party of excursionists, mostly Germans, from the Mediterranean at Haifa, past Carmel, over the Brook Kishon, by Megiddo and the foothills of the mountains of Galilee, between Mounts Hermon and Gilboa to the Valley of the Jordan, 800 ft. below sea level, where, under the basalt arches of the new bridge over the river, the excursionists, scorched by the burning sun on the platform cars, were (tell it not in Gath!) refreshed with copious draughts of Münich beer by the hospitable German engineer who is building the railroad.

During the Hungarian railroad strike the employees took possession of the railroad telegraph, and the management could send no messages except through the lines open to the public and belonging to the Post Office Department. To avoid the recurrence of such a condition, it is now proposed to turn over the railroad telegraphs to the Post Office Department permanently. As the railroad management needs to have and to use employees who have other duties, partly in telegraphing, this would seem an objectionable change. In a government with military habits and traditions one would suppose that the most obvious remedy would be to provide severe penalties, under the criminal law, for using the wires except in strict conformity to the regulations.



Standard Water Tank.

Station at Pomona, Cal.

Bridge near Los Angeles.

### Disastrous Wreck at Eden, Colorado.

On the evening of August 7 at 8:45 o'clock, near Eden, Colorado, southbound passenger train No. 11, of the Denver & Rio Grande, broke through a trestle bridge which had been weakened by a flood, and the engine, baggage car and first two passenger cars fell into the water; and the cars were carried down stream by the powerful current that was flowing. Every person on this part of the train went down with the wreck, and all but three of them were killed. One of those who escaped was Fireman F. Mayfield. Two sleeping cars and a dining car (the rear part of the train) remained on the track. The total number who lost their lives was estimated on Tuesday at 100. Seventy-four bodies had been found (three unidentified) and 26 persons were missing. Of the dead and missing, 65 belonged in Pueblo, and four were employees.

Eden is 36 miles south of Colorado Springs, 111 miles south of Denver, and eight miles north of Pueblo. The scene of the wreck is the crossing of Dry creek, an arroyo which is usually dry and rarely flooded. The trestle bridge spanning it was about 100 ft. long and 15 ft. high. The flood is said to have been the result of a "water spout." Rain had been falling but a short time and no report had been received at the despatcher's office of damage to the track on this or any other part of the road; but the rain was heavy and the engineman was running slowly, probably about 15 or 20 miles an hour. The fireman was standing in the gangway between the engine and tender holding a torch as the engine entered on the bridge. The last words from the engineman were, "Put out that torch," shouted to the fireman as he felt the cab settle when the engine had nearly crossed the bridge. The fireman was thrown out of the engine as it fell over to the right, and managed to grasp a piece of wreckage from the bridge, on which he floated down stream to a curve in the bank, where he succeeded in crawling ashore. He started toward Eden to give the alarm and on the way met the station agent. The reports that the water was flowing over the track when the train ran upon the bridge appear to be erroneous; but the flood was a furious one, as is evident from the fact that the bodies of the cars floated half a mile or more down stream. The bodies of the persons who were drowned were found all along down stream for two or three miles, and some even further, one being taken out of the river at Pueblo, eight miles away. Many of the bodies were half buried in sand. The flood lasted but a short time and it seems likely that it was at its height just at the time that the passenger train reached the bridge.

The track was washed away for several hundred feet on each side of the bridge. Train No. 4, northbound, had passed over the bridge in safety about 45 minutes before the wreck. The train was in charge of Conductor J. H. Smith and Engineman Charles Hinman, both veteran employees of marked trustworthiness; and a traveling engineer was on the train, probably on the engine.

### Railroad Shop Tools.

(*Continued.*)

BORING MILLS.

The 66-in. tire boring and turning mill, shown in Fig. 1 is made by the Niles-Bement-Pond Company, New York. This machine is designed especially for turning steel tires. It is simpler in construction than boring mills which are intended for general use. When fitted with a fixed cross rail this machine is very rigid, so that a heavier cut can be taken than with a boring mill of the same size designed for general service. This makes it an economical tool, when there is enough tire turning to keep the machine in constant use.

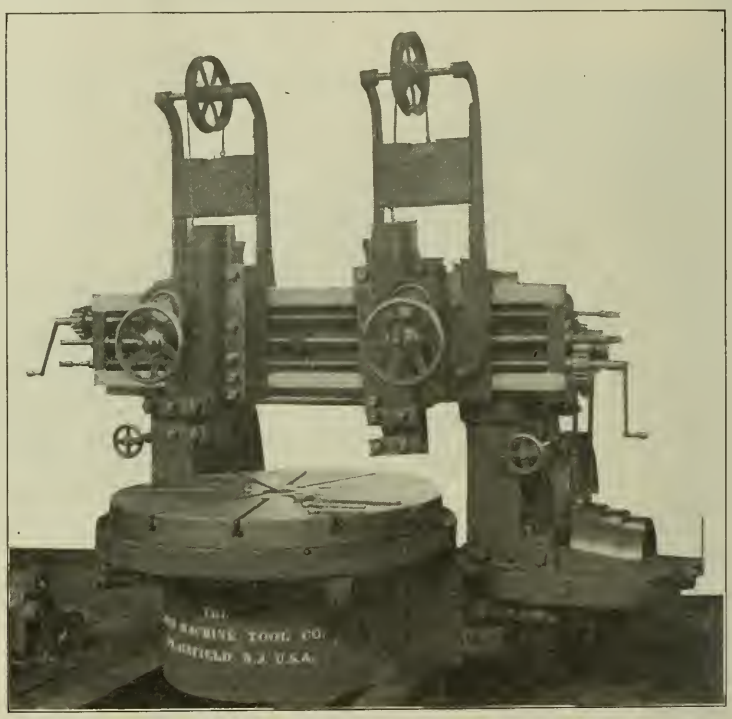


Fig. 1—The Niles-Bement-Pond 66-in. Tire Mill.

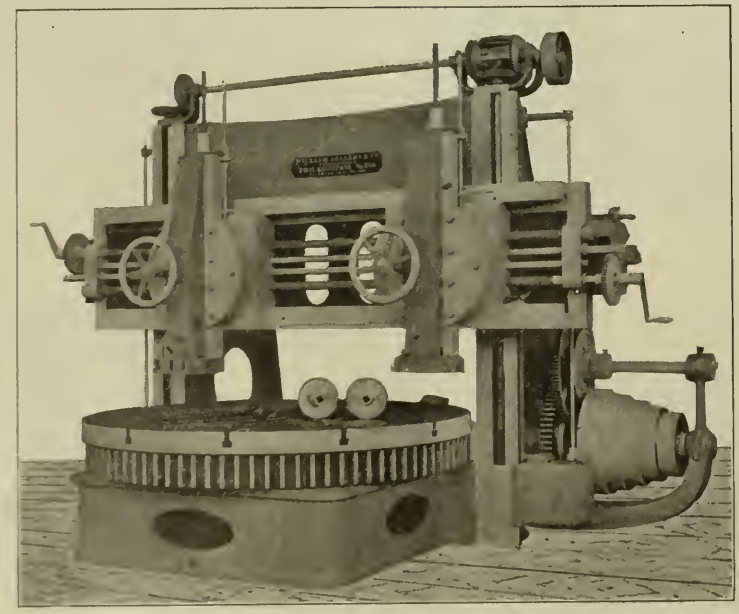


Fig. 2—The Sellers 84-in. Turning Mill.

The machine when fitted with a fixed cross-rail will take work 68 in. in diameter, and 16 in. high. When fitted with an adjustable cross-rail the machine will take work 30 in. high. The face plate is 60 in. in diameter and has 12 changes of speed. It is driven by a cone which is geared to an external gear. The face plate has a wide bearing on the bed, and is mounted on a spindle having large bearings which can be adjusted to take up wear. The table has no opening through the top. A trough is provided around its edge for catching the lubricant used on the tools. The tool slides are counterbalanced and have a traverse of 16 in. They have large flat bearing surfaces which bear the entire length of the swivel. The tool slides are fitted with tool holders made up of two straps and four bolts. The cross-rail has a large flat wearing surface, deep arches, and a double walled back. When an adjustable cross-rail is used it is elevated by power. The saddles are fitted with taper packings and are moved by steel screws. The feed of each tool is independent of the other both in

amount and direction. The feed is operated by a disc driven friction wheel and can be instantly changed from O in. to the maximum feed.

The 84-in. boring and turning mill shown in Fig. 2 is made by William Sellers & Company, Philadelphia, Pa., and was especially designed for turning locomotive tires. The table is 84 in. in diameter and the maximum clearance under the cross rail is 39 in. The depth of the cross-head bar is 30¾ in. The vertical slides have a 26½ in. adjustment and are furnished with detachable tool holders. The cross-head is raised and lowered by power. The saddles have independent feed and can be operated from both ends of the cross-head. The feed mechanism and the driving-gear are provided with safety devices to prevent breakage by overloading the gearing. The cone pulley has five steps, and there are two changes of gearing, with which 15 changes of speed can be obtained. The spur gearing for the table is all cut from the solid. The pulleys on the countershaft are 22 in. in diameter with a 5-in. face, and they should run at 280 r.p.m.

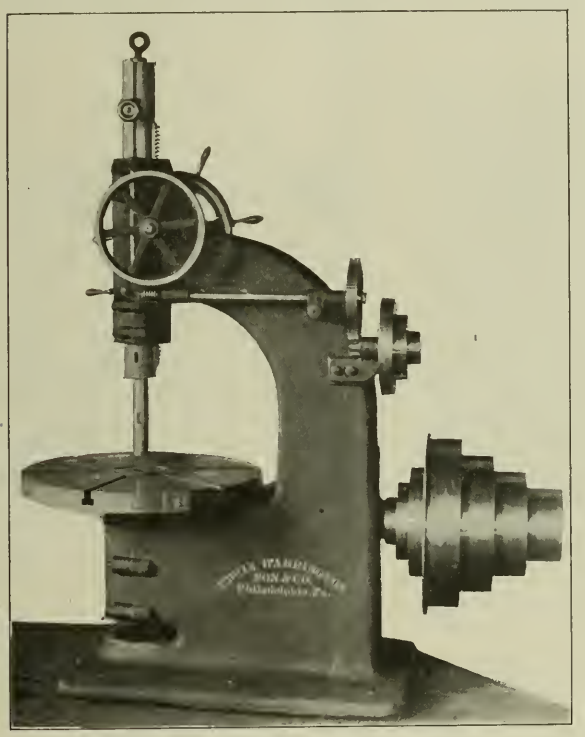


Fig. 3—The Harrington Vertical Boring Mill.

The vertical boring mill, Fig. 3, is made by the Edwin Harrington, Son & Company, Philadelphia, Pa. The mill is made in two sizes, 29 in. and 60 in., and is adapted for boring car wheels, pulleys, and general work. The spindles are crucible steel. They are power fed and are equipped with automatic stop and quick returns. They are also counterbalanced by a weight and chain. The table is driven by a cut bevel gear and pinion, the gear being bolted to the table. The table has six T slots for holding the work. There is an opening at the bottom of the mill for the escape of chips. The steps of the driving cone have a 4½-in. face. The countershaft has two 22 in. x 4½-in. pulleys and should run at 90 r.p.m. The weight of the 39-in. mill is 4,000 lbs. and the weight of the 60-in. mill is 5,000 lbs.

The 72-in. boring mill shown in Fig. 4 is made by the Colburn Machine Tool Company, Franklin, Pa. This mill is known as the widened pattern, as it is made from the 60-in. pattern, excepting the bed, which is widened sufficiently to give the required swing between housings. This machine will swing full 74 in. and is 45½ in. wider under cross rail. The table is 58 in. in diameter and is geared 21 to 1 and 105 to 1, with back gears in. There are 20 changes of speed. The spindle is cast iron, having large angular babbitted bearings at the top and straight vertical bearings in the center. All of the bearings which run at a high speed are bushed with bronze. The heads are independent of one another in their movements, and can be set any angle up to 45 degrees. The tool bars carried in the heads have a movement of 25 in. A center stop determines the correct position of the heads when used for boring. The cross-rail is 9 ft. x 6 in. long and is raised and lowered by power. The feeds are positive gear driven and have 10 changes ranging from $^1/_{32}$ to ¾ in. horizontally and from $^1/_{64}$ to ⅜ in. in vertical and angular directions. The thread cutting arrangement is fitted to the right-hand side, and will cut from 4 to 13 threads per inch, including 11½ per in. for pipe thread. The machine is supplied with a five step cone for a 3-in. belt. The full range of speed is obtained by changing the countershaft speed between each successive step of cone which gives 10 changes. The number of changes in speed is doubled by throwing in the back gears. The floor space required for this machine is 12 ft. x 7 ft. 10 in. The extreme height of the machine is 8 ft. 10 in. The cone pulleys are supported on both sides and are placed between the housings. The net weight is about 21,000 lbs.

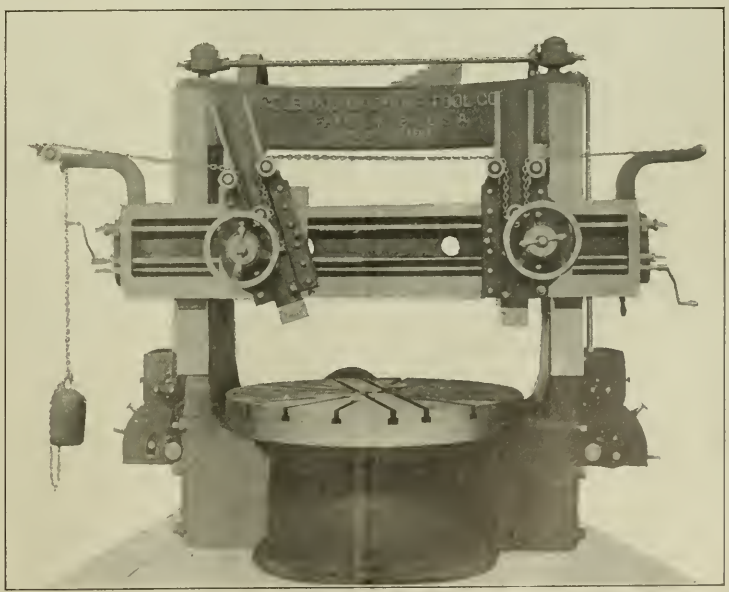


Fig. 4—The Colburn 72-in. Boring Mill.

*(To be continued.)*

## Alternating Current for Heavy Traction.

A contributor to the *New York Evening Post* of Aug. 6 points out some of the advantages of alternating current for heavy traction. The writer who signs himself "An Old Transportation Man" is evidently familiar with the subject so that the rather liberal extract from his article which is given below will no doubt interest readers of the *Railroad Gazette*:

Main line railroad managements have during the past five years regarded electricity as a means of transportation, with a mixture of admiration and suspicion. They have first of all dealt with it as an expensive evil, but necessary to provide more comfort in tunnels to their patrons. Thus, the B. & O., to improve its Washington service and in competition with the Pennsylvania, made the start. The New York Central, warned by serious tunnel accidents, and in fear of losing its suburban travel follows suit, and finally the Pennsylvania, to make its Hudson River tunnel franchise available, could not avoid adopting this modern motive power.

While the last two improvements for terminal facilities can be considered a step in the right direction, yet their effect from a financial point of view will not be apparent for many years to come, owing to the excessive capital outlay for the type of electrical apparatus selected. This type is the direct current which requires expensive substations and conductors to convey the large amount of current needed for moving the heavy main line traffic.

The introduction of the direct current traction for this heavy traffic not only increases by about 40 per cent. the capital outlay over that required for the equipment of alternating current traction, but the operating expense necessary for turning the high voltage alternating current, as generated at the central station, into low tension direct current, would be increased over 10 per cent. This is due to the cost of power for chang-

ing the current and added cost of supervision of the sub-stations and repairs.

It has, therefore, been clear in the minds of those familiar with electric traction that the direct current system now in use, either with the overhead trolley or third rail, in moving the comparatively light units at frequent intervals on surface, suburban, interurban, and rapid transit lines, would not answer for the electrification of main-line railroads; where heavy units at long intervals have to be moved. When, however, the direct current traction has been decided on for the equipping of terminal facilities of main lines, covering a short mileage, the increased capital outlay and higher operating cost were not considered as factors in the problem.

In Europe, where these economic questions receive greater attention, the designing of an alternating current traction system was started nearly eight years ago by one of the most competent electric construction firms. Their problem was not to create an extraordinary high-speed road, which eight months ago received so much press attention, but a system which would readily adapt itself to the existing traffic conditions of any main line.

This system, installable at lowest cost, results in a great saving in operating expenses as compared with the cost of moving the traffic with steam locomotives.

This system, after having been carefully tried on a specially constructed test road, was finally placed on a main line railroad* belonging to the Italian Government. It has now been in daily operation for about three years, the entire equipment and plant having been officially received by the Italian Government in September, 1902.

An American expert, specially versed in electric traction, has recently secured an opportunity to make a most careful investigation of this system on the spot. The result of this investigation proves conclusively:

(a) The complete development of an absolutely practical system for the moving of all heavy traffic, both passenger and freight, on main line roads.

(b) That it will move such traffic with a high degree of safety, and with far more comfort to passengers than the present steam locomotives.

(c) That the cost of conducting transportation and maintenance of equipment as compared with the present cost of operating with steam locomotives would show a sufficient saving to allow the capital outlay for electrification to be written off within a reasonable time, and still leave more surplus than at present so that the distributable profit could be increased.

(d) That the roads adopting electrification could regain a part of the suburban traffic now carried by trolley lines. Such increase, or any other increase of traffic, would entail but a proportionately slight additional cost in conducting transportation.

(e) That the installation can be placed on any road without its construction interfering with the traffic.

Beyond these advantages there is another important one, and this is the reduced wear of the sub-structure owing to the balanced rotating motion of the electric motor as compared with the unbalanced reciprocating motion of the steam locomotive.

The above statements can be substantiated, and the only reasons to explain the delay in adopting these striking advantages on American roads might be the prejudice of Americans to follow European engineering, or that no prior opportunity of a minute investigation on the part of an American engineer of recognized standing had presented itself.

Of the student of political economy, the question might be asked why should the principal industries of the country battle with semi-stagnation when through a saving in the cost of one of our daily principal expenditures (cost of transportation) the means can be found to capitalize a great improvement which would distribute work to them all for many years to come and would, furthermore, enrich the country through distribution of larger profits earned by American railroads.

*The railroad referred to is the Valtellina, in Italy, which is equipped with the Ganz system. Mr. G. Leve, 114 Liberty street, New York, is the American representative of the Ganz Company.

## Pile and Timber Trestle Bridges on the Santa Fe.*

While the plans of pile and timber trestles shown here differ somewhat from the preliminary plans of the Association's committee on wooden bridges and trestles, they have been based on several years of investigation and careful study of the problems involved. It is a difficult matter to get up a set of plans which are equally adapted to the local conditions on every railroad, and these are presented merely to show the standard practice of the Santa Fe and not as a suggestion for changes in the preliminary standard plans of the committee. In making up the designs here shown a set of preliminary sketches or studies was first made up and thoroughly discussed, after which came the first set of general drawings. When these had been carefully studied by the Chief Engineer of the system, they were sent to the chief engineer of each grand division with a request for criticisms and suggestions for improvement. Three of the best bridge and building foremen on the system were also called in and asked to criticise in the most severe manner possible, every part and detail shown on the drawings. After all of these final reports had been received and discussed, the present set of plans here shown were finished up.

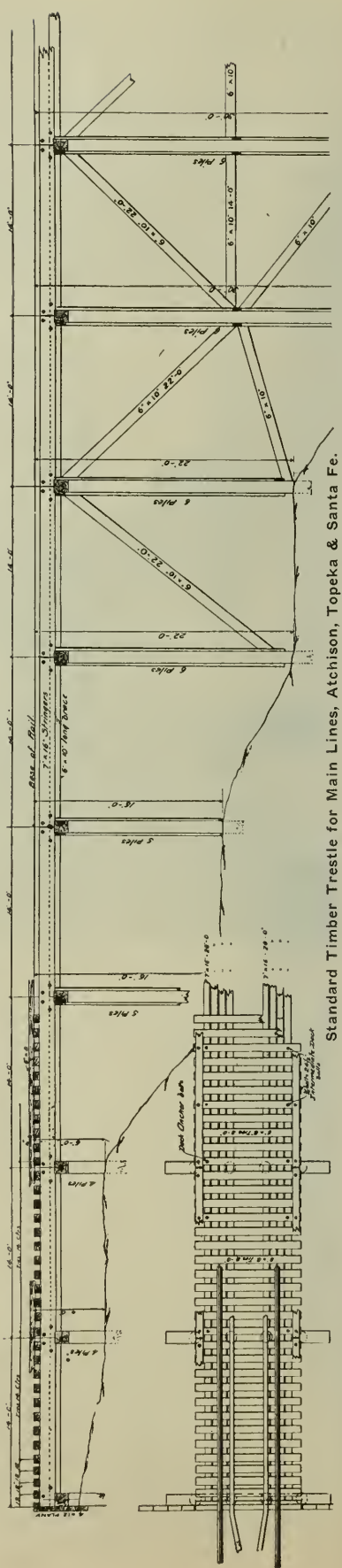
The reasons for adopting the various details shown in the plans may be briefly summarized as follows:

(a) *Guardrails.*—The timber guardrails are to be so dapped or housed over the ties that the upper surface of the traffic rails and the guardrails shall be in the same horizontal plane.

In all cases, there must be as much as 1-in. dap in order to guard against bunching of the ties. Dapping guardrails to prevent bunching of the ties is not altogether successful, no matter what may be the depth of the cut, as the projecting parts split off easily under derailments and in weathering. This, however, has been the universal practice and the writer knows of no economical method that would give better results. Usually lap splices are made, but they are very unsatisfactory and expensive. A butt splice with the extra bolt required will cost less than the half-and-half lap splice, and will give better service. The butt splice can also be made by any ordinary hatchet carpenter, while the lap splice requires a skilled workman.

(b) *Ties.*—Ties 8 in. in depth may be preferred by some, but it was considered best in the present plans to adhere to the 6-in. depth previously in use on the road. One derailment on a 6-in. soft-wood tie will cut it so badly where the wheel flanges roll over that it must be removed. An 8-in. tie would

*Extracts from a paper by A. F. Robinson, Bridge Engineer of the Santa Fe, published in Bulletin No. 53, of the American Railway Engineering and Maintenance of Way Association as an exhibit to the report of the Committee on Wooden Bridges and Trestles.



Standard Timber Trestle for Main Lines, Atchison, Topeka & Santa Fe.

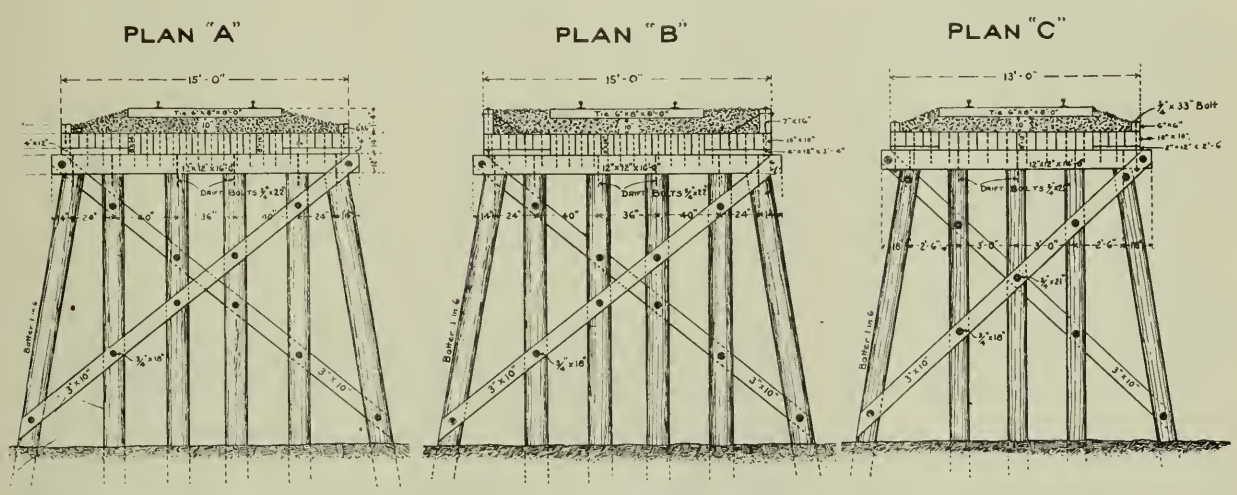
stand a more severe derailment without breaking or several derailments where the wheel flanges only cut into the top of the tie. On the Santa Fe we have not been able to obtain acceptable oak or hardwood ties for some years past at a cost that would warrant their use. At most times good hardwood ties cannot be obtained quickly, no matter what the cost may be. As to length, many engineers prefer a 12-ft. tie, while others think 8 ft. is sufficient. The length of tie shown on accompanying plans has been standard on the Santa Fe for many years. It has given good results in service and it was not deemed best to make any variation.

(c) *Stringers.*—Stringers 7 x 16 in. in cross-section have been almost universally used for so many years that they have become a regular mill size. Under these conditions they cost no more per M. feet B. M. than any other regular sizes. For the plans under discussion it was thought best to adhere to the regular size of stick already in use and to increase the number of pieces under each rail if necessary. Long leaf yellow and white pine sticks more than 16 in. in depth are expensive and hard to get; Oregon or Douglas fir will also be equally hard to obtain within a very few years. Stringer timber 8 x 18 in. costs $2.00 per M., and 8 x 20 in. $4.00 per M. ft. B. M. more than 7 x 16 in. Again, as the size of the stick increases the quality of the timber decreases, and from year to year we have found it more and more difficult to obtain the high grade of material desired even for timbers 16 in. in depth. Some engineers may consider an extreme fiber stress of from 1,400 to 1,800 lbs. per sq. in. as excessive under regular fast traffic, and 2,000 to 2,100 lbs. as altogether too much to allow. On the Santa Fe our stringers have been standing for many years under loading that causes fiber stresses of 1,600 to 1,800 lbs. per sq. in. On our branch lines, where engines are light and the number of trains per day comparatively small, our stringers last little, if any, longer than on main lines. In the above unit stresses, impact effects are not considered. A stringer may be considered as a machine which is capable of doing a certain amount of work. By the use of heavy loading and the accompanying high fiber stress, we obtain the maximum amount of work the stringer is capable of performing before it has lost very much from decay. I have never known the three or more pieces that make up a stringer or chord supporting one rail to break at the same time. In fact, I have no record of more than one piece breaking at any one time under traffic. It may therefore be assumed that so long as the percentage of broken stringers is small, we are reasonably secure, no matter whether the stringers are six years old or 12, and whether the fiber stress is 1,200 or 2,000 lbs. per sq. in. While the "Heavy Grade Loading" of our specifications for metal bridges shows extreme fiber stresses of 2,070 lbs. per sq. in. in stringers, it should be noted that 1,800 lbs. per sq. in. is the highest stress shown by any engine or car now in service. Whenever our engines reach the weight shown by the specifications above mentioned, if the percentage of broken stringers should be increased materially, we would have to increase the number of pieces used or increase their size.

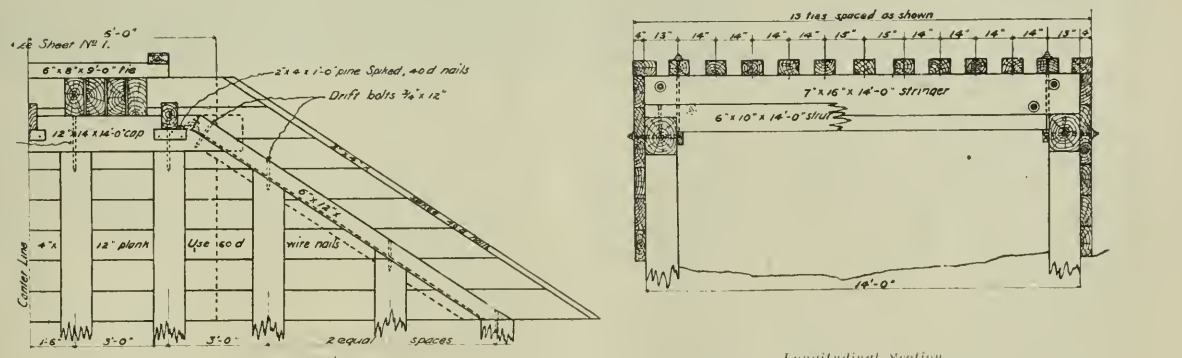
For bearing of the stringers on the caps the nominal area is 42 sq. in. per stringer, although actually it will be, in service, about 38½ sq. in., which gives a maximum load of 330 lbs. per sq. in. on the caps. So long as the bearing or crushing load on timbers such as are used in all ordinary pile and timber trestle bridges is not more than 500 lbs. per sq. in., there should be no trouble.

(d) *Bents.*—In the bents, there are three fairly well defined stresses that must be provided for. First: The transverse or lateral swinging of the engines, causing the bents to vibrate or wave from side to side. Second: The longitudinal movement caused by the tractive force of the engines. Third: The direct effects of vertical loading. The tendency would be for the first effect above noted to increase the unit stresses in stringers and bents.

In pile bents of moderate heights, as ordinarily built, no special provision is made for this twisting from the transverse and longitudinal forces. Where the bents are high the horizontal and vertical longitudinal bracing, as usually designed, is so loose that small movements in the bents will always occur, and under heavy or fast traffic these movements will always increase. Under our standard loading the piles will carry 33,000 lbs. each in four-pile bents, and 22,000 lbs. each in six-pile bents. For heavy




Cross-Sections of Standard Solid Floor Trestles, Atchison, Topeka & Santa Fe.

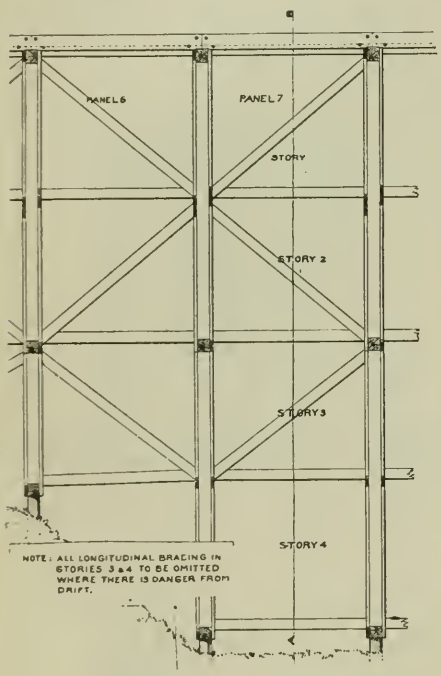



*Cross Section.* *Longitudinal Section.*

Standard Bulkhead and Underpass, Atchison, Topeka & Santa Fe.

grade loading the piles will carry 48,300 to 32,200 lbs. each in four-pile and six-pile bents, respectively. In both cases the stringers and caps have been considered to distribute uniformly the vertical loading between the piles in any bent, which in actual practice is doubtful. In timber bridges as usually designed the vertical loading is seldom, if ever, uniformly distributed over all piles making up the bent. For average conditions, piles carrying loads of from 15 to 25 tons each will probably not give irregular settlement under traffic.

In the plans under discussion the piles are so spaced that they can be driven (in rebuilding) without disturbing the stringers and also that the effects of loading will be uniformly distributed. As a result there


PANEL 6
PANEL 7
STORY
STORY 2
STORY 3
STORY 4
NOTE: ALL LONGITUDINAL BRACING IN STORIES 3 & 4 TO BE OMITTED WHERE THERE IS DANGER FROM DRIFT.

Elevation of High Trestles.

should be but little, if any, settlement in the piles, and no irregular settlement. It should be remembered that settlement of piles under traffic, and especially irregular settlement of the individual piles in any bent, is one of the most fruitful sources of high maintenance charges.

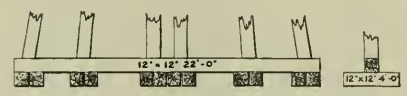
All caps and stringers have their upper surfaces completely covered with galvanized iron. This is mainly to guard against fires, but is also a protection from weather effects. In order to accomplish these objects, it is necessary that there be no open holes left in the iron where moisture could collect and start decay or coals start a fire. Our plans have no uncovered holes in the galvanized iron except where upper horizontal longitudinal struts are fastened to caps and for the passage of tie to stringer bolts. The latter are drained and covered by both the tie and the cast washers, while the former is covered by the struts. The deck anchor bolts are secured to the bents by eye-bolts passing horizontally through the caps. Chuck blocks on top and sides of caps or spiked to the under side of the stringers have been unsatisfactory in the past and hurry decay. If the eye-bolt plan does not work satisfactorily we will have to adopt some other one which will.

(e) *Bracing.*—Sash and sway bracing is made up of 3 x 10-in. material fastened to the posts and piles by ¾-in. bolts. All other bracing is of 6 x 10-in. pieces arranged, as far as possible, to act in compression. All their connections with bents are forked or crotched, and the boat spikes or drift bolts are merely to keep the pieces from jarring sideways out of proper position to act to best advantage.

(f) *Bolts and Washers.*—The bolts used are all ¾ in. in diameter and the boat spikes of regular stock sizes. Drift bolts have chiseled points and end upset only enough to permit drawing with claw bar. The cast washers are 4 in. in diameter, and so designed as to reduce their weight to the least possible limit consistent with proper strength. The importance of this item will be realized when it is remembered that the ordinary O. G. washers previously in use on the road weighed from 2¾ to 3 lbs. each, while those now in use weigh 1¼ lbs. each, and that during the past few years an average of about 10,000 washers per month have been used on the system. When the bolts have a stress of 20,000 lbs. per sq. in. net, the pressure of the washers against the timber will be about 500 lbs. per sq. in.

(g) *Material Bill.*—No set of plans can be considered as complete without a full bill of material. This is especially the case where the plans are to be used over such a large territory and where the climatic and supply conditions are so varied as on the Santa Fe.

*Conclusion.*—While timber bridges are

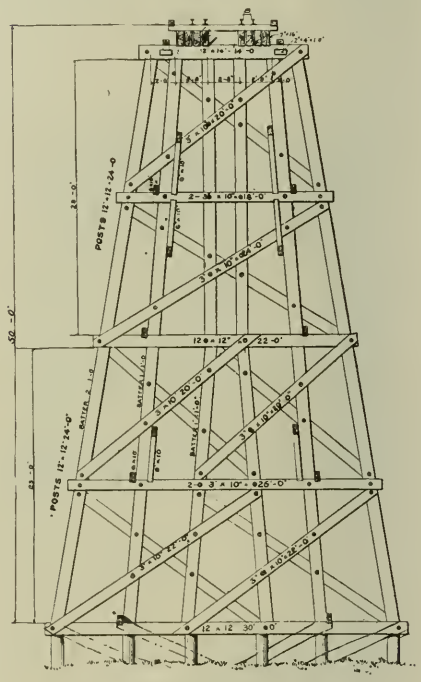



General Type Mud Sills for All Bents.

properly considered as temporary structures, they will undoubtedly be used by the railroads of this country for many years to come. It is therefore important that they be designed with due reference to first cost, probable life and average annual cost of maintenance. The writer knows of only one or two railroads in the country where what may be styled as the old time bridge carpenters are still retained, men of this grade requiring from one-third to one-half more wages than are usually paid to bridge carpenters on most lines. In designing our bridges, we have had in mind at all times the grade of labor obtainable or that it seemed to be the policy of the company to keep in their service. The system of horizontal and longitudinal vertical bracing has been so designed as to provide as far as possible against all of the small or minor movements of the structures. Very few maintenance engineers appreciate at their full value the effect of these minute movements in their structures. The writer's attempt has been to obtain at moderate cost structures that would be as nearly rigid in every particular as it was possible to make them. It is his belief that the small or minute movements of structures under traffic are the cause of the major portion of maintenance expenses, as these movements will be allowed to pass unnoticed from month to month until they have become so marked that the structure is declared unsafe, thus causing extensive repairs, which could easily have been avoided had proper provision been made originally to prevent these minute movements. Another item of considerable importance is that the number of different sizes of material required should be kept to the lowest possible limit. In the present plans, there are eight sizes of sawed timber. Only one size of bolts and washers is used, and in other particulars care has been taken to keep the details as nearly regular as possible.

In getting up new plans for timber structures, the designer should not make any more radical departures from the plans previously in use than are absolutely necessary. Structures made on the old plans will have to be maintained for from one to ten years after the adoption of the new ones. Any changes in the sizes of material will be liable to cause confusion in the field, and will also necessitate the Store Department keeping on hand a supply of material to agree with both the old and the new plans.

The bents and bracing for branch line structures are lighter than those for main line traffic. On many of our branch lines where the light engines are used, it will not be necessary for the heavy stringer chord to be used for some years to come. When-




Cross-Section of High Trestles.

ever traffic requires, the extra line of stringers can be put in without disturbing the deck and at a very moderate cost.

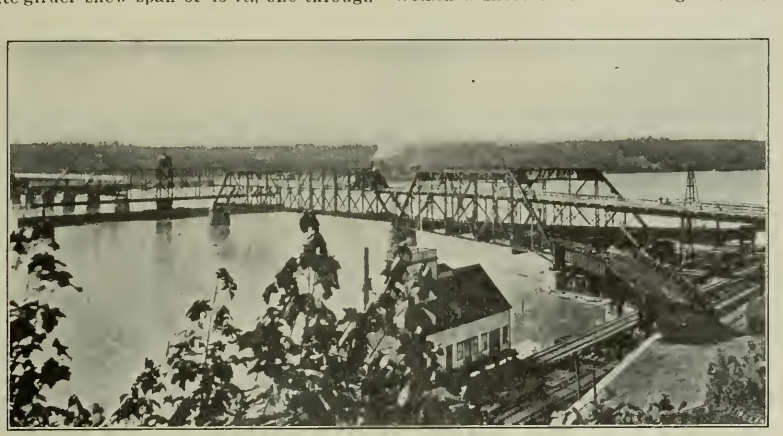
The plans for creosoted ballasted deck trestle are shown with the other work in order to present the whole scheme together.

## The New Fraser River Bridge.

The bridge across the Fraser River at New Westminster, British Columbia, which was described in the *Railroad Gazette*, Aug. 29, 1902, was opened for traffic with appropriate ceremonies on July 23. It was built by the Provincial Government and cost about $1,000,000. New Westminster is situated on the north bank of the Fraser river, about 15 miles from its mouth. The Vancouver line of the Great Northern runs along the south bank and across the river farther up, and a branch of the Canadian Pacific from Westminster Junction on the main line runs along the river's edge into the town. The new bridge, which is a double-deck structure, carries vehicles and foot passengers on the upper deck and has one track for steam and electric cars on the lower deck connecting the two lines of railroad on both sides of the river and giving the Great Northern an entrance over the Canadian Pacific tracks into the heart of the town.

The Fraser river at this point is 2,100 ft. wide at a mean stage of water, and the tidal

difference is about 14 feet between high and low water. The new bridge is a steel structure supported on masonry piers, and consists of one through truss fixed span of 225 ft., one through truss fixed span of 380 ft., one through truss swing span of 380 ft., and five through truss spans of 159 ft. each. The five short spans carry the carriage roadway on the top laterals, the trusses being made only deep enough to give 16 ft. headroom for the railroad tracks on the lower deck. In the other three spans the roadway deck is 16 ft. below the top laterals, supported on floorbeams connected to the posts of the trusses. Beginning at the first pier from the north shore the railroad track branches out into a Y, with 12 deg. 30 min. curves, to connect with the tracks of the Canadian Pacific which run along the river's edge, and the inshore span is widened out to 135 ft. 6 in. at the shore end to give the necessary spread for the curves of the Y. The railroad approaches at this end consist of one deck plate-girder skew span of 90 ft., two through plate-girder skew spans of 53 ft. 6 in. each, and one deck plate-girder skew span of 41 ft. for the east approach, and one deck plate-girder skew span of 71 ft. 6 in., one through plate-girder skew span of 43 ft., one through plate-girder skew span of 38 ft., and one deck plate-girder skew span of 32 ft. for the west approach. The wagon approach on the north side is from a high earth embankment over short plate-girder spans supported on steel bents to the main spans of the bridge. On the south side a wooden trestle carries the roadway, steam and electric tracks down to their respective connections. The total length of the steel work in the bridge is 2,400 ft., of the railroad approaches 7,715 ft., of the roadway approaches 1,870 ft., and of the bridge and all approaches 11,985 ft. About 4,000 tons of steel in all was required.



New Bridge over the Fraser River at New Westminster, B. C.

In the substructure there are 11 piers, 12 pedestals and three abutments. Piers 1 to 5 were sunk to bed rock by open dredging, and piers 6 to 11 are concrete and masonry shafts resting on timber cribs filled with concrete and piles. The deepest pier was sunk 141 ft. below high water and penetrates the river bed 69 ft. The draw span pivot pier has a penetration of 90 ft. into the river bed.

The bridge was designed and built under the supervision of Messrs. Waddell & Hedrick, Kansas City, Mo. Armstrong, Morris & Balfour, Vancouver, B. C., were the contractors for the substructure and approaches, and the Dominion Bridge Co. (Ltd.), Montreal, was the contractor for the superstructure and erection. Work was started in August, 1902, and was finished just previous to the opening.

## A Review of the Cast Iron Wheel Situation.

BY C. W. GENNET, JR.

When the demand was made for a car wheel capable of withstanding an increase of from 40 to 60 per cent. of the load calculated for it to bear, the thought did not simultaneously occur that existing standard designs were inadequate. The familiar 600-lb. chilled iron wheel had for years given the best of service as regards safety and economy of operation, and a departure from the regulation design of tread, flange, brackets and plates appeared radical and unnecessary. Thus when the 30-ton capacity car grew into one of 40, and then into one of 50 tons, the natural and guiding impulse was to simply add 50 or 100 lbs. to the weight of the cast-iron car wheel, pains being taken at the same time to systematically distribute this additional weight to such parts as would seem the best and the easiest of adaptation for the increase.

In some cases the thickness through the tread was increased, but almost without exception the alterations adopted were in the thickness of the plates, in the dimensions of the hub and in the number of the brackets. Within a short time trouble began to occur abundantly. Particularly on mountain roads, where either the number of grades compelled frequent action of the brakes or where there were many curves, wheels began to show signs of weakness under the heavy loads. Flanges began to break off and wheels burst, and in both cases the occurrences were generally accompanied with much damage. This result, which was perhaps invited, has been the subject of much agitation, not only among railroad men in general, but also among wheel makers, and the resultant co-operation has been productive of many new designs and improvements which, if adopted, should eliminate much of the trouble.

It is assumed that, by reason of an active and well maintained inspection of wheels previous to their being put into service, which compels the rejection outright of such lots of wheels as fail to stand the required tests, that only those entirely free from defects are allowed to be used. Moreover, it is assumed that a vigorous inspection of wheels under cars precludes the possibility of further use of defective wheels according to the Master Car Builders' rules.

Two expressions are usually employed to describe the breaking of wheels in service, viz., "flanges breaking" and "wheels bursting." The first class of failures has its origin in the fracture of a small piece of the flange, which break sometimes occurs a long distance from the scene of the final disaster. Then, as the wheel continues to revolve, the weakened flange often creates a hammer blow on the rail with the continuing effect that with each revolution the break is increased until finally the entire wheel is more or less demolished. The reason for this class of failures, that is, what causes a piece of the flange to first break off, has been variously explained; but where no inherent defect is apparent the theory is that a combination of the heating effects produced by the grinding action of the flange on the rail and by the action of the brakes causes an uneven or unequal expansion and contraction of the metal, which ultimately causes cracks running longitudinally around the wheel in the throat and which so weaken the metal that failure results.

To this class of failures is closely allied the other, that of wheels bursting; but the cause of the latter is not supposed to originate in a weakening of the flange. The action of the brakes in continually heating the tread of the wheel and the subsequent cooling that ensues is regarded more than the flange action on the rail as the primary cause of a crack running from the throat across the tread. A weakening effect thus spreads through the tread and finally into the plates, so that the wheel is generally broken clear through, as in the thermal test.

The production of heat that comes from either the grinding action of the flange on the rail head or the continual application of the brakes, or both, is regarded as the real source of the trouble. This heating effect is generally indicated afterward by a deep bluish color given to the metal in the broken wheel. As insignificant as it may be considered, it constitutes a never-ceasing menace. Some idea of the degree of heat produced can be gathered from an attempt to hold the hand on the flange of a trolley car wheel after it has rounded several curves, and, while this heating is small in comparison to that produced by a heavy car descending a grade on a curve, the effect is sufficiently startling to convey an impression of its intensity.

Highly interesting experiments with wheels subjected to a process slightly differing from the regular thermal test have shown that the action of heat around the periphery of a cold wheel may produce a crack in the chilled iron which, by not extending to the surface, is consequently invisible to the most careful surface inspection, but which by its very existence materially weakens the value of metal in the throat. It is a fact that of the two classes of failures, those of broken flanges have been in the majority with the use of heavy cars, so that it is a reasonable supposition that this is the part which requires the most attention. To effect a correction in this vital part of the wheel is an extremely difficult problem; for, with the numberless frogs and switches of almost universal dimensions, the prime requisite, which seemed to be to increase the thickness through the flange from the throat, was obviously impossible.

Although it was at first conceded that an increase in weight of a car wheel of 16 per cent, was insufficient to withstand an increase in its loaded rating of 60 per cent., the makers were able, in a measure, to meet this objection by asserting that, if properly paid for their efforts, they could produce a wheel of such quality of iron that its effectiveness at a comparatively small increase in weight would be thoroughly satisfactory. Whether doubt of their ability to do this or unwillingness to pay the price demanded, can be taken for the reason, it is known that generally their offer was not accepted. At the same time the merits of steel-tired wheels were discussed, and although their large factor of safety as shown on passenger equip-

ment was an argument for their further use, their great cost necessarily rejected them for freight use. As a matter of interest, it has been shown that even under passenger equipment the use of steel-tired wheels fails to show primary advantages. Perhaps their adoption for Pullman cars has been their best recommendation, for the comparative figures of various companies show no decrease in cost of maintenance over cast-iron wheels, and, as has been stated, the first cost is much greater. In other respects records show that a small guarantee is offered by the use of steel-tired wheels, and it is quite apparent that any favor for their use has been founded on the fact of their being steel instead of iron.

Improvements in designs of cast-iron wheels have been almost entirely along such lines that the price has not been increased beyond that required by the slight addition of weight. In almost every case the fundamental idea has been to strengthen the flange and in this direction four primarily different styles have been devised. The first to make its appearance consisted of simply a projection on the inside rim of the wheel back of the flange. This projection was so shaped that the thickness of the rim back of the flange was increased, the projecting form being rounded off to meet the rim again at a point back of the throat. Undoubtedly a step in the right direction, the effect of this addition was not spontaneously proven, for the difficulties which attended making such a casting with the necessary chill, led to some apprehension.

A change more generously adopted has been to increase the radius in the throat of the wheel and at the same time maintain the other characteristic dimensions. This radius, long ago set by the Master Car Builders at five-eighths of an inch, has been increased to as much as fifteen-sixteenths in the wheels of such weight as selected for the heaviest cars. By this alteration, the depth of chill can easily be kept at the desired amount, and the wheel thus made is exactly according to the best-known standard designs, excepting that the metal through the throat has been increased about one-eighth of an inch. The fact that the greater radius increases the tendency for the wheel to mount the rails has not been considered hazardous, for the change in the curve of the throat outline is so slight that the design is believed to be still well within the limits of safety.

More radical than either of these designs has been that of a proposed single-plate wheel, and another which has a projecting ring of rib-like section placed on the inside rim in such a position that, while it comes directly over any guard rail or switch point it easily clears. This latter wheel is supposed to strengthen by reinforcing, and as the idea seems to possess no detrimental features the design may come into more general use. The former wheel is made with a single plate extending with a reverse curve from the outside of the hub to the inside of the flange. Ribs, alternately placed on the outside and the inside, connect the plate with the rim and the hub, and besides the feature of strength which is claimed for the flange thus connected, the wheel should offer none of the defects sometimes found in those double-plate wheels made with cores.

While these forms of wheels have been designed with a view to reinforce the weakest part and thus to eliminate troubles which have occurred, their use to the present time has been limited to such an extent that any accurate data as to their success as a whole is impossible to obtain, and the adoption of any one form is a matter largely of personal favor. While these forms do somewhat increase the actual weight of the wheels beyond that which are customarily used for the various capacities of cars, still this increase is not enough to make it a very important item of expense, and the benefits to be derived are believed to be so great as to justify their careful consideration.

Efforts to increase the efficiency of wheels have also been made with the use of cast steel in place of iron. Several years ago there was put on the market a single-plate wheel made from a steel casting, which had the regular form and shape of standard wheels, but was deficient in not having a smooth and entirely circular tread. This rough casting was heated and revolved with rollers pressing on the tread and flange, so that when finally finished the effect was a tread and flange as neat and accurately formed as is generally found with cast-iron wheels. These wheels are reported to have given first class results, but their cost, though not quite equal to that of the usual rolled steel tired wheel, has been so great as to not permit of their extended use.

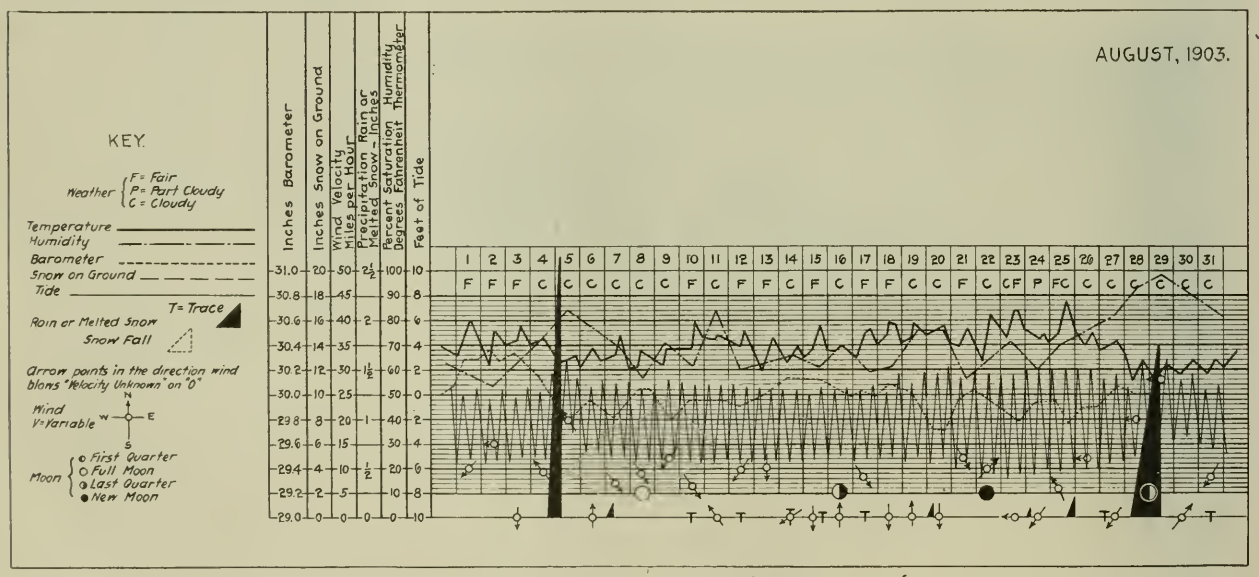
Another form has been made which has for its fundamental principle the extreme hardening of the metal composing the flange and tread by the addition of manganese to the steel. This wheel has its single plate formed like a folding fan; that is, the folds or corrugations radiate from the hub, and give an appearance of much strength to the wheel. Wheels produced in this way are extremely hard, as proved when submitted to the drop test, and that this hardening does not indicate brittleness is shown by the manner with which they have withstood the thermal tests.

Within the last year experiments have finally succeeded in producing a wheel made of steel, by combined pressing and rolling. In this, the steel ingot is first pressed into shape and then successively rolled to give it the required finish.

With these different forms available, wheel makers and users are struggling for results, and how their efforts are best succeeding must be left for time to tell. The great question is whether or not experience will demonstrate that the cast-iron wheel must give way to steel, and the matter of expense will have relatively slight influence on the decision, if other requirements demand the change.

## Engineering Office Weather Records.

The accompanying cut illustrates a form of weather record which is prepared with little trouble and which has been found most satisfactory, as being easily referred to, and




A Graphic Weather Record for Engineering Offices.

While it is not supposed that offices are as a rule equipped with instruments for recording the various phases of the weather, it is customary for one or more of the daily papers to publish a tabulated weather report, which is always available in the neighborhood of large cities. These newspaper reports may be augmented by the daily weather bulletin issued by the United States Government, which is always accessible. When the work is at tide water, the tide record may be supplied from the nearest, self-recording tide gage, as the records are usually available at the office of the department of docks, or the tide may be plotted from observations by the inspector.

The scale adopted for the record is such that extreme refinement in plotting is not warranted, it being sufficient to plot the maximum and minimum values at the time of occurrence each day. The record is plotted on thin profile paper, from which blue prints may be taken.

## THE NEW YORK CENTRAL ELECTRIC SERVICE.

The purchase by the New York Central of a controlling interest in the Syracuse Rapid Transit and the Utica & Mohawk Valley electric lines was discussed in the *Railroad Gazette*, July 22. Announcement has now been made more fully in regard to the steps which have been taken to make the trolley lines across New York State, which have been such formidable competitors of the steam road, allies and feeders to the main line.

Apart from the short haul competition around Utica, which was taken care of by the Utica & Mohawk Valley purchase, the most threatening competitive territory was that lying between Syracuse and Rochester, and especially the strip of country south of the main line served by the old Auburn road of the New York Central. The immediate plans of the steam road provide for the electrification of the West Shore between Utica and Syracuse and of the Auburn road between Syracuse and Rochester. When this is accomplished one of the two great advantages possessed by electric roads in their competition with steam roads for short haul traffic will have been provided for. This is the economy of being able to run a frequent service in small units. The other great advantage of the interurban companies—that of being able to collect their traffic in the city streets, thus affording a service far more convenient to short distance travelers than that provided from a city terminal—will be gained when the full plans are carried out, by running the cars singly through the streets much after the present fashion and then assembling them in multiple unit trains for the between-towns part of the trip. Although this system, involving the use of the old steam line between cities, precludes the use of the main streets of the intermediate towns as a transportation route, it is not expected to make much difference in this specific locality, since the Auburn road runs directly through the small places along the way instead of a mile or so away from them, as has often been the case in territory where the electric roads have been able to exert the most successful competition. The Auburn road will be rebuilt for the traffic, and it is thought that this plan will combine in a highly advantageous manner the terminal convenience and small unit economy of the electric roads with the high speed possible on a solidly built line running on private right of way. Short-haul traffic from Little Falls all the way to Rochester will be taken care of in this way by the present plan. Afterwards it seems wholly likely that the idea thus placed in experimentation will be extended to provide an electric service right across New York State.

This principle of running interurban cars singly through city streets and then assembling them into multiple unit trains worked on private right of way between short-haul terminals is such an admirable solution of the electric competition problem and one which can be so readily put into operation, that it must be a matter of surprise to all who have studied the problem that it should have been developed so late. The competitive points in the country where some plan similar to this can be put in operation are legion. All through Massachusetts, Connecticut, Ohio, Indiana and Michigan, to cite only the most striking instances, conditions exist similar to the one now being met by the New York Central. Whether or not the New Haven road, by its recent purchase of trolley control, intends to carry out a similar plan must be a matter of conjecture, but it would seem highly advantageous for that road to pick up short-haul traffic in the streets of such cities as New Haven, Bridgeport and Hartford in its interurban cars and then assemble them in multiple unit trains and maintain a fast local service to points where the electric competition had been severe.

In one of the series of articles which have been printed in the *Railroad Gazette* during the last two or three years discussing electric competition, it will be recollected that a manager of interurban roads was quoted as saying that there should be three distinct kinds of railroad service: that for through traffic; a purely local short-haul service at moderate speed, such as is now conducted by interurban lines, and a service midway between the two designed to combine convenience, rapid transit and economy in hauling passengers for distances of forty or fifty miles. By control of the interurban lines in New York State the New York Central provides for the local short-haul and feeder traffic. By electrification of branch lines to be worked as noted above—by interurban cars assembled in multiple unit—the intermediary service is also provided, for the first time, leaving the main lines to perform their own function of through traffic, for which they are best adapted and equipped.

The possibilities of the extension of this development seem almost boundless, both from the standpoint of the traveler, who will be furnished real rapid transit on short journeys, and from the standpoint of the operating companies, who have only to look at the tremendous new business created by the electric roads to realize the profit which goes along with a convenient and popular service. The intermediary electrified branch line service presents many new problems in electrical traction, for it is in its essentials quite a radically new proposition, but it is reasonable to expect that in the present state of the art of electric transportation these problems will not long remain unsolved. It is fair to say that the lesson just taught by the New York Central and New Haven roads in gathering in their short-haul competitors to form a systematic and centralized transportation system where before was a scattered and half-met competition, is the most important event in the history of short-haul transportation since first the local city and village trolley lines began to join hands with one another and to create the word "interurban" in its present significance.

## DEVELOPING MICHIGAN FRUIT TRAFFIC

An account is given in another column of an interesting decision by the Interstate Commerce Commission holding that the charges for icing the refrigerator cars which are used in shipping fruit from Western Michigan are exorbitant, the evidence showing that since the two roads—the Pere Marquette and the Michigan Central—have made exclusive contracts with the Armour car lines the charges for refrigeration have been increased from 50 to 150 per cent. On the face of this report the case against the railroads would seem to be almost conclusive; but a perusal of the full text of the opinion shows that there may be something to say on the other side. But whether there is or is not, the full report, prepared by Commissioner Prouty, who is always lucid and forcible, makes very interesting reading. It shows the present condition of the fruit shipping business in Western Michigan in nearly all of its details. The industry is quite new, however, and it looks as though the lower rates of two or three years ago, with which the present high rates are compared, had been made by the railroads experimentally with a view to development of the traffic. And, indeed, the Commission evidently recognizes this aspect of the case, for it refrains from making any specific recommendation; it says that the railroads and the refrigerator company can adjust the irregularities much better than can the Commission, and therefore the matter is left open until October 1. If, by that time, no readjustment has been made, the Commission will take further action. It began the present investigation on its own motion.

The statement of facts shows that peaches, pears, plums and berries of all kinds grow in great abundance between Lake Michigan and the Grand Rapids & Indiana Railroad. Fruit growing has largely increased during the last 15 years, and during the last three or four years the railroads have stimulated it by furnishing refrigerator cars for shipments to distant cities. In 1903 the Pere Marquette shipped 6,000 cars and the Michigan Central 600. Of the 6,000 cars, 1,700 were iced; and of the 600 about three-fourths. Shipments are made to Boston, Duluth, Dubuque, and other distant places, and a car is usually gone four weeks. The traffic manager of the Pere Marquette says that he needs 2,500 refrigerator cars at the beginning of the season, which lasts only three months and which is active only about six weeks; but Mr. Pronty thinks that 1,000 would be enough. Until 1902 the Pere Marquette got its refrigerators from its neighbors, but this was not satisfactory, as shippers frequently desire to change destinations, and railroad companies will not allow their cars to be diverted. The Pere Marquette made a contract with Armour at the beginning of the season of 1902, the car company furnishing the ice and taking the responsibility of icing through to destination. The railroad company pays 7½ mills a mile for the cars and agrees not to use other refrigerators for foreign shipments, while the car company has the privilege of charging the shipper for its services. The Michigan Central has a similar contract. The Armour lines (a consolidation of the Fruit Growers' Express, the Kansas City Fruit Express, and the Armour Refrigerator Lines) owns 6,000 refrigerators devoted to the fruit traffic; and the Continental Fruit Express, an allied concern, owns 1,500. The Continental Fruit Express is another affiliated company, and there are no others of consequence in the country; so that the

Michigan roads could not get a fair supply of refrigerator cars from any other source and could not satisfy the needs of their shippers in any other way than they do unless they were to have refrigerators made for themselves. Up to about four years ago the railroads furnished the ice free; in 1901 and 1902 they charged for it at cost, and connecting roads had to look after reicing. Now the car company does this, having ice houses and agents at suitable points, and charges, for example, $55 a car to Boston, where the railroads, when they charged cost, collected only $20. To Dubuque, Iowa, the freight is $110; ice, formerly $7.50 to $15, is now $37.50.

Before the contract was made the principal trouble was lack of a reliable supply of cars, though at Grand Rapids, where competition was active, cars were always in good supply. A number of shippers testified that they were satisfied with the present arrangement. The cost is increased but the service is much better. These witnesses were brought to the hearings without expense to themselves, but "there is no reason to doubt their honesty." One reason for the increased charge is that the cars now used carry four to five tons of ice, about 60 per cent. more than those formerly used. Ice costs $2.50 a ton and the quantity used appears to be not over 10 tons to the car, even on long journeys. Comparing this with the charges made, the Commission concludes that the Armour Company collects very much too large a sum for superintendence. One shipper, Moseley, of Grand Rapids, owning 30 refrigerator cars for his own use, furnishes his own ice, receives 7½ mills for his cars, and pays the railroad for reicing on the road at actual cost. The cost per car for refrigerating is invariably much less than in Armour cars, usually about one-half the Armour charges.

In view of all these facts, the Commission, as before stated, holds that the charges for refrigerating service in Armour cars ought to be reduced. As a preliminary to this, and by way of additional justification of its action in taking up the question, the Commission holds that the furnishing of refrigerated cars is a public duty. The opinion says:

> We think that it is the duty of the respondent railroad companies to furnish refrigerator cars for the transportation of this fruit. While it is possible that these carriers might at the outset have legally declined to provide this special kind of equipment, they ought not to be permitted to do so at this time. For years they have voluntarily made such provision, and this industry has grown up upon the strength of that arrangement. Such cars are generally furnished in all parts of the country when required for this species of traffic. While a refrigerator car costs somewhat more than an ordinary box or flat car, the additional expense is not great. Railroads at this day might as well decline to provide stock cars for the transportation of live stock as refrigerator cars for the carriage of perishable commodities. But this duty does not spring from the Act to regulate commerce, nor has this Commission any jurisdiction of that matter. It arises out of the common-law liability of the defendant railroad companies as common carriers, and redress for failure to fulfil it must be sought in the courts.
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> The defendant railroads may provide such cars either by purchase on their own account or by lease from other roads, and if the latter plan is adopted they may undoubtedly enter into exclusive contracts like that before us. This has been settled by the Supreme Court of the United States. Whether the carrier is legally compellable to furnish ice for the refrigeration of such cars is more doubtful. In our opinion it should be. While the shipper might attend to the initial icing, he could not, without great difficulty, provide for reicing en route. If the railroads were to insist that it should be done by the shipper in each instance, it would result in throwing the transportation of perishable commodities into the hands of a few large shippers, who could afford to provide the necessary icing facilities. That the carriers can, without great inconvenience, furnish ice is evidenced by the fact that for a long time they have and in many cases still do so. These lines provide ice for the shipment from Michigan points of dairy products and all other commodities except fruits.

So much for the Commission's view of the duty of the railroad to the public. As to the abstract justice of a law compelling a railroad to furnish refrigerators, where there is a considerable volume of perishable freight, there cannot be much difference of opinion, and probably the courts would quite readily sustain any law which a fair-minded legislature might pass. Former luxuries are now necessities, and the courts are ready to do their share toward keeping our civilization up to date. The practical application of such a statute is, however, another matter. With the fluctuating character of such a traffic as that in fruit, the shortness of the season and other risks, a railroad may well find many difficulties in deciding how much money it can reasonably expend for stimulation and development, or even for minimum accommodations; and where a railroad company deems it profitable to neglect the traffic it will be difficult for the State to force or coerce it into doing otherwise. Difficult, we mean, because the reasons that actuate the railroad officer will also have their effect on the officer of the State; he will find it hard to decide what is equitable.

The immediate question with the railroads in the Michigan case would seem to be, not their duty to the State, but their duty to themselves. They gave this fruit traffic a good start by furnishing ice at cost. Having after a time decided, apparently, that they were giving the fruit man too much for his money, they increased the charges; but in so doing they took in a partner—the refrigerator car company—which may have been so greedy as to check the growth of the traffic, or even have caused it to decline. An increase of 33 per cent., or even a much smaller increase, in the selling price of a basket of peaches at Boston or Dubuque would, we should think, have a pronounced effect on the total quantity sold, and therefore on the traffic of the railroads. Commissioner Prouty may have to study the traffic for a number of years before he can decide whether the time of the icing-boss at Buffalo, or Karner, or some small division terminus, is worth ten dollars a car, or one dollar for ten cars, or some figure between these two; but the traffic manager of the railroad ought to be able to decide quite readily whether a reduction in the cost of delivering fruit at any given point would increase the movement to that point.

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The paper published in *Gunton's Magazine* by Mr. H. T. Newcomb, part of which is reprinted elsewhere in this issue, was intended by the author as a reply to a recent magazine article published by Mr. Prouty, of the Interstate Commerce Commission, in which it was alleged that the railroads were imposing a constantly increasing burden upon the public at large by increases in their rates. Mr. Prouty is well known as an advocate of enlarged powers for the Commission, and his maxim that "the only way to regulate rates is to regulate them" has been widely quoted. Without refuting this proposition directly, Mr. Newcomb reviews the situation as an economist, and devotes his argument to the fundamental principle, often overlooked, that the cost of any commodity, in the broad sense of the word, or of any service rendered, is entirely a relative thing, and that an arbitrary sum in dollars and cents is quite meaningless unless its purchasing power be taken into account. No one would deny, for example, that the great difference in industrial wages here and in Germany is due in large part to the difference in the cost of living in the two countries, yet Mr. Prouty neglects to apply this same principle in his assertion that recent increases in railroad rates are a mere arbitrary measure, carrying with them an increased purchasing power that enriches the transportation companies at the expense of their customers. Money is only useful for what it will buy, and Mr. Newcomb clearly shows that the railroads are able to buy less, instead of more, with the recompense received for a unit of service rendered, than they were five, ten, or twenty years ago. Railroad rates, therefore, when viewed from their purchasing power, or "control over commodities," as the author expresses it, have been growing steadily less, rather than greater.

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### July Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of July, printed in another column, contains accounts of 17 collisions and 37 derailments. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| Date. | Killed. | Inj'd. |
|---|---|---|
| 1. Laquin, Pa. | 2 | 2 |
| 2. Tony, Wis. | 3 | 16 |
| 3. Litchfield, Ill. | 24 | 45 |
| 5. Frankford, Pa. | 2 | 1 |
| 5. Cameron, Colo. | 3 | 60 |
| 5. Oakford, Ill. | 1 | 15 |
| 6. Woodbine, Iowa | 1 | 2 |
| 10. Midvale, N. J. | 16 | 69 |
| 13. Glenwood, Ill. | 18 | 25 |
| 16. Shippen, Pa. | 2 | 3 |
| 23. Atglen, Pa. | 0 | 0 |

The three most notable cases in this list have been noticed in former issues. In a disaster like that at Litchfield a measure of relief is felt when it is discovered that the misplacement of the switch is not chargeable to the negligence of an employee; but this feeling would be far more comfortable, and less qualified by regrets, if switches on American railroads were more generally connected with cabins and protected by distant signals or electrical indicators, or both. We assume that in this case the switch was so situated that the engineman had only a few seconds' view of it before he was upon it. This being so, the safety of fast trains depends in a measure on the incessant vigilance of the engineman; inattention on his part for a second or two may make the difference between life and death for a passenger or a trainman. Such a requirement is an unreasonable burden to put upon the engineman, day after day and year after year. It is true that interlocking and distant signals, and even a continuous track circuit, may not always thwart a train-wrecker; but it is also true that a good share of the persons who attempt to wreck trains do seem to be half hearted. Many of them are half witted or worse. They do not pursue their object with vigor, intelligence and persistency, and it seems quite likely that systematic and thorough repressive measures would be effective in some cases where our present loose protective measures are not effective. The equipment of a railroad with

interlocking and block signals not only makes it more difficult for a miscreant to accomplish the breaking or physical disturbance necessary to carry out his purpose, but also aids in keeping the line clear of lawless persons by the increased number of patrolmen employed. The presence of signalmen, repairmen and inspectors tends to improve the morale of the roadway force as a whole.

The Midvale collision occurred under the telegraph block system. The question whether the system was being worked at its best—that is, whether the signalman who was at fault was a man of the right temperament, working under favorable conditions and with all apparatus and accessories in good condition, and the discipline perfect—are questions which probably will not be answered, as there is no public investigating body in New Jersey. However this may be, such a serious collision is likely to give an impetus to the movement among American railroads to increase the use of automatic block signals. At Midvale the line is single track, so that the most approved provision against collisions, according to the present view of signal engineers, would be the electric train staff or controlled manual block signals, though automatic track-circuit signals would meet every requirement, so far as *rear* collisions are concerned. The Erie has a considerable mileage of its double-track road equipped with controlled manual signals, but we do not hear of the extension of that system either on the Erie or elsewhere.

We have no important information concerning the Glenwood collision beyond that given in our issue of August 5, page 220, except that Thornton was not a block-signal station and the brakeman on the freight had been in the service only six months. As the Chicago & Eastern Illinois is recorded as a block signaled line it is of interest in a case like this to know just how and to what extent the block working was modified or suspended. To run a train against the current of traffic, on double-track, obviously requires an interruption of the normal procedure. This appears to have been done in this case by the direct orders of the train despatcher. It is desirable, of course, in such movements to run all trains from block-station to block-station; and running from Thornton, not a block station, or using the crossover there, was objectionable. If avoidable it was more than objectionable. The agent at such a station would be less likely to use all precautions within his power than would a man more familiar with space-interval processes. The existence of a crossover at any other place than a block station is also objectionable, as is an unprotected switch a long distance from a station, like that south of Thornton, connecting the west siding to the southbound track. This road is no worse in this respect than many others, operating thousands of miles; but that does not make the practice any better. Care must be taken not to discredit the block system by charging it, in whole or in part, with collisions which occur where it is nominally in use but where the appliances and the practices are admittedly imperfect. A satisfactory telegraph block system presupposes the protection of all switches and crossovers in such a way as to make sure that no train or engine can enter any part of any block section without the knowledge and consent of the signalman at one end of the section. This implies, of course, the knowledge and consent of the man at the other end also, as free communication between the two signalmen is a fundamental feature of the system. The admission of two trains within a single section at the same time is admittedly a suspension of the space-interval principle, demanding the utmost precaution.

We are not unmindful of the fact that Engineman Hoxie appears to have been grossly reckless and that his testimony is unobtainable because he has disappeared; the points which we have presented need to be considered, nevertheless, by reason of their bearing on the general discipline of enginemen. Conductor Cooper appears not to have given Hoxie any very clear and emphatic instructions at Thornton; so that the impression conveyed by the first reports, that Hoxie had recklessly disregarded the conductor's orders, may not be correct.

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The number of electric car accidents reported in the newspapers for July was 27; in which six persons were killed and 147 injured.

## Railroad Losses from the Packing House Strike.

Figures showing the receipts and shipments of packing house products at Chicago since the beginning of the strike are indicative of the immediate loss which the railroads have suffered. Provided the strike is not too long continued, abnormal movements of livestock and provisions at its conclusion should in considerable part make up for this loss, but, unlike the situation at the time of the anthracite coal strike, it is evident that much of the meat consumed in the eastern cities is being supplied locally. It is hardly to be expected, therefore, that the demand for provisions shipped through from the west after the strike is settled will compare in proportionate volume to the heavy movement of coal after the close of the coal strike.

Livestock receipts at the Chicago market for three weeks subsequent to the inauguration of the strike numbered 9,710 cars, and shipments were 3,815 cars, exclusive of horses. For the corresponding period last year the respective figures were 17,096 and 4,585 cars, the decrease amounting in the first case to 43 per cent. and in the second, to 17 per cent. Shipments of packing house products between the first of July and the middle of August had fallen off from one-quarter to one-half on different commodities as compared with the similar period for 1903, the percentages being as follows: Dressed beef 44 per cent.; canned meats 16 per cent.; other meats 19 per cent.; lard 30 per cent.; barreled pork 43 per cent.; beef packages 56 per cent. There is also more or less interchange of products between the packing centers, yielding a considerable traffic in the aggregate, which has shown a marked decrease. The percentages of decrease at Chicago for the several commodities listed above, for the same periods, were 34.5 per cent. for dressed beef, 33 per cent. for canned meats, 37 per cent. for lard, 21 per cent. for barreled pork, and 42 per cent. for beef packages. The items of "other meats," as might have been expected, increased to a total of 21 per cent.

Another strike loss is that sustained by the switching roads at the different packing house points. At Chicago all cars into and out of the stock yards are handled by a single terminal company, whose losses during the strike will be proportional to the decrease in the number of cars received and despatched. But the net current losses are probably somewhat less than the foregoing figures would indicate, due to the efforts of many of the smaller, and so-called independent, packers and butchers, whose business is not included in the market reports, to meet the demand created by the strike.

## TRADE CATALOGUES.

*The Wellman-Seaver-Morgan Company*, Cleveland, Ohio, sends a booklet containing an explanation of what it does. This company carries on a general engineering and manufacturing business, such as designing and building new plants, modernizing old plants, designing and building special equipments, etc. In fact, anything from the taking of the ore out of the mine to turning it into completed product. The booklet is illustrated throughout with a number of half-tones showing various installations made by the company. Illustrations are also given of the Wellman-Street steel car and truck bolster.

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*Rodger Ballast Car Company*, Chicago, has prepared a neat little pamphlet entitled "Useful Hints About Railway Cars," the type discussed being the Rodger ballast Hart convertible design. The discussion is presented under seven heads, viz., adaptability, economy, simplicity, durability, practicability, special work, and details. It is followed by views and cross-sections of the different classes of cars, which include the World's Fair type, 150 of which are now used to haul coal to the Exposition. Their load limit is 110,000 lbs. and their cubic capacity 2,300 cu. ft. The Rodger double plow distributing car is also shown.

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*The Kennicott Water Softener Company*, Chicago, has reprinted and issued in pamphlet form the article on "Water Softening on the Union Pacific," by A. K. Shurtleff, Assistant Engineer of the road, printed in the *Railroad Gazette*, June 24, 1904. The pamphlet is 9x12 and is printed in two colors on heavy cream-colored paper. A large half-tone view of some one of the Union Pacific softeners faces each reading page, and the front cover appropriately bears the Union Pacific emblem in colors.

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*The Gisholt Machine Company*, Madison, Wis., has sent us the first five pages of its new bulletin. Accompanying these leaves is a neat cover in which to bind them, as well as future leaves which the company proposes to publish. Illustrations and descriptions of various machines made by the company including its big bore turret lathes are shown. A detailed description of the method of machining different pieces of work, as well as illustrations of the work done on these machines, is also given.

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*Jenkins Bros.*, New York City, have just issued a booklet bearing the title "Valve Troubles and How to Avoid Them." The first part is devoted to the difficulties encountered in the installation and use of valves, and suggestions for the remedy of these difficulties. The balance of the book is devoted to illustrations and descriptions of the principal valves made by this firm, including a transparent half-tone which shows the construction of the "excelsior" straightway back pressure valve.

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*The Abner Doble Company*, San Francisco, Cal., sends a pamphlet descriptive of its tangential water wheels. These wheels are made to operate under high heads of water and are provided with patented ellipsoidal buckets. A detailed description and illustrations of the different parts of the wheel are given. There is also a line drawing showing a 160 h.p. water wheel direct connected to a 100 k.w. Crocker-Wheeler generator.

This machine runs at 700 r.p.m. under a pressure of 300 lbs. per sq. in.

*The S. Obermayer Company*, Pittsburg, issues its August bulletin. It contains an interesting article on "The Locomotive Industry," by Frank Fayant, which is the first of a series to appear, and the paper on "Labor-Saving Suggestions for the Foundry," by H. F. Frohman, read at the Indianapolis meeting of the American Foundrymen's Association. It also contains other miscellaneous matter of interest to foundrymen. The publication of the Bulletin at Pittsburg was begun with this number.

*The Ingersoll-Sargeant Drill Company* sends an illustrated pamphlet bearing the title "Before and After." Two illustrations are given showing the North Amherst quarry of the Cleveland Stone Co. before and after the installation of a central compressed air plant. Comparative costs are given for operating the machinery in this quarry by steam and by compressed air, which shows a daily saving of $164.95 in favor of compressed air.

*The Baltimore Gas Machinery Company*, Baltimore, Md., is issuing a pamphlet descriptive of its suction gas producers. The pamphlet contains a number of facts which are of interest to those who use gas engines. A complete description and general drawing of the machine is given. An itemized comparison of the cost of power produced by electricity, city gas, gasoline, steam with soft coal and Producer with anthracite coal are also given.

*The Engineering Company of America*, New York City, issues a pamphlet called "Concrete Construction." It is bound in an appropriate colored cover and contains an interesting preliminary treatise on concrete and concrete construction. Illustrations of buildings and bridges constructed of concrete are given as well as line drawings showing the different methods of re-enforcing concrete with steel.

*The Steel Car Forge Company*, Pittsburg, has just issued a new illustrated catalogue of forgings for steel and wooden freight cars, mine and special forgings, and chain manufactured at its works at Ellwood City, Pa. It is 6 x 9 inches in size, printed on plate paper with cover stamped in gold. There are about 40 pages of illustrations and descriptive matter conveniently indexed for reference.

*The Worthington* steam-hydraulic accumulator is described in Bulletin 100 published by Henry R. Worthington, New York City. This device consists of an ordinary steam cylinder combined with a ram cylinder similar to that of a weighted hydraulic accumulator, and is applicable to all purposes requiring the storage of water under high pressure.

*The General Construction Company*, Seattle, Wash., has issued a catalogue descriptive of the Bewsher sand pumps and gold dredging machinery. This catalogue is intended for those who are interested in "placer mining." It is illustrated throughout with both half-tone and line drawings.

*The Barnett Equipment Company*, Newark, N. J., sends a pamphlet describing the "Barnett Connector." This is a device which automatically couples the air, steam and signal hose and the safety chains between the cars. A full page half-tone illustration of the device is shown.

*R. D. Wood & Company*, Philadelphia, Pa., have issued a pamphlet bearing the title "Gas for Power and Fuel." A description and illustrations of Producer gas power plants are given. Also a short description of "Mond Gas" and of gas producers for metallurgical use.

*The B. F. Sturtevant Co.*, Boston, has issued a new economizer catalogue. This contains the details of the Sturtevant standard and pony types of economizers, and also treats of the subject of mechanical draft and natural draft. It should be of interest to all steam users.

*The Betts Machine Company*, Wilmington, Del., sends a catalogue of boring and turning mills. About 18 machines of this type are illustrated and described. The attachments used on these machines are also shown in detail.

# CONTRIBUTIONS

## Collisions Caused by Misreading Train Orders.

To the Editor of the Railroad Gazette:

I have read your note of August 5, page 207, calling attention to Government Bulletin No. 11, which records four seemingly unnecessary collisions in 12 months resulting from failure to observe the word "second" in train orders. Before I can bring myself to believe that all of these orders were misread by the men in responsible charge of the trains, and also by the brakemen and firemen, such fact will have to be positively asserted. It is improbable that this number was covered by the thumb of every one of these men while scrutinizing the orders. In a former communication (*Railroad Gazette*, April 8, page 265,) I called attention to the fact that many officials are opposed to the practice of one man reading an order to another, on account of the many disasters that have resulted from so doing. Many men have omitted words or read orders in a way that would give the listener an impression not warranted by the language of the orders; wrong impressions which would have been at once noticed and, no doubt, corrected, if each man had been required to himself carefully scan his instructions. Hearing an order misread often lodges an impression in the mind that a personal inspection may not efface. Then there is always the chance that after hearing an order read the listener may pocket it without taking the precaution to look it over. It is regrettable that we have not the facts at hand to show whether or not in cases of this kind the orders complained of were read by all of the men employed on the train, or whether some of them were only told of the contents of the orders. Were they read to the engineman by the conductor and then handed to the fireman, or did the fireman content himself with hearing the orders read and allow his engineman to retain them without demanding that they be given to him to read? What possible objection can there be to each man reading orders, instead of having them read to him? Quite likely the orders would be afterward discussed and any possible misunderstanding thus corrected.

The writer is an enthusiastic supporter of the Revised Code, but when under those rules any particular kind of accident becomes abnormal and it can be shown that modification will reduce the list the plain lesson is to continue revising until trains can be safely moved, regardless of preconceived opinions. Rules theoretically sound are execrable if in practice it be demonstrated that collisions have not been materially checked by their use. If it is a fact that some known safe practice has been discontinued merely to economize telegraphing perhaps it would be wise to take a little more time, even if here and there an extra $300 or $400 a month must be expended for another set of despatchers. After a superintendent has cleared up a few wrecks which have resulted from strict adherence to Code rules he cannot be blamed if he becomes a warm advocate of revision. You remember the story of the Irishman in jail: To him, the beautifully logical deductions of his attorney, showing that he could not be placed behind the bars were of no comfort; he was in durance vile notwithstanding, and was principally concerned in gaining his liberty.

There is a growing conviction that a mistake was made when the word "section" was dropped from the rules. On roads that have departed from the former practice of spelling figures in duplicate there would be strong opposition to the suggestion that the custom be returned to, but it is doubtful if many would object to the word "section." If a train order were to instruct that 2d No. 1 (too commonly written 2d 1) would run one hour late, the section named is often the first word written near the upper left hand corner of the blank and is so situated that it may be easily overlooked or hidden; there is not so great likelihood of this occurring if the word "section" follows "2d." As "section" will make the order fully as clear as if the number of the section were to be spelled out, and is a word that will be generally acceptable, it is to be hoped that, beginning at once, it will hereafter be inserted in orders.

In all fairness, it must be admitted that while this particular phase of the matter may be thus substantially remedied there yet remains an opening for error if a 3 is mistaken for a 5, or 4 for 6, when trains bearing these numbers are on a district at the same time. Perhaps the rule hardest for hundreds of railroad officers to accept with equanimity is the one directing that time be expressed only by figures. Yet few accidents have occurred through overlooking the time in orders, or because the figures were so badly formed that they were misread. It is decidedly safer to express 10 by numerals only than to also spell it out, (10 ten). This sometimes creates the impression that a train has until ten minutes after the hour to make a station.

H. W. FORMAN.

## Excessive Charges for Icing Refrigerator Cars.

The Interstate Commerce Commission, in an opinion by Commissioner Prouty, has announced its decision in the matter of charges for the transportation and refrigeration of fruit shipped from points on the Pere Marquette and the Michigan Central, a case involving refrigeration charges on cars furnished by the Armour Car Lines.

The Commission holds that in the transportation of fruit from points in Michigan it is the common law duty of the railroad companies to furnish refrigerator cars for such service; that they may provide such cars by purchase or by lease, and if the latter plan is adopted they may make contracts with one company which exclude the use of cars owned by other companies; that carriers should, in the opinion of the Commission, be legally compellable to furnish ice for the refrigeration of refrigerator cars

used upon their lines, but if it is not part of the obligation of a common carrier to provide such refrigeration, when the carrier does furnish it and at the same time prohibits the shipper from obtaining it from any other source, the charge for refrigeration is part of the total charge for transportation furnished by the carrier, and must be reasonable; and that when charges for refrigeration are applied in the transportation of perishable freight, such charges should be published and adhered to exactly as all other transportation charges are published and observed.

## Have Railroad Rates Advanced?*

No one denies that for certain specific freight services the railroads now collect more than they would have received for carrying the same tonnage on the same articles between the same places in the year 1898. That this fact means that railroad charges are now actually higher than formerly is, however, open to serious question. Every one knows that the value of money, no less than that of commodities and services, is subject to fluctuation and comparisons of prices, wages or rates which leave these fluctuations out of the account are always defective and may be seriously misleading. Fluctuations in the value of money are measured by fluctuations in prices which are stated in terms of money. Reduce the prices of all commodities and services, giving each its proper weight, to general averages for successive years and these will express with precision the rise or fall in the value of the standard. The United States government has undertaken to do this, within practicable limits, through the Department of Labor and the movement of wholesale prices is portrayed by a series of index numbers compiled under the thoroughly competent direction of Carroll D. Wright. Comparing the yearly averages for all commodities with an average for the decade from 1890 to 1899 and stating the results as percentages the Department gives the following results:

| Year. | ALL COMMODITIES. Price. |
|---|---|
| 1898... | 93.4% of average for decade 1890 to 1899 |
| 1899... | 101.7% of average for decade 1890 to 1899 |
| 1900... | 110.5% of average for decade 1890 to 1899 |
| 1901... | 108.5% of average for decade 1890 to 1899 |
| 1902... | 112.9% of average for decade 1890 to 1899 |

In other words the purchasing power, with reference to commodities in general, of $1.12 in 1902 was no more than that of 93 cents in 1898. One million dollars of railroad revenue in 1898 would have purchased as much in general commodities as $1,208,779 in 1902. Of course the reverse of this would be true unless railroad rates, as stated in money, had advanced; that is, had there been no changes in the figures of the rate schedules the average quantity of commodities required to pay for a given transportation service would have been much less in 1902 than in 1898. As a matter of fact there have been changes in the railroad rate schedules and these have taken up a part of the reduction in the value of the money in which railroad charges are paid. By no means all of the reduction, however, has been offset in this manner. In 1902 it would have required $1,208,779 to purchase as much in general commodities as $1,000,000 would have bought in 1898, but for $1,208,779 in 1902 the railroads would have carried 159,680,185 tons of freight or 60,865,005 passengers one mile, while in 1899 for $1,000,000 they would have carried 138,121,547 tons of freight or 51,948,052 passengers the same distance. If these figures are clearly apprehended volumes could not tell more. They mean that in order to obtain the same command over commodities, i.e., the same purchasing power, the railroads had to perform 15.61 per cent. more freight transportation and 17.17 per cent. more passenger transportation in 1902 than in 1899.

In the following table the receipts per passenger-mile and per ton-mile have been reduced to index numbers similar to those adopted by the Department of Labor and the results stated in parallel columns with the index numbers to which the Department has reduced wholesale prices.

*Wholesale Prices and Rates Compared with Averages for the Decade from 1890 to 1899—Percentages.*

| | Railroad Rates. | | Wholesale Prices. | | | |
|---|---|---|---|---|---|---|
| Years. | Passenger Rates. | Freight Rates. | Food, etc. | Cloths and clothing. | Fuel and lighting. | All commodities. |
| 1890-99. | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1890... | 105.7 | 112.2 | 112.4 | 113.5 | 104.7 | 112.9 |
| 1891... | 104.4 | 106.7 | 115.7 | 111.3 | 102.7 | 111.7 |
| 1892... | 103.7 | 107.0 | 103.6 | 109.0 | 101.1 | 106.1 |
| 1893... | 102.8 | 104.6 | 110.2 | 107.2 | 100.0 | 105.6 |
| 1894... | 96.8 | 102.5 | 99.8 | 96.1 | 92.4 | 96.1 |
| 1895... | 99.5 | 100.0 | 94.6 | 92.7 | 98.1 | 93.6 |
| 1896... | 98.4 | 96.1 | 83.8 | 91.3 | 104.3 | 90.4 |
| 1897... | 98.6 | 95.1 | 87.7 | 91.1 | 96.4 | 89.7 |
| 1898... | 96.2 | 89.7 | 94.4 | 93.4 | 95.4 | 93.4 |
| 1899... | 93.9 | 86.3 | 98.3 | 96.7 | 105.0 | 101.7 |
| 1900... | 97.7 | 86.9 | 104.2 | 106.8 | 120.9 | 110.5 |
| 1901... | 98.1 | 89.4 | 105.9 | 101.0 | 119.5 | 108.5 |
| 1902... | 96.8 | 90.2 | 111.3 | 102.0 | 134.3 | 112.9 |

The foregoing shows that while the average price of each group of commodities was higher in 1902 than the average for the decade used as the basis both the passenger rates and the freight rates of the railroads were lower than the basis.

The price quotations used by the Department of Labor are secured from all sections of the country and are in 260 series representing an equal number of commodities. Separate comparisons with the ten-year average are given for each commodity and thus the price of every one of the 260 articles may be compared with railroad rates. Such comparisons show that the prices of all but 20 of the articles had advanced in 1902 to relatively higher figures than freight rates and those of all but 45 to relatively higher figures than those attained by passenger rates. The following table shows for each of the nine different classes of commodities the volume of railroad service which could have been purchased in 1902 by the sum which would have been realized in that year from the sale of a quantity sufficient, at the average prices and rates of the decade from 1890 to 1899, to have paid for, respectively, 1,000,000 passenger-miles and 1,000,000 freight-ton-miles.

1.—Passenger miles, purchasable in 1902 for quantitity of commodity indicated sufficient to have paid for 1,000,000 passenger-miles at prices and rates of 1890-1899.

2.—Freight-ton-miles purchasable in 1902 for quantity of commodity indicated sufficient to have paid for 1,000,000 ton-miles at prices and rates of 1890-1899.

| Classes of commodities. | 1. | 2. |
|---|---|---|
| Farm products | 1,348,140 | 1,446,785 |
| Food, etc. | 1,149,793 | 1,233,925 |
| Cloths and clothing | 1,053,719 | 1,130,820 |
| Fuel and lighting | 1,387,397 | 1,488,914 |
| Metals and implements | 1,210,744 | 1,299,335 |
| Lumber and building materials | 1,227,273 | 1,317,073 |
| Drugs and chemicals | 1,179,752 | 1,266,075 |
| House furnishing goods | 1,159,091 | 1,243,902 |
| Miscellaneous | 1,178,719 | 1,264,967 |
| All commodities | 1,166,322 | 1,251,663 |

The foregoing shows that the same quantity of an average commodity in any of these groups would pay for from 5.37 to 48.89 per cent. more railroad transportation at the prices and rates in force during 1902 than at the average prices and rates of the years 1890 to 1899. These figures settle the question whether there has been an actual advance in railroad charges with a distinct and unquestionable negative.

Among the heaviest expenditures of the railroads, aside from wages, are those for fuel and rails. In the fiscal year 1902 the former item represented an expenditure of $120,074,192 and the latter one of $16,952,102. Taking prices for George's Creek coal at the mines as the standard it appears that from 1898 to 1902 bituminous coal advanced 132.88 per cent. from 91.25 cents to $2.125 per ton. During the same time steel rails increased in price 58.87 per cent. from $17.625 to $28.00 per ton. At the prices of 1898 the fuel and ties which cost, together, $137,026,294 in 1902, would have cost but $62,230,967. If the railroads paid for these two items of their necessary supplies out of their freight revenues the expenditures, at the rates and prices of 1902, represented the movement of 18,101,227,741 tons of freight one mile while at the rates of the fiscal year 1899 and the prices of the calendar year 1898 they would have represented but 8,595,437,431 ton-miles. If paid for out of passenger revenues the cost in service in 1902 was equal to carrying 6,899,611,984 passengers one mile as against 3,232,777,506 passenger-miles in 1899.

So far this paper has been restricted to the brief period of four years within which Mr. Prouty asserts that railroad exactions have added greatly to the burdens of the people. It has been shown that not only is this not the case but that within the period in question producers of all classes have seen their products increase in price as compared with railroad transportation so that the latter is now relatively cheaper than in 1898 or 1899, which is equivalent to saying that rates are lower than ever before.

The only criticism of the statistics and arguments herein presented that is worthy of consideration is based upon the assertion that the passenger-mile and ton-mile units have been so modified by commercial changes that the revenue averages related to them no longer constitute a reliable indication of the changes in the general level of railroad charges. This criticism is as unsound as the contention which it is intended to support. The growing geographical concentration of industry and the increased importance of domestic manufactures, together with the augmented consuming power of the masses of the people which has been a direct consequence of unparalleled industrial activity, has given to the railroads an increasing proportion of high-grade traffic. The same causes have also resulted in enhancing the relative importance of local business. Westward-bound freight has for several years been far heavier in proportion to eastward-bound than ever before. All these things mean that there has been a decided rise in the quality of the ton-mile unit. In other words the payment per average unit is for a service of much higher and better quality than it was in the earlier years for which comparisons have been presented. Of course no one questions the improvement in the average unit of passenger service.

*Extract from a paper in *Gunton's Magazine*, by H. T. Newcomb.

## Compound Locomotives in France.

Mr. A. Mallet, the originator of a type of locomotive bearing his name, and well known the world over as a locomotive designer, in discussing the recent paper of M. Sauvage (see *Railroad Gazette*, April 8 and May 20, 1904,) calls attention to the part which he has had in the development of the modern four-cylinder balanced compound. He writes as follows:

He said that 25 years ago (June, 1879,) he read a paper on the compounding of locomotives, giving the results obtained in that way since 1876. The question was quite new at that time, and, so far as could be judged from the discussion that took place, the general impression amongst the members present at the meeting, save Mr. F. W. Webb, was that the subject offered but little probability of a definitive success. The author,

on the contrary, expressed a great deal of confidence in the future of the compound locomotive and the results have fully proved that he was right in his expectation. In 1879, there were a dozen compound locomotives, all of which were of moderate or small size. Their number to-day is more than 18,000 and amongst them are included the largest engines ever built. In Russia, as an instance, compound engines constitute one-half the total number of locomotives.

Mr. Mallet was delighted at the success of the four-cylinder locomotive as largely used on French railroads. In fact, he believed he was in some measure entitled to credit for having been the first to point out the essential features of that type of engine, that is to say, the coupling together of axles, one being worked by a pair of h.p. cylinders and the other by a pair of l.p. cylinders. Such an arrangement was described by him in a paper read in 1877 before the French Society of Civil Engineers. It is only in 1888-89 that the principle was put into practice on the French roads, as the first de Glehn four-cylinder locomotive built in 1889 had not the driving axles coupled together and thence no balancing effect could be obtained. It was, in some measure, roughly speaking, a Webb compound engine with the l.p. cylinder divided in two, otherwise it was an improvement as regards the facility of starting and the regularity of the turning moment. At that time, the use of four cylinders with distinct working gears was yet considered as a substitute of coupling rods, as shown in several early designs.

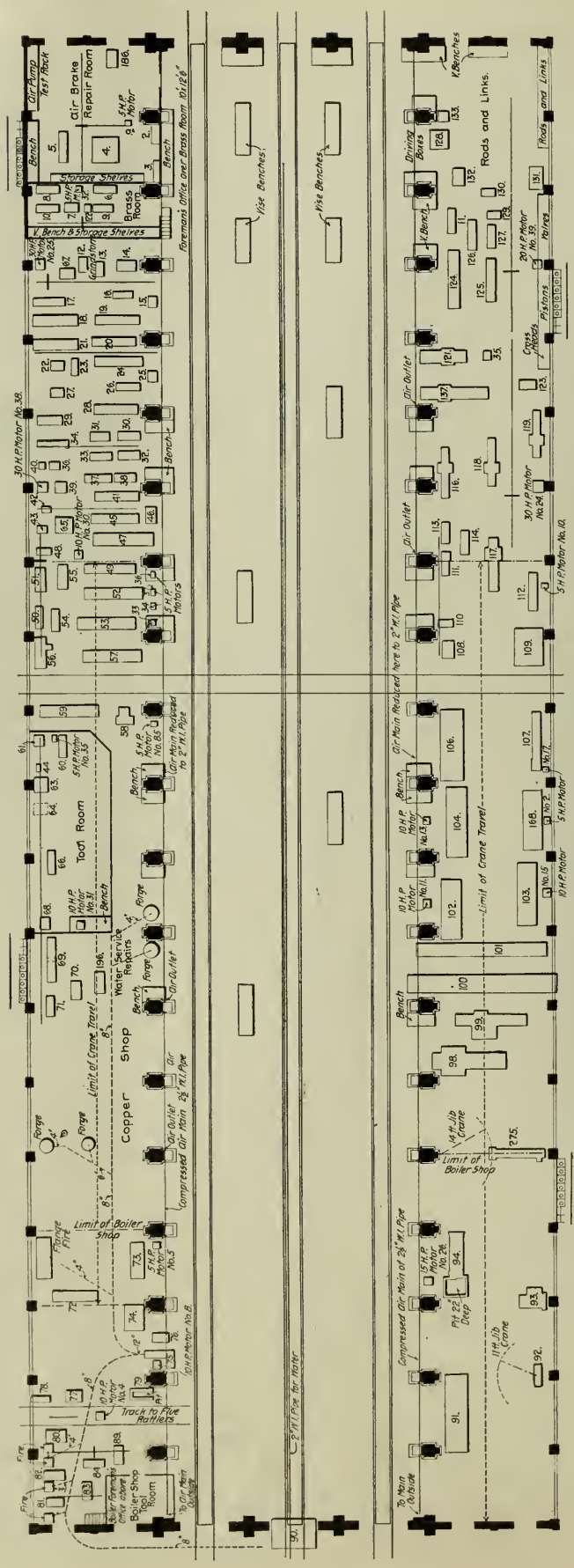
Mr. Mallet did not claim much personal experience about quick reversing engines. He has worked in another direction—the slow speed, high traction power locomotives But he made a few remarks about some details of the four-cylinder engines, to which Mr. de Glehn attaches much importance; that is to say, the intercepting valve for starting and the independent reversing gear. Mr. Mallet is not prejudiced against these features that he was the first to use in two and four-cylinder locomotives, but he thought that if these details are suitable for two-cylinder compound locomotives, they introduce, without any necessity, when used in four-cylinder locomotives, an unavoidable complexity, and, what is more, the possibility of mismanagement on the part of the engine driver, etc.

Mr. Mallet called attention to a paper on the development of the compound locomotive by A. Von Borries in the Transactions of the American Society of Mechanical Engineers, 1893, which said that "the arrangement of working one set of drivers by a pair of h.p. cylinders and another set by a pair of l.p. cylinders, the two sets of drivers being coupled or not, placed in the same rigid frame or in two articulated frames was first mentioned in Mr. Mallet's memoir of 1877, p. 958, and therefore the engines should be classed under the head of Mallet's system."

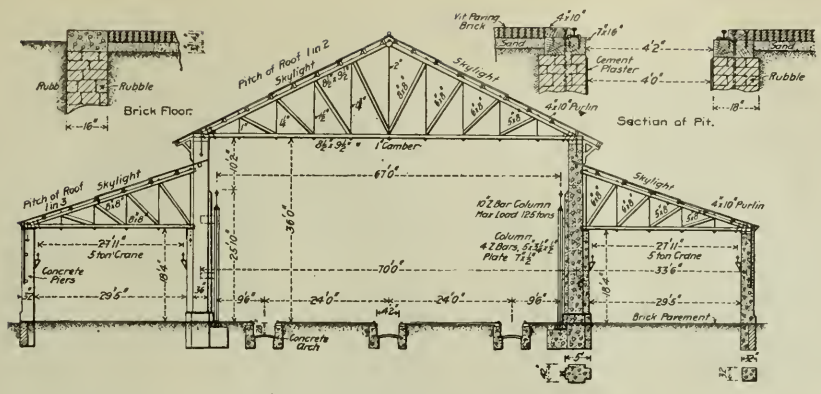
## The Mexican Central Shops at Aguascalientes.—III.

BY C. T. BAYLESS.

*Machine, Boiler and Erecting Shops.*—The machine, boiler and erecting shops occupy a building 400 ft. long by 140 ft. wide. This building has a center bay and two side bays as shown in the illustration; the center bay has three longitudinal tracks running through it. These connect at each end to the yard tracks. The center and both side bays for a distance of five panels or 100 ft. at the north end form the boiler shop, the erecting shop occupies the remaining 300 ft. of the center bay, and the machine shop is located in the side bays on each side of




General Plan of Machine, Boiler and Erecting Shop, Showing Location of Tools.




Section through Machine and Boiler Shop.

the erecting shop. Provision has been made for an extension of this building at both ends.

The construction of this building is quite different from any that has been illustrated recently, and is only possible in a climate that is not subject to cold. Both the roof and sides of the building are made of corrugated galvanized iron nailed directly to the purlins in the first case, and to stringers let into the columns in the second. Below this galvanized iron, the sides of the building are entirely open for 7 ft. 4 in. above the ground. The ends also are furnished with large door openings. These, together with the space between the roofs of side and center bays furnish a great deal of the natural lighting and all the ventilation that is necessary, and do away with the question of heating and ventilation which is so important in the United States. Further lighting is supplied by roof skylights of ribbed glass over all bays.

The ends and all columns of this building supporting the roof are of solid concrete built into place by using forms which were detached as rapidly as the concrete hardened. The columns supporting the runway girders of the large cranes are built up of 10 in. steel Z bars and anchored to the concrete columns at two different heights. The roof trusses are all of yellow pine. The machine and erecting shop has a floor made of vitrified brick laid on edge on top of a 3¾ in. layer of sand; the boiler shop has a dirt floor, tamped hard.

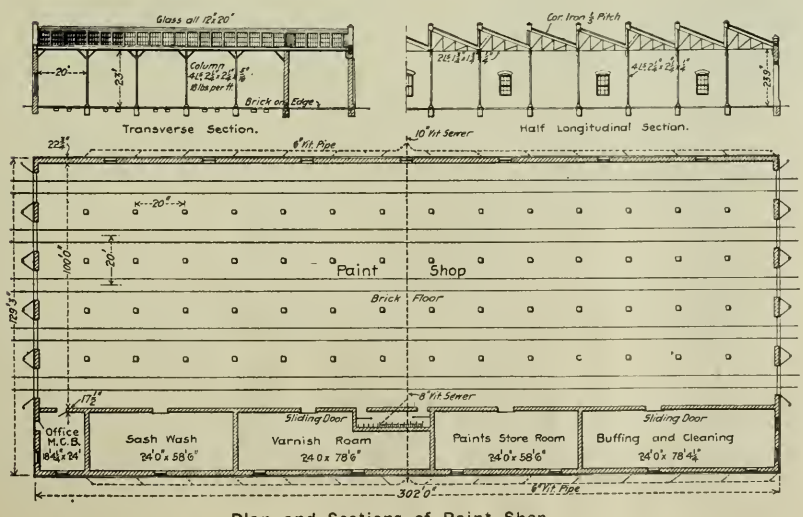
The engine pits are 24 ft. on centers and extend the full length of the center bay. They are 4 ft. 2 in. wide, with side walls of rubble masonry faced with cement and an arched bottom of concrete. Three drains are provided, one at each end and one at the center, the depth of pits at drains being 34 in. and at highest point between drains 28 in. On top of the rubble side walls are laid 7 in. x 16 in. creosoted yellow pine stringers, lapped at the ends and bolted to the walls with ¾ in. anchor bolts. The rails are spiked to these stringers and 4 in. x 10 in. creosoted timbers form the finish between the brick floor and the rails. Two cross tracks are provided, one in the second panel of the boiler shop extending from the center pit outside of the buildings to the flue rattlers, and the other across the building at the ninth panel from the south end. This latter track connects with the roundhouse drop pit, so that wheels may be brought in to the wheel lathes.

Typical Group Drive in Machine Shop.

The arrangement of machinery in the boiler and machine shop is shown in the illustration. The light machine tools are driven in groups from short line shafts by motors varying in size from 30 h.p. to 10 h.p. They are for the most part located at the south end of the shop in both the east and west bays, but there is also a group of light tools in the extreme northeast corner of boiler shop section, and the water service repair and tool room group. The heavy tools are all individually driven, and with the exception of the 84 in. quartering machine and the 84 in. boring mill, are all old tools arranged for motor drive by the railroad. The four largest motors driving groups of tools, numbers 24, 25, 38 and 39 are supported on frames 7 ft. 6 in. high located against the columns of the building. By this arrangement the motors are not so exposed to dirt and injury as when placed on the floor, and at the same time are more accessible than if they were placed on the roof trusses. The smaller motors are placed overhead on the roof trusses, as in case of repairs they are lighter and can easily be lowered to the floor.

There are two tool rooms, one for boiler shop tools and a general tool room, which together with the room for the making of small brass parts and the air-brake repair room, are enclosed to prevent theft. The enclosing partitions consist of matched boards for a height of 4 ft. 0 in. above the floor, and wire netting of No. 11 wire, 1 in. mesh, above the netting, while permitting ventilation and entrance of light, effectually prevents stealing. In all the contract machine shops in Mexico City the employees are systematically

End Elevations of Paint Shop.




Plan and Sections of Paint Shop.

searched both when they leave at noon and night, this being the only way to prevent petty thieving. The railroad shops have not followed this practice and suffer in consequence. Frequently passenger cars are robbed of their brass journal bearings even when standing in the paint shop. Cast and malleable iron shells with a brass crown and heavy babbitt lining have been used on freight equipment for a good many years in order to prevent the theft of solid brass bearings.

The accompanying table gives a list of the tools that are electrically driven and sizes of motors used.

The side bays are spanned by five-ton traveling cranes made by Maris Brothers, the east bay having one crane with a travel of 11 panels, and the west bay two cranes traveling 13 panels. The cranes have a span of 27 ft. 11 in. from center to center of runway rails, with bridges built of two 15 in. I-beams. The hoist is provided with both mechanical and electric brakes. Hoisting speed with full load is 15 ft. per minute. In addition to these light cranes the double punch and shear No. 92 and the large single punch No. 275 are each provided with jib cranes which swing under the traveling crane and are operated by hand.

Spanning the center bay are two 60-ton, 4-motor electric traveling cranes made by the Niles-Bement-Pond Company. They are 76 ft. from center to center of runway rails and have a lift of main hook of 24 ft. Each crane is provided with a 10-ton auxiliary hoist.

Along both sides of the center bay are compressed air mains of 2½ in. pipe for half the length of the bay and reduced to 2 in. for the remainder. These air mains rest on the top anchors which hold the steel columns of crane runways to the concrete piers, and have outlets of 1 in. pipe extending down the side of each column in the boiler shop section and every other column in the erecting section. These outlets end in a standard Westinghouse hose coupling with an angle cock just above coupling. This permits an easy connection for hose leading to air hammers, drills, etc.

When an engine is brought in for heavy repairs, the tender is first disconnected and run in on the tracks leading to the tank shop and the engine is set on the center pit at the south end of the shop. As the engine is stripped the parts are placed on racks just east of the building. After stripping the 60-ton cranes lift the engine off the wheels and set it down on blocks on any one of the three pits. The wheels are put on the cross track by the crane and either run out east of the shop for storage or taken in at once to the wheel lathes. An engine is finished as much as possible at the place where it was originally set down by the crane. After the wheels are run under and connected up the engine is removed by the cranes to one of the side pits at the south end of the shop, receives its tender, is fired up, and run out on the yard tracks to be broken in.

*The Coach Paint Shop.*—This building which is shown in Fig. 2, was designed to be used as a coach paint shop only, but as the coach repair shop, located to the north of it, has not yet been built, it is at present used for both coach repair and paint shop. As a result, the capacity of the shop is somewhat overtaxed, as all the general coach repair and painting for the system is done here.

This building, 129 ft. 3 in. wide x 302 ft. long outside, is closed in completely to prevent the entrance of dust and is provided with a saw-tooth roof to get the necessary light, which enters from the north. The walls are of adobe, plastered, with brick

INDIVIDUAL MOTORS.

| Tool No. | Description. | Method of Driving. | Motor No. | H.-P. of Motor. |
|---|---|---|---|---|
| 49. | 42-in. Engine lathe | Motor geared to countershaft | 36 | *2 V. 5 |
| 52. | 48-in. Engine lathe | Motor geared to countershaft | 37 | 2 V. 5 |
| 53. | 48-in. Engine lathe | Motor geared to countershaft | 34 | 2 V. 5 |
| 57. | 48-in. Engine lathe | Motor geared to countershaft | 33 | 2 V. 5 |
| 58. | 51-in. boring mill | Motor geared to countershaft | 85 | 2 V. 5 |
| 59. | 48-in. Engine lathe | Motor belted to countershaft | 35 | 2 V. 5 |
| 73. | 60-in. Radial drill | Motor geared to countershaft | 5 | 5 |
| 75. | No. 6 Sturtevant blower | Motor belted to countershaft | 8 | 10 |
| 85. | Flue rattler | Motor geared to machine | 12 | 10 |
| 92. | Double punch and shear | Motor geared to machine | 74 | 10 |
| 93. | No. 3 shear | Motor geared to machine | 29 | 10 |
| 94. | 10-ft. bending rolls | Motor geared to countershaft | 26 | 15 |
| 275. | No. 7 punch | Motor geared to machine | 28 | 15 |
| 98. | 72-in. x 72-in. planer | Motor geared to countershaft | 64 | 2 V. 15 |
| 99. | 48in. x 48-in. planer | Motor geared to countershaft | 23 | 2 V. 10 |
| 102. | 79-in. driver lathe | Motor geared to countershaft | 11 | 2 V. 10 |
| 103. | 79-in. driver lathe | Motor geared to countershaft | 15 | 2 V. 10 |
| 104. | 79-in. driver lathe | Motor geared to countershaft | 13 | 2 V. 10 |
| 168. | Car wheel lathe | Motor geared to countershaft | 2 | 2 V. 5 |
| 106. | 84-in. quartering machine | Silent chain drive | 1 and 40 | 3 each |
| 107. | Wheel press | Motor geared to machine | 17 | 5 |
| 109. | 84-in. boring mill | Motor geared to machine | 94 | 2 V. 10 |
| 180. | Axle lathe | Motor geared to countershaft | 10 | 2 V. 5 |

*2 V. = two voltage.

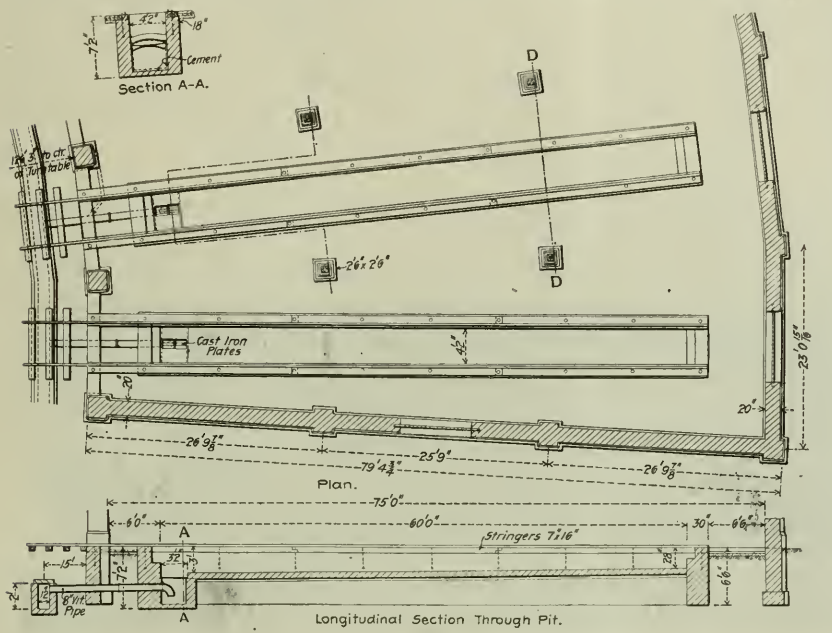
GROUP DRIVEN.

| | | | | |
|---|---|---|---|---|
| | **Air-Brake Repair Room, Group "A."** | | | |
| 186. | Pipe cutter | Motor belted to lineshaft "A" | 9 | 5 |
| 4. | Air-brake repair machines on bench | | | |
| 5. | 17-in. engine lathe | | | |
| | **Brass Room, Group "B."** | | | |
| 6. | Fox brass lathe | Motor belted to lineshaft "B" | 32 | 5 |
| 7. | Brass miller | | | |
| 8. | Fox brass lathe | | | |
| 9. | Fox brass lathe | | | |
| 10. | Fox brass lathe | | | |
| 122. | 12-in. sensitive drill | | | |
| | **Group "C" and "D."** | | | |
| 12. | Grindstone | Motor belted to lineshaft "C," which is connected by belt to lineshaft "D." | 25 | 30 |
| 13. | 15-in. shaper | | | |
| 67. | No. 3 milling machine | | | |
| 14. | 12-in. shaper | | | |
| 15. | Guide grinder | | | |
| 16. | 18-in. shaper | | | |
| 17. | 16-in. engine lathe | | | |
| 18. | 24-in. engine lathe | | | |
| 19. | 24-in. engine lathe | | | |
| 20. | 24-in. engine lathe | | | |
| 21. | 24-in. engine lathe | | | |
| 22. | Forming lathe | | | |
| 23. | Grindstone | | | |
| 24. | 24-in. engine lathe | | | |
| 25. | Guide grinder | | | |
| 26. | 16-in. engine lathe | | | |
| | **Group "E" and "F."** | | | |
| 27. | Forming lathe | Motor belted to lineshaft "E," which is connected by belt to lineshaft "F" | 38 | 30 |
| 28. | 36-in. engine lathe | | | |
| 29. | Stud lathe | | | |
| 30. | 17-in. engine lathe | | | |
| 31. | 17-in. engine lathe | | | |
| 32. | 17-in. engine lathe | | | |
| 33. | 12-in. engine lathe | | | |
| 34. | 17-in. engine lathe | | | |
| 36. | Centering machine | | | |
| 37. | 17-in. engine lathe | | | |
| 38. | 16-in. engine lathe | | | |
| 39. | Emery grinder | | | |
| 41. | 36-in. engine lathe | | | |
| 42. | Bolt cutter | | | |
| 43. | Bolt pointer | | | |
| 45. | 36-in. engine lathe | | | |
| 46. | Grindstone | | | |
| 47. | 42-in. engine lathe | | | |
| 40. | Oil separator | | | |
| | **Group "G."** | | | |
| 48. | 20-in. shaper | Motor belted to lineshaft "G," which is carried by brackets bolted to columns and is below crane | 30 | 10 |
| 50. | 32-in. drill press | | | |
| 51. | 36-in. drill press | | | |
| 54. | 32-in. drill press | | | |
| 55. | 36-in. drill press | | | |
| 56. | 60-in. radial drill | | | |
| 65. | 3-in. spindle drill | | | |
| | **Tool Room, Group "H."** | | | |
| 44. | Yankee drill grinder | Motor belted to lineshaft "H" | 31 | 10 |
| 60. | 32-in. drill press | | | |
| 61. | Double wet emery grinder | | | |
| 63. | B. & S. universal grinder | | | |
| 66. | 16-in. tool room lathe | | | |
| 68. | B. & S. miller | | | |
| | **Water Service Repairs:** | | | |
| 69. | 24-in. engine lathe | | | |
| 70. | 32-in. drill press | | | |
| 71. | 12-in. shaper | | | |
| 196. | Pipe cutter | | | |
| | **Group "J," "K" and "L."** | | | |
| 77. | 30-in. drill press | Motor belted to lineshaft "J," which is connected by belt to lineshafts "K" and "L" | 4 | 10 |
| 78. | Flue cutter | | | |
| 80. | Flue welder | | | |
| 82. | Flue welder | | | |
| 83. | Three-head bolt cutter | | | |
| 84. | One-head bolt cutter | | | |
| 89. | Stay-bolt swage | | | |
| | **Group "M" and "N."** | | | |
| 108. | 12-in. slotter | Motor belted to lineshaft "N," which is connected by belt to lineshaft "M" | 24 | 30 |
| 110. | Grindstone | | | |
| 111. | 60-in. radial drill | | | |
| 113. | 16-in. engine lathe | | | |
| 114. | 16-in. engine lathe | | | |
| 116. | 30-in. x 30 in. planer | | | |
| 137. | 36 in. x 36 in. planer | | | |
| 121. | 36 in. x 36 in. planer | | | |
| 35. | Centering machine | | | |
| 123. | Grindstone | | | |

Group "O."

| | | | | |
|---|---|---|---|---|
| 124. | 30-in. engine lathe | Motor belted to lineshaft "O" | 39 | 20 |
| 125. | 36-in. engine lathe | | | |
| 126. | 16-in. engine lathe | | | |
| 127. | 16-in. engine lathe | | | |
| 129. | 15-in. shaper | | | |
| 130. | 20 in. shaper | | | |
| 131. | 50-in. drill press | | | |
| 132. | 15-in. slotter | | | |
| 11. | 32-in. boring mill | | | |

Horse power of all motors driving machine tools is ..... 341
Horse power of crane motors..... 292½
Total horse power of all motors in building. 633½

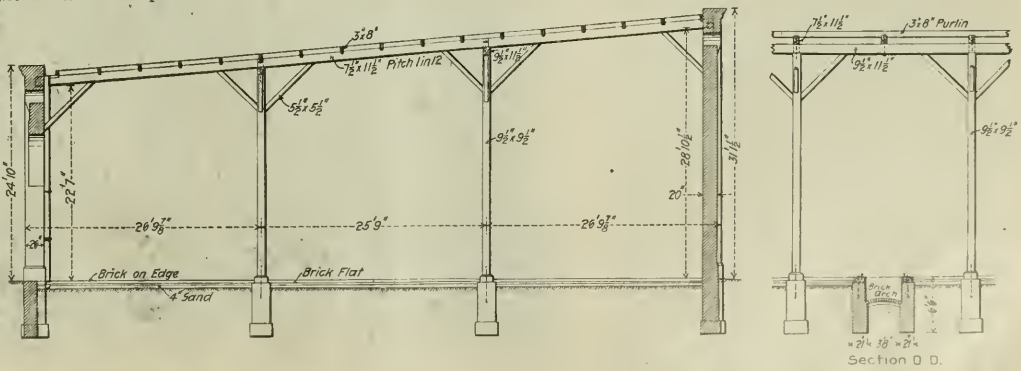



Part Plan of Roundhouse and Section through Pit.

pilasters and brick trimmings around the windows and doors. The roof trusses and interior supporting columns are made of steel angles. The roof is of galvanized iron the same as all the other buildings. Five longitudinal tracks, spaced 20 ft. center to center, traverse the building and connect at both ends to the yard tracks. The floor is made of vitrified brick, set on edge and laid on 4 in. of sand. Rooms along the west side of the building are used for the Master Car Builder's office, sash washing, varnishing, paint storeroom, and for buffing and cleaning. These, of course, are at present used also by the coach carpenters, who will go to the coach repair shop as soon as it is built. At the north end of the paint store room for the distance of one panel, or 20 ft., a small room devoted to the manufacture of mineral brown paint is partitioned off. The iron ore is obtained in bulk, and is crushed, ground, sifted and mixed up into mineral brown paint for freight cars. This paint machinery is driven by a 10 h.p. motor, No. 92.

*Roundhouse.*—Provision has been made for a roundhouse with 56 stalls and one with 25 stalls, but at present only a section of the former containing 12 stalls has been built. The construction of this roundhouse is somewhat novel, all the walls being of concrete. The roof slopes towards the center with a pitch of 1 in 12. It was originally made of galvanized iron but it did not take long for the gases from the engines to destroy this and it was relaid with 1 in. pine boards covered with asphalt roofing paper. This has given complete satisfaction. Wood smokejacks are used and all the engines head into the house. In the walls just below eaves of roof are openings for ventilation and 8 ft. x 12 ft. windows are put in the outside wall in line with each pit. The entrances for engines are 12 ft. wide and 17 ft. 4 in. high. They are concrete arches resting on 2 ft. 2 in. square concrete columns. The pits are 60 ft. long in the clear with 12 in. added at each end for a step. Their side walls are of concrete with 7 in. x 16 in. stringers laid on top and anchored to them with ¾ in. bolts. The bottoms are brick arches and slope towards the center. The house is served by a 60 ft. turntable, designed and patented by C. L. Strobel, Chicago.

Roundhouse—Company Houses and Hospital in the Background.




Section through Roundhouse.

## Discipline.*

On most of our railroads to-day the Division Superintendent is charged with the responsibility of conducting investigations and applying discipline; in this he is assisted by the Trainmaster. "Blue Monday" or "Court Day" is looked upon by the average employee with fear and trembling. He fears the result if he tells the truth, and he trembles, fearing that he may be found out if he does not tell the truth, so he approaches the Superintendent with the full determination of consolidating his feelings by telling as little as possible, and accepting the consequences. It is at this point where the average disciplinarian fails; not because he is not con-

*Extracts from a paper by J. B. Yohe, General Superintendent of the Pittsburgh & Lake Erie, read before the Railway Club of Pittsburg, May 27.

scientious in his efforts to do justice, not because he lacks the courage of his convictions, but rather because the truth is withheld, and he must render his decision upon circumstantial evidence. Where a board of inquiry is appointed to conduct investigations and apply discipline it usually consists of one officer from each department. It is thought that under this plan more facts are gleaned, and under the intelligent questioning of the examining board the employee is made to feel that if he tells the truth, the whole truth and nothing but the truth, he will receive justice. This system also has some objectionable features, the most notable being the disposition on the part of heads of departments to "saddle it onto the other fellow," and many a "Blue Monday" has been enlivened by a struggle between representatives of the transportation, mechanical and maintenance departments. However, the result is usually satisfactory to all concerned, and the employee generally accepts the decision of a board of inquiry with better grace than he would that rendered by any single individual, and there is also less liability of the case being appealed to a higher official.

All investigations, whether conducted by individual or board, should be fair and impartial, the decision reached should be based upon the evidence produced, and the sentence imposed without fear or favor, always, however, tempering justice with mercy.

Mr. Yohe then went on to refer to the merits of Brown's discipline, quoting from Mr. Brown's book on the subject, and continuing said:

A most thorough education on the part of employees as to the principle involved is absolutely necessary before the Brown system could be effectually introduced, and to properly educate on these lines railroad companies should have the training of their subjects from the day they enter railroad service. On roads that select their employees from the farm hands and country boys living along their line, the matter of education is comparatively easy, and any form of discipline, properly understood, could be intelligently enforced. On roads that are compelled to select their employees from those who have seen service on, or have been dismissed from other railroads, and who are also compelled to reinforce their numbers from the floating element of railroad men, many of whom place but little estimate on the value of their positions, the question of education is far more serious, and experience has convinced me that in dealing with this latter class, the manager who insists upon his men being given a fair and impartial trial, and then imposes discipline by actual suspension or dismissal, obtains the best results.

The greatest care should be exercised by the official charged with the duty of conducting investigations. He should be a man of wide experience in railroad service, one tireless in his efforts to secure all the facts in the case, willing to go over the ground personally, if necessary, so as to "put himself in the other man's place," and if, perchance he should discover that the one under suspicion has performed his duty to the best of his ability and understanding, he should not hesitate to overlook the offense, but first have a "heart to heart" talk with his man alone in his office, pointing out to him the effect of the accident on the reputation of his company, and on his own reputation as a railroad official. On the other hand, if, after a careful personal investigation it is found that the one being investigated has misrepresented his case, made false statements, or withheld facts, he should be punished by actual suspension, or, if the circumstances warrant such a course, be dismissed. If extreme penalty is imposed it should be final.

The speaker ended by giving, as an example to be emulated, a specimen of the discipline dealt out by President Lincoln, telling how he showed mercy to a soldier who had been sentenced to be shot for sleeping at his post.

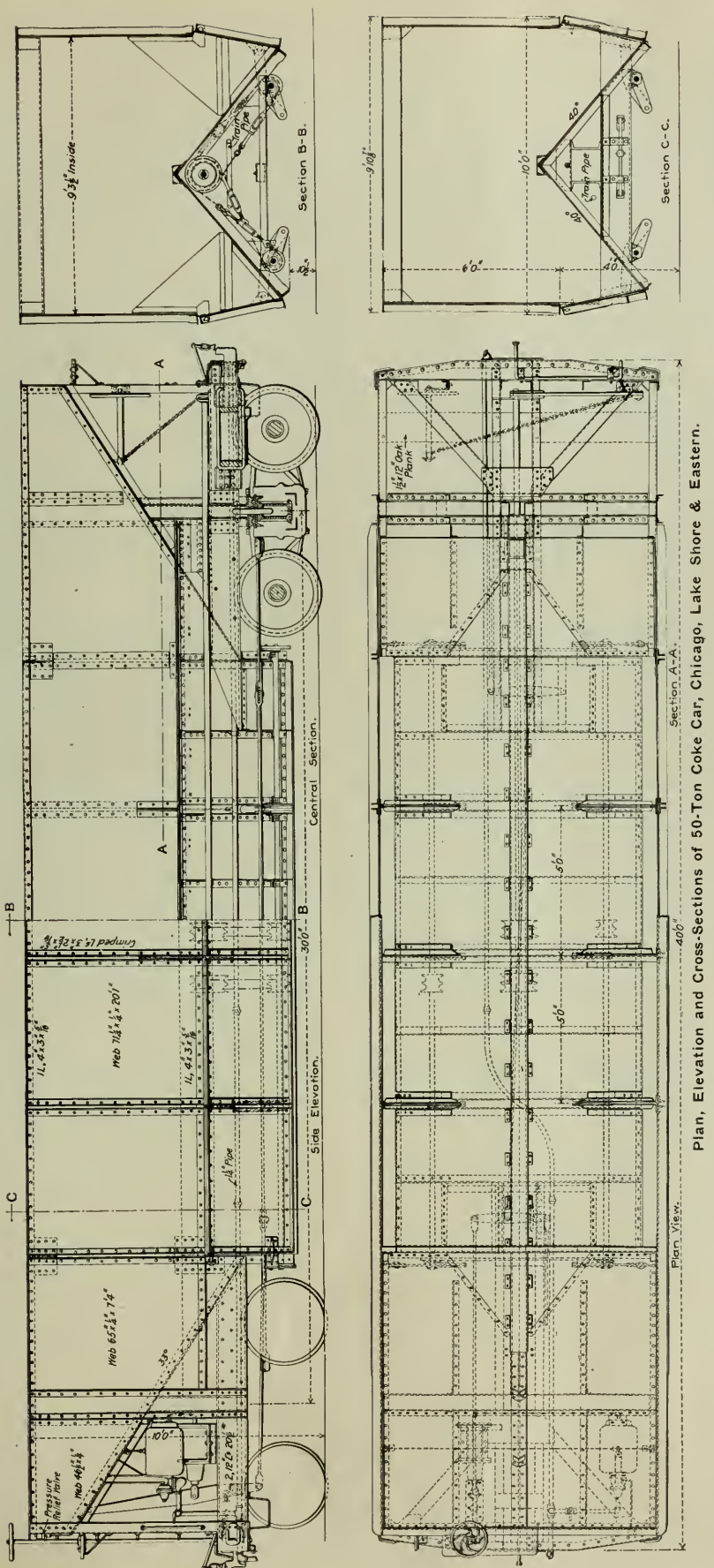
## 100,000-lb. Coke Cars for the Chicago, Lake Shore & Eastern.

The Chicago, Lake Shore & Eastern has had in service for about a year a number of 100,000-lb. coke cars, which in design are similar in many ways to the steel coke cars of the Pennsylvania Lines West described a year ago (*Railroad Gazette*, June 26, 1903). The dimensions of these cars are somewhat smaller than the Pennsylvania car, being 40 ft. over end sills, 10 ft. high from rail to top of side, 39 ft. 10 in. long inside, and 9 ft. 3½ in. wide inside.

A distinguishing feature of the design is the absence of continuous center sills. The floor supports the load as well as transmitting all buffing and pulling stresses. It is composed of ¼-in. web plates riveted at their adjoining edges to a 4-in. x 4-in. x ¾-in. angle, and to triangular frames of angles spaced 2 ft. 6 in. apart. The base member of these frames is a 3-in. x 3-in. x $^{5}/_{16}$-in. angle, and the sides, which extend 1 ft. $1^{11}/_{16}$ in. beyond the base, are 4-in. x 3-in. x $^{5}/_{16}$-in.

Self-Clearing 50-Ton Coke Car, Chicago, Lake Shore & Eastern.

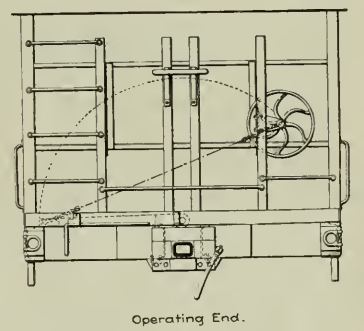
Operating End of Car, Doors Open.




angles. Connection to the side girders is made by gusset plates, three on each side, formed of two bent plates spaced 4¼ in. apart to provide an opening for the door-operating latch, and riveted along their upper edge to the top gusset which is a single plate.

The center sills are 12-in., 30-lb. channels, 12 ft. 4 in. long with flanges out. The inner ends are cut at an angle to conform to the slope of the floor and are tied together and to the floor by a sill plate 31 in. x $^{5}/_{16}$ in. x 5 ft. 3½ in. riveted to the bottom flanges and to the floor web plates. Bent plates are also riveted to the top flanges and to the apex angle of the floor. Transverse floor girders at each end of the door openings, formed of 12-in., 20-lb. channels, are riveted to the bottom flanges of the center sills.

The body bolster and support for the overhang of the hopper floor are combined in a deep box girder, as shown in the drawings. The web plates of the girder are bent at the top to fit the slope of the hopper, to which they are riveted, the inner plate having a bend sufficient to overlap the bend of the outer plate. One set of rivets passes through both plates and the hopper floor. Holes are cut through the webs for the center sills, to which the bolster is secured by bent plates. The bolster is stiffened over its center plate by two vertical Z-bars riveted to both webs and having two of their legs adjoining. Additional vertical stiffening is




**End Elevation of 50-Ton Coke Car.**

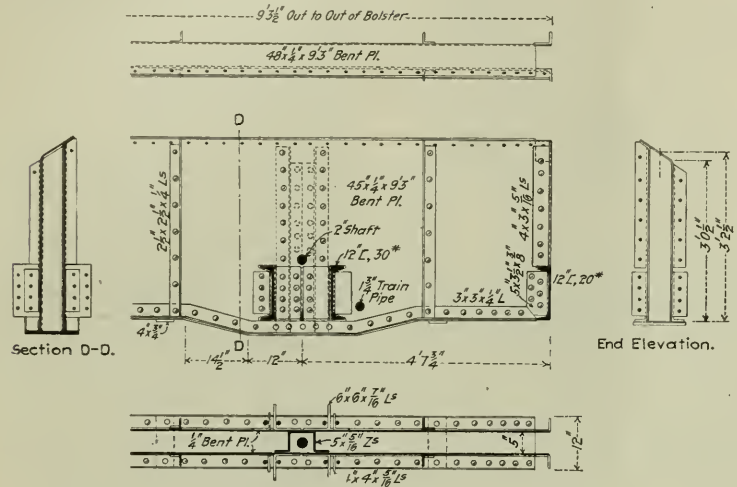
provided by angles spaced 2 ft. 4½ in. each side of the center.

The end sills are 12-in., 20½-lb. channels, with flanges turned in, and bent backward at a point 2 ft. 7¾ in. from each end to give an end displacement of 5 in. A top cover plate is riveted to the flange and is bent up 5 in. for riveting the end framing. The end sill is cut out at the bottom to a depth of 6¼ in. for the coupler shank, the opening being reinforced with straight and bent plates securely riveted to the channel web. Diagonal braces extend from the outer ends of the end sill to a connection with a plate riveted to the top flanges of the center sills just in front of the body bolster.

The side girders are tied together at the top with three channels, the one at the center being a 10-in., 15-lb. channel, and those on each side of it 8-in., 11¼-lb. channels. The doors are 19 ft. 11½ in. long and 2 ft. 10½ in. deep. The operating mechanism consists of a central shaft running the length of the car below the apex of the floor, with two sheaves on it near the center, around which chains pass to smaller sheaves on auxiliary shafts on opposite sides of the car near the bottoms of the doors. Fastened to each of these latter shafts are five latches, connected to the adjacent door. The form of these latches may be seen in the cross-sections. At one end of the car there is an arm on the central shaft, its normal position being horizontal. A chain passes from its outer end to a horizontal chain-shaft above it and on the opposite side of the car. Turning the

hand-wheel on this shaft winds up the chain, lifts the lever and opens the doors. A runway, made of a 7-in., 9¾-lb. channel, with the flanges down, is placed above the apex of the floor, being supported by bent plates riveted to the latter. The cars have Westinghouse friction draft gear, Simplex bolsters and Barber trucks, and weigh approximately 47,500 lbs. Practically all of the material used is commercial shapes. There are 265 of the cars in service.

Although designed primarily for coke service, the car will handle coal, stone, iron ore




Detail of Body Bolster for 50-Ton Coke Car.

and other similar coarse freight to advantage. For capacity loads of coke, racks 24 in. high are provided. In testing the car for time of unloading, 49 tons of coke were dumped in 45 seconds. With coal and stone, capacity loads were dumped in one to one and a half minutes. Wet ore, which adhered to the sides of the car and was heavy, took a maximum time of eight minutes. One of the cars was in an accident and received a blow severe enough to break the sills at the end and damage the draft rigging. The floor stood the shock without apparent injury.

## Train Accidents in the United States in July.[1]

dn, 1st, Norfolk & Western, Kenova, W. Va., a freight train became uncontrollable on a steep descending grade and ran off the track, demolishing two boarding cars and injuring 12 workmen who were in the cars.

dn, 1st, Susquehanna & New York, Laquln, Pa., a string of 19 cars of logs and one car containing a log loader were bumped by a string of three empty cars, and, becoming uncontrollable on the steep grade, ran at high speed toward Towanda. After running a short distance the string of cars broke into three parts and the last part, consisting of the three empty cars, was overtaken by an engine which pursued them. The front portion, consisting of five cars, ran to Monroeton, 12 miles, where it was turned on to a side track and ditched, notice having been sent to the agent by telegraph. The middle portion, consisting of 12 cars, was thrown off the track as it crossed the bridge over Schrader's Creek, near Barclay, and with the bridge, which was a wooden one, fell to the creek below. The engine and three cars, following, approached the bridge too fast to be stopped, and plunged into the wreck at the bottom of the creek. The men on the engine jumped off and saved themselves.

bc, 2nd, Minneapolis, St. Paul & Sault Ste. Marie, Tony, Wis., westbound passenger train No. 7 ran into an eastbound freight train, badly damaging both engines, three freight cars, one baggage car and one mail car. A postal clerk and two tramps were killed, and the engineman, three trainmen and 12 passengers were injured.

eq, 2nd, Pennsylvania road, Roxburg, N. J., a freight train was derailed by a broken axle and 20 cars were thrown down a bank and wrecked. Two trainmen were killed.

bc, 3rd, 8 p.m., Chicago, Burlington & Quincy, Lytles, Wis., butting collision between a stock train and a switching engine, wrecking both engines and several cars. The engineman of the switching engine was killed. It is said that this engine had run past a train order signal set against it.

unf, 3rd, 5.36 p.m., Wabash road, Litchfield, Ill., a southbound passenger train running at full speed was derailed at a misplaced switch, and the engine, baggage car and first three passenger cars were wrecked. The engine was turned completely around, and the combination baggage and smoking car was stood upon end. A number of freight cars on a side track were knocked over and demolished. The wreck took fire at once and seven of the nine cars in the train were burnt up. Twenty-one passengers and three employees were killed and 45 passengers were injured, the bodies of some of the killed being destroyed by fire. The coroner's jury which investigated the wreck reported that the switch had been disconnected from its stand, and the officers of the road have no doubt that it had been tampered with. The last preceding train (a passenger train) had passed it only about 40 minutes before the disaster, and the switch had not been used in the intervening time.

rc, 5th, Ruffin, N. C., fast mail train No. 97 ran into the rear of a preceding work train, damaging the engine and wrecking two freight cars. The fireman was injured.

bc, 5th, Wisconsin Central, Rugby Junction, Wis., butting collision between a freight train and an empty engine, wrecking both engines and several cars. One trainman was killed and four other trainmen were injured.

†bc, 5th, Philadelphia & Reading, Frankford, Pa., butting collision of passenger trains, wrecking both engines and damaging two cars. One passenger was killed and two were injured, one of them fatally. The southbound train had run only about a quarter of a mile from its starting point. The northbound train had disregarded a telegraphic meeting order. At the inquest the engineman admitted that he confused two orders. "He said he merely glanced at them, thinking the customary instructions regarding train 901 were in the order." When nearing Frankford, however, the brakeman asked to see the orders and pointed out the mistake. The air-brakes were then put on, but it was too late. Another witness at the inquest said the two men would not have lost their lives if they had not jumped from the car. The jury refrained from censuring the conductor and engineer, who had already been punished by dismissal.

†5th, Colorado Springs & Cripple Creek District, Cameron, Colo., the rear car of a passenger train, which became uncontrollable while being switched, ran some distance to a curve, where it was overturned and wrecked. Three passengers were killed and 60 were injured.

uuf, 5th, Chicago, Peoria & St. Louis, Oakford, Ill., a passenger train was struck by a cyclone and the cars were lifted off the track and tumbled down a bank. The baggageman was killed and 12 passengers and three employees were injured.

*eq, 6th, Chicago & North Western, Woodbine, Iowa, a freight train was suddenly stopped by an automatic application of the air-brakes, due to some defect, and two cars were thrown off the track and fell across the rails of the adjacent track. A freight train on the latter track ran into the wreck. The broken cars at once took fire and 17 of them, with their contents, were burnt up. One man was killed and two others were injured.

unf, 7th, Ohio Central, Bellefontaine, Ohio, a freight train was derailed by running into a washout, and the engine and five cars fell into a creek. Five trainmen were injured.

xc, 8th, 11 p.m., Wabash road, Detroit, Mich., collision of passenger trains running at low speed, one of the trains running backward. One sleeping car was overturned. Two passengers were injured.

8th, Atchison, Topeka & Santa Fe, Mendon, Mo., mail train No. 7 was derailed at a point where the track had been weakened by rain, and the tender, four baggage cars and one mail car fell down a bank. Two trainmen and one trespasser were injured.

unx, 9th, Raleigh & Cape Fear, Raleigh, N. C., a passenger train was derailed and one car was overturned. Forty passengers were injured, most of them slightly.

†rc, 10th, 10 a.m., Erie road, Midvale, N. J., a special excursion train standing at the tank was run into at the rear by a following regular passenger train, crushing the rear car of the standing train and damaging the engine and several other cars. Sixteen passengers were killed and more than 60 were injured. The point at which the collision occurred was only 470 ft. beyond a block signal which, it appears, had not been thrown to the stop position after the passage of the special train and therefore indicated "all clear" to the following train. The investigation developed the fact that the flagman of the standing train was out only a very few car lengths. He had an opportunity to go back a much greater distance.

10th, Missouri Pacific, Labadie, Mo., an excursion passenger train was derailed and two passenger cars were thrown down a bank, turning over twice before they reached the bottom. Two other cars were also derailed and 17 passengers were injured. It is said that a wheel of the tender rode the point of a switch.

unx, 12th, Cincinnati, New Orleans & Texas Pacific, Oakdale, Tenn., passenger train No. 3 was derailed and one trainman was killed.

†13th, 8 p.m., Chicago & Eastern Illinois, Glenwood, Ill., a northbound excursion passenger train, running on the southbound track to get around an obstruction, collided with a part of a freight train which had been moved southward on the southbound track, contrary to orders, and the first three cars of the excursion train were crushed. Eighteen passengers were killed and 25 or

[1] Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defect of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

more injured, most of them being members of a Sunday school, for which the excursion was run. This collision was reported in the *Railroad Gazette* of July 22 and August 5. At last accounts Engineman Hoxie, who moved the freight cars, could not be found. He disappeared within a day or two after the collision.

13th, Cleveland, Cincinnati, Chicago & St. Louis, Sharon, Ohio, the engine and several cars of a freight train, while crossing a bridge on a side track, broke through the bridge and were wrecked. The fireman and one brakeman were killed and the engineman was severely scalded.

13th, Louisville & Nashville, Crestview, Fla., a freight train which had become uncontrollable on a steep descending grade was derailed, apparently by the breaking of the flange of a wheel of the engine, and the whole train, consisting of the engine, nine cars of lumber, and a caboose, was ditched and wrecked. One brakeman was killed and the engineman, fireman and conductor were injured.

13th, Chicago, Rock Island & Pacific, Havana, Ark., eastbound passenger train No. 2 was derailed and broke through a bridge, the mail car and smoking car falling to the creek below. Eight passengers and four trainmen were injured.

unx, 14th, Grand Trunk, Gorham, N. H., an eastbound passenger train was derailed and the engine and four cars fell down a high bank. One passenger, three trainmen and a mail agent were injured, the latter fatally.

unx, 14th, Southern Railway, Fayette, Ala., a passenger train was derailed and broke through a trestle bridge, the engine and first two cars being overturned. The engineman and fireman, mail clerk and express messenger were injured.

rc, 15th, Bessemer & Lake Erie, Fredonia, Pa., a special train ran into the rear of a preceding freight train; the superintendent of the road and two other men were injured.

unx, 15th, Atlantic Coast Line, La Pine, Ala., a pay car train was derailed, and one employee was killed.

bc, 15th, 5 a.m., Pennsylvania road, Shippen, Pa., butting collision between northbound passenger train No. 107 and southbound freight train No. 152, badly damaging three locomotives and wrecking the baggage car. Two firemen were killed and several other trainmen were injured. The freight had passed from double-track to single-track without right, the engineman having failed, in a dense fog, to keep a good lookout for the stopping place. He stopped soon after passing the switch but not soon enough to prevent the collision.

†unf, 16th, Eastern Texas, Druso, Tex., a passenger train was derailed at a point where the track had been weakened by heavy rains, and two passenger cars were overturned. One passenger was killed and two were injured, one of them fatally.

unx, 17th, Pennsylvania road, Portageville, N. Y., an excursion train was derailed and a tool house near the track was demolished by the derailed engine. Four passengers were injured.

unx, 17th, Southern Railway, Edmunds, S. C., a freight train running at high speed was derailed and several cars of fruit were wrecked. One brakeman was killed and another injured.

unx, 17th, Gulf, Colorado & Santa Fe, Dallas, Tex., passenger train No. 67 was derailed and eight of the nine cars in the train were ditched, two of them being wrecked. Of the 400 passengers on the train, only six were injured. The brakeman in the baggage car was crushed by an iron safe.

†unx, 18th, Illinois Central, Cold Springs, Miss., southbound passenger train No. 1 was derailed and four of the five passenger cars were overturned and fell down a bank. The conductor and 10 passengers were injured, one of them fatally.

dn, 18th, Boston & Maine, Portsmouth, N. H., an engine and five freight cars ran off the track at an open drawbridge and fell into Piscataqua river. Four trainmen fell into the stream and one of them was injured.

dn, 19th, Chicago & North Western, Stanwood, Iowa, an eastbound passenger train was derailed by a misplaced switch, badly damaging the engine and four cars and a building near the track. The engineman and fireman were killed and four other persons were injured.

bc, 22nd, Baltimore & Ohio Southwestern, North Vernon, Ind., a passenger train ran over a misplaced switch and into the head of a freight train standing on the side track, damaging both engines. One fireman was killed and three other trainmen were injured.

unf, 22nd, Central of Georgia, Statesboro, Ga., a freight train was derailed by sand which had been washed upon the track at a crossing and three train men were injured.

bc, 22nd, Chesapeake & Ohio, Blue Sulphur Springs, W. Va., rear collision of freight trains, damaging the engine and four cars. Three trainmen were injured. The leading train had been suddenly stopped, and the following section, ordered to run at cautionary speed, appears to have been following too closely.

unf, 22nd, Southern Railway, Franklin, Va., passenger train No. 9 was derailed by a car door which had fallen from a freight train and lay across the track. The engineman and fireman and a flagman riding on the engine were killed and the baggageman was injured.

eq, 23rd, Atchison, Topeka & Santa Fe, Kinsley, Kan., eastbound passenger train No. 6 was derailed by a brake-beam of the mail car which fell to the track. The express car and one passenger car were ditched. The express messenger was killed and several other persons were injured.

23rd, 11 p.m., Pennsylvania road, Atglen, Pa., an eastbound freight train on track No. 1 collided with a part of a westbound freight train which was switching on the main track, damaging both engines and several cars. A moment later a second eastbound freight train on track No. 2 ran into the wreck. Altogether three engines and 15 cars were spread across the four main tracks.

bc, 25th, Pennsylvania road, Delavan, N. Y., butting collision of freight trains, wrecking both engines and 20 cars. One engineman, one fireman and one brakeman were killed, and one engineman was injured.

26th, 3 a.m., Southern Railway, Boydton, Va., a passenger train was derailed by spreading of rails, and the tender, baggage car and two passenger cars were overturned. Ten passengers were slightly injured.

dr, 26th, Southern Railway, Jonesboro, Tenn., a freight train was derailed by spreading of rails and ten cars and two new "dead" locomotives were badly damaged. The man in charge of the new locomotives was badly injured and four trainmen less severely hurt.

26th, Baltimore & Ohio, Banning, Pa., a passenger train was derailed by a defective rail or switch and the dining car was overturned. Three passengers and two employees were injured.

eq, 27th, Chicago, Rock Island & Pacific, Godfrey, Colo., passenger train No. 5 was derailed by the breaking of an axle of the baggage car, and four passenger cars were overturned. Although the train was running at 35 miles an hour, it is said that the passengers in the overturned cars did not go into a panic, and only six of them were seriously injured.

†rc, 28th, St. Louis, Kansas City & Colorado, Jeffriesburg, Mo., rear collision of passenger trains; one passenger was killed and two were injured.

unf, 28th, Great Northern, Leavenworth, Wash., a freight train was derailed by a rock which had fallen upon the track, and the engine was ditched. The engineman was killed.

bc, 29th, Pennsylvania road, Sharpsville, Pa., butting collision between a passenger train and an empty engine, wrecking both engines and the foremost passenger car, which was next to the tender. The engineman of the passenger train was killed and the fireman fatally injured. Three other trainmen were injured. The empty engine was running on the time of the passenger without orders.

rc, 30th, Cincinnati, Hamilton & Dayton, Russellville, Ind., a heavy freight train ascending a grade was run into at the rear by a following light freight train. A fireman (off duty) was killed.

rc, 30th, St. Louis & San Francisco, Beaumont, Kan., a freight train ran into the rear of a preceding freight, wrecking the engine, caboose and two cars. The engineman was injured.

xc, 31st, 11 p.m., New York, New Haven & Hartford, New Haven, Conn., an eastbound passenger train collided with a freight train which was backing onto a side track, damaging the engine and several freight cars and throwing the passenger engine down a bank. The engineman was killed and the fireman injured.

31st, Glover, Ill., a freight train of the Chicago & Eastern Illinois ran into a freight of the Peoria & Eastern at the crossing of the two roads, wrecking several cars and ditching the engine.

unx, 31st, Louisville & Nashville, Boyles, Ala., a freight train was derailed and nine cars were ditched. One brakeman was killed.

## A Third-Rail Electric Heating System.

BY WILLIAM GREENOW, JR.

The formation of ice on the third rail is due to the difference in temperatures between the third rail and the atmosphere. As all metals are slow to respond or conform to these sudden changes, it is but natural that rain or moisture falling upon a thoroughly chilled rail, will quickly freeze and form a hard coating of ice, which is difficult to remove mechanically. This coating of ice, being an insulation of high resistance, effectively prevents the current from flowing to the collectors or shoes of the motor car, until the temperature of the rail rises above the freezing point.

To remove this coating of ice, many mechanical appliances, such as wire brushes and scrapers, have been employed, but without complete success, except in such instances where specially constructed scrapers or blades were brought to bear with enormous pressure upon the third rail. These pressures have been found to be prohibitive, however, as they not only damage the third rail by repeated cuttings, but also impair the stability of the insulator mountings.

The only effectual way to remove and even prevent these ice coatings is to heat the third rail by means of electricity. Plans have been suggested requiring a special form of rail section or a complication of connections and apparatus for the conversion of the electric current. No regard, however, has been given to the cost of these electric heating systems nor to their applicability to the T sections of third rail now in use.

The writer has devised a method which is applicable to the T rails now in use, whereby the temperature of the third rail can be quickly raised a number of degrees above the surrounding air, with an economical use of current.

The steel heating wire extends along the length of the third rail, from which it is insulated by porcelain bushings. It is securely held in position close under the rail head by wood strips, which also extend along both opposite sides of the rail, enclosing it. One end of the heating wire is directly connected to the third rail, while the other end is connected to the ground by a switch provided with a magnetic blow-out break and which may be operated electrically from any point to close and open the heating circuit. This heating wire is also provided at intervals with tubular, telescoping joints, which permit of its expansion and contraction, when heating and cooling. The wood strips serve to shield the rail from the wind and also to maintain the temperature of the rail when raised for a greater length of time.

The following data, proving the feasibility

of this system, was obtained from a series of tests made in the car yards of the Connecticut Railway & Lighting Company at Bridgeport, Conn., on different days during February and March, 1904, on a 70-lb. T rail, 30 ft. long, to which one heating wire was mounted in the manner already described. This wire was connected in series with a water barrel rheostat for purposes of test, showing clearly that the amount of current consumed by the rheostat and wire is equivalent to the amount of current consumed by a similar wire, half a mile long, heating a half mile of third rail.

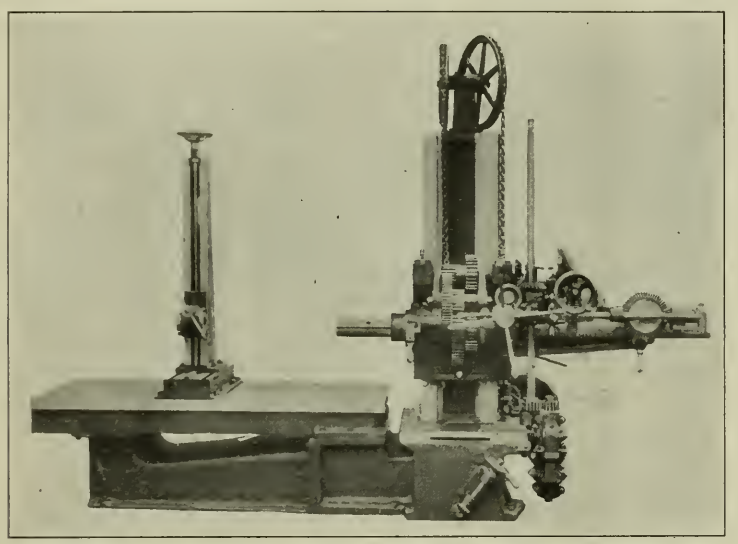


Fig. 1—The Fosdick Horizontal Boring and Milling Machine.

This rail was kept outdoors, where it was exposed to the weather under conditions similar to any installed third rail. The temperature of the air ranged from 15 deg. to 31 deg. F. during the tests. At times water was poured over the rail the night before to produce a thick coating of ice, for purposes of demonstration the following morning. I was assisted in making these tests by Messrs. W. T. Oviatt, Electrical Superintendent, and R. B. Davis, both engineers of the above railway company. The averages taken from all tests give: Temperature of air, 23 deg. F.; current consumed, 90 amperes at 500 volts pressure; time in which ice was melted, 12 to 15 minutes; rise in temperature of rail above 32 deg. F., 2 deg. to 19 deg.

When the temperature of the air was 15 deg. F., the temperature of the rail would in 15 minutes be raised to 34 deg. F., and 2 deg. above freezing, when melting of the ice would occur. This condition, however, is not a natural one and will not occur in practice, but serves to demonstrate the efficiency of the system and to what extent the temperature of the rail can be raised within the stated time. Again, when the temperature of the air was 31 deg. F., the temperature of the rail would be raised in 12 minutes to 50 deg. F., or 18 deg. above freezing. The temperature of the one heating wire employed in these tests was about 475 deg. F., according to calculations, consuming an electrical energy of 45,000 watts.

It was noticed that almost regularly within eight minutes after the heater circuit was closed the ice would crack and loosen from the rail, when it could be readily pushed off, and, four to seven minutes later at the end of 12 or 15 minutes' closed circuit, the ice would entirely disappear. Even thick slabs of loose ice placed upon the rail would quickly melt and drop away.

It is safe to assume that, by employing two heating wires, one each side under the rail head, requiring, however, twice the amount of current, the above results can be obtained in nearly half this time. After the current was cut off from the heating wire the temperature of the rail would continue to rise, after which it would be very slow in dropping back to its former normal condition, due no doubt to the protection afforded by the wood strips enclosing its web or sides. For obtaining correct rail temperature readings, the thermometer bulb was inserted in a hole drilled in the rail head; this hole was filled with quicksilver, to afford good metallic conductance to the bulb. A test tube was then slipped over the thermometer to exclude it from the air.

With this system I propose to heat half mile and single mile lengths of third rail with a continuous heating wire of corresponding unit length and resistance, whereby the temperature of the wire may be maintained between 450 and 500 deg. with an approximate current consumption of 45 to 90 k.w., respectively, and which, at two cents per k.w. per hour, for, say, 15 minutes, will represent an approximate cost of 23 cents for the removal of ice from one-half mile of third rail, and 46 cents for one mile. Greater unit lengths of heating wire than one mile would not be well or safe to recommend, the size or diameter of the wire reaching its maximum for that length owing to the limited space wherein it can be insulated and enclosed under the rail head.

This system may be applied and mounted to any T rail section without drilling holes in rail. The present rail-joint plates in use can be exchanged or replaced by a special form having a channel or groove for the reception and enclosure of the heating wire. The heat radiating from the wire is not so great as to char or discolor the wood groove, though in practice this groove could be lined with asbestos cement, which can be thickly applied with a brush before placing and securing the wood strips in position.

## Railroad Shop Tools.

*(Continued.)*

### HORIZONTAL DRILLING AND BORING MACHINES.

This type of machine is considered by many to be next to the lathe in usefulness. It is used for horizontally boring, drilling and facing, and is adapted to a great variety of work. Cylinders may be bored, faced on the flanges, drilled and tapped for studs with but one setting. Valve seats can be milled off and the ports cut out, while for driving boxes and other bearings a machine of this kind is very useful. The construction of these machines is such that work can be set rapidly and with ease. Owing to the different uses that these machines are put to it is important that they should have a wide range of speed and feeds. Although a number of builders make this type of machine, the general design is about the same, the several designs differing principally in size and in the details of construction.

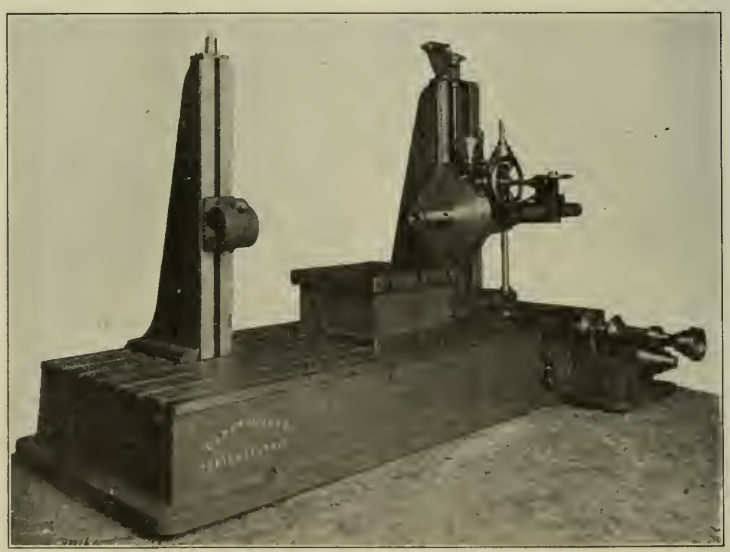
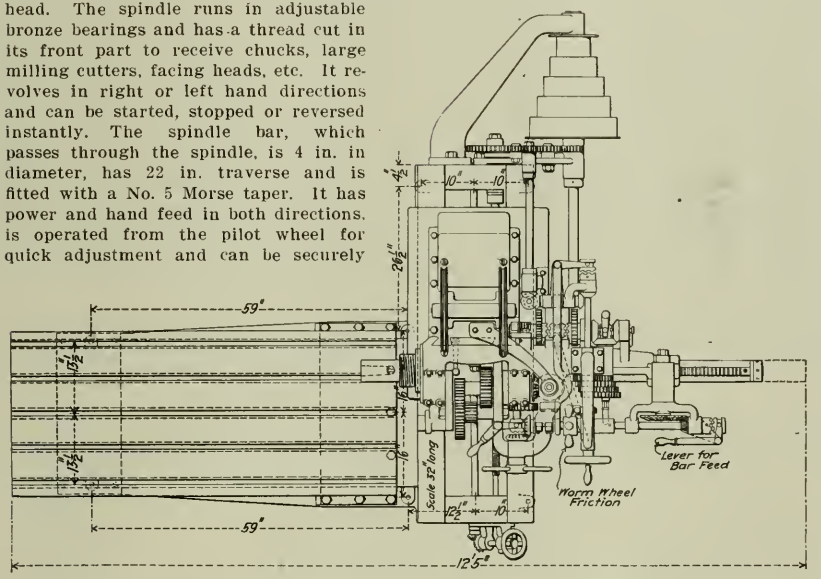


Fig. 3—The Espen-Lucas Horizontal Boring, Milling and Drilling Machine.

The horizontal boring, drilling and milling machine, shown in Figs. 1 and 2, is made by the Fosdick Machine Tool Company, Cincinnati, Ohio, and is used for boring, drilling, reaming, facing, milling, etc. The machine is driven by a splined shaft which trav-

erses the driving cone on the rear of the bed. The column carrying the spindle head has a horizontal movement on the bed by hand or power in both directions; also a quick forward and return motion by power operated by the handwheel on the front of the bed. The spindle head, which is counterbalanced and fitted with a safety chain, has a vertical movement on the column by hand or power in both directions, and for quick adjustment is operated by means of the pilot wheel on the front of the spindle head. The spindle runs in adjustable bronze bearings and has a thread cut in its front part to receive chucks, large milling cutters, facing heads, etc. It revolves in right or left hand directions and can be started, stopped or reversed instantly. The spindle bar, which passes through the spindle, is 4 in. in diameter, has 22 in. traverse and is fitted with a No. 5 Morse taper. It has power and hand feed in both directions, is operated from the pilot wheel for quick adjustment and can be securely clamped for face milling purposes. The back gears are on the spindle head, bringing the power direct to the work, thus relieving the outer shafts from unnecessary strain, and also reducing the vibration of the cutting tools to the minimum. The lever for operating the back gears is on the spindle head. These gears can be engaged or disengaged while the machine is running. The outer support for the boring bar can be clamped securely to the table and has horizontal and vertical adjustment. It is provided with graduated steel rules, as is also the face of the column and the bed, and the spindle sleeve is also graduated. The table in which the T slots are planed is stationary and bolted to the bed and base, insuring perfect alinement of the work. The horizontal feed of the column and of the spindle bar and the vertical feed of spindle head, are taken from the spindle. The feeds are positive geared and are eight in number. All feeds are reversible and can be operated by either hand or power, and are arranged in geometrical progression from .007 in. to ¼ in. per revolution of the spindle. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 r. p.m. The gear ratio from the cone driving shaft to spindle is 2⅔:1; that is, when the driving shaft makes 2⅔ revolutions, the spindle makes 1. The ratio of back gears is 13.6:1. All of the bearings are bushed with bronze. The bevel and miter gears are all planed from the solid. The maximum distance from the table to the center of the spindle is 44 in. The minimum distance is 8 in. The table is 31 in. x 72 in., and the distance from the top of the table to the floor is 22 in. The column has a horizontal adjustment on the bed of 32 in. The distance from the end of the spindle to the end of the bed is 12 ft. 6 in. The total height of the machine is 8 ft. and the net weight is 12,000 lbs.




The accompanying illustration (Fig. 3) shows the horizontal floor boring, milling and drilling machine made by the Espen-Lucas Machine Works, Philadelphia. This tool, while it conforms in its principal features to the more expensive and larger machines, is able to do the boring and a large amount of the milling heretofore necessarily done on the long milling machine. It covers a wide range and a great variety of work, being applicable to all kinds of boring, tapping, reaming and milling, such as key-seating long, heavy shafting in short places, which operation otherwise requires a larger machine. It can be used for face milling, with a rotary cutter head like a rotary planer, and will do all kinds of end milling and can be used for cotter drilling and cutting key-seats with end mill. Large castings can be placed on the platen and all work finished with but one setting.

The spindle, which is made of hammered crucible steel, is 4 in. in diameter and feeds through a gun metal sleeve. The boring bar has 24 in. feed, and has a No. 6 Morse taper hole in the end, also a pin hole for retaining the bars and milling tools in place. The head has a vertical adjustment of 30 in. and can be clamped in any position for milling. The column carrying the spindle head has automatic feed and quick return in both directions, giving a 42 in. horizontal movement to the spindle head for milling. The spindle has feed in either direction for boring and counterboring both ends of cylinders. The spindle is geared for heavy work and has a five-step cone, which gives 80 changes of feed and 20 changes of speed. The gearing is made of steel, cut from the solid, and the bearings are all lined with bronze. The machine can be built with plain or compound table, or with both. The platen is 42 in. x 84 in. The tail support is built with or without a horizontal adjustment. Adjusting screws and micrometer adjusting dials are also attached, if required. The countershaft is arranged so that the spindle can be run in either direction. The length and width of the table and also the length of movements in all directions can be increased to suit requirements.

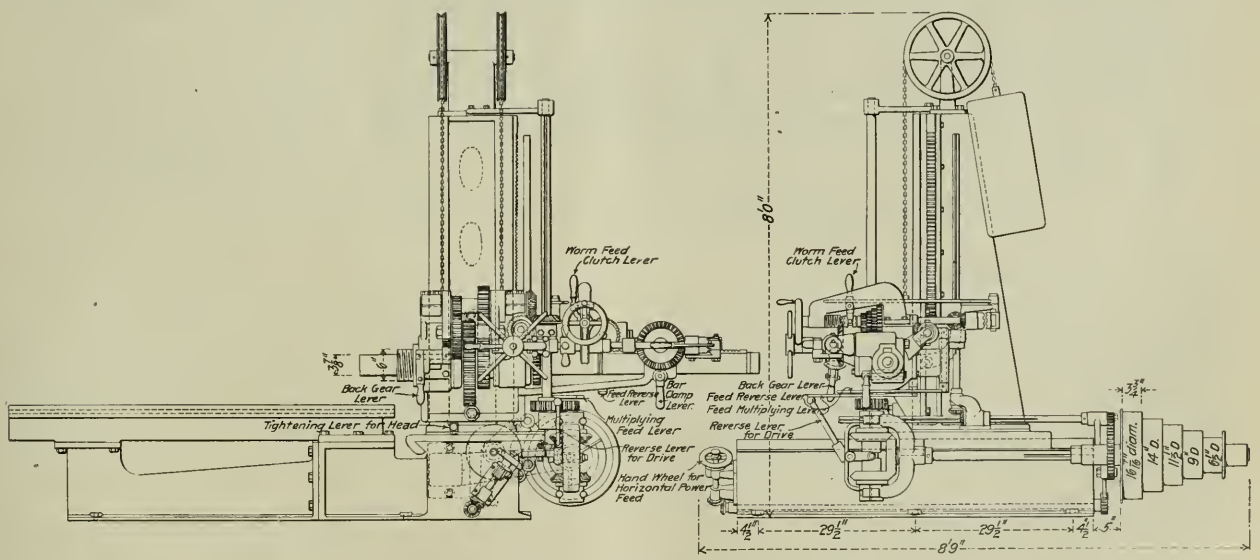



Fig. 2—The Fosdick Horizontal Boring and Milling Machine.

*(To be Continued.)*

## The Growth of the Missouri Pacific.—II.

(*Continued from page* 189.)

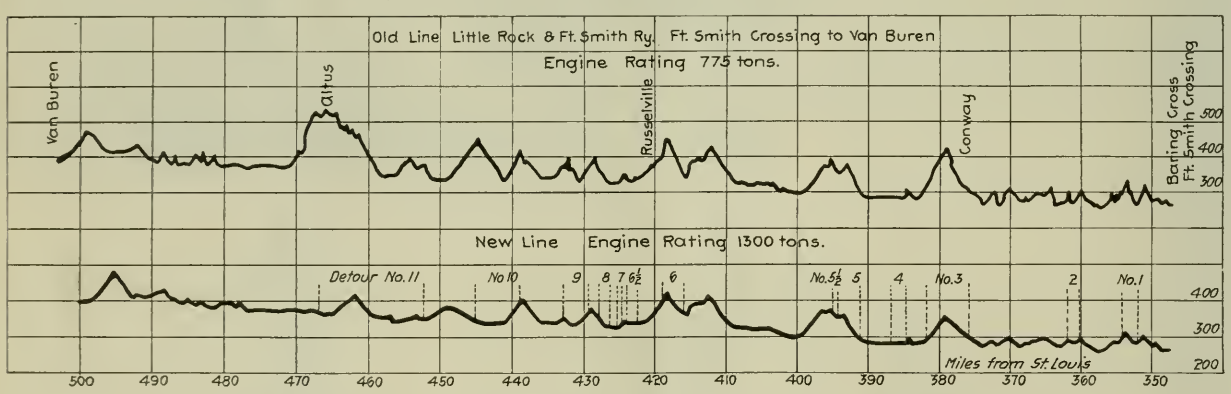
The preceding article outlined the early history of the Missouri Pacific System from the time of its acquisition by Jay Gould up to the present period of expansion, which began six years ago. This article will briefly describe the reconstruction work which has been done and the new lines which have been built, all of which is a part of a well defined plan of improvements made before any of the work was started. In a subsequent issue, the purposes of the work which has already been done and the ultimate aim of the management will be pointed out.

The first extensive piece of work which was undertaken was the change of grade and alinement on the main line of the Iron Mountain through Arkansas. This part of the system had always carried a heavy traffic both in freight and passengers and had a large earning capacity, although in many ways it was one of the worst lines to operate economically because of its adverse physical conditions. From St. Louis south to De Soto, Mo., the road follows the Mississippi for much of the way and has no grades of any consequence, but between De Soto and Piedmont it crosses the range of hills known as the Iron Mountain, from which it takes its name, and over the summit of these hills there was a 2 per cent. grade. From Piedmont south through Arkansas to Texarkana, grades of 1 per cent. were quite frequent and in a number of places bad curves had been located in the original survey. Plans were made to cut down all grades between Newport, Ark., and Texarkana to a maximum of .6 per cent., and to improve the alinement also, at the same time taking out the numerous sags and filling in the low spots through the swamps. The work was begun early in 1898 and was stretched out over about 75 miles of track north of Little Rock and at a number of the worst hills south of Little Rock. Steam shovels were put to work in the heaviest cuts and although delayed by unfavorable weather and other causes, the preparation of the subgrade and shifting of the tracks to the new alinement was practically completed by the end of 1900 on the line north of Little Rock. South of that point, the improvements were not completed until the end of 1902, for the work on that section while not spread out over so much ground was much heavier and more difficult to complete.

During the time that these improvements were being made, the traffic on the Iron Mountain increased tremendously in volume and made any rapid completion of the grade adjustment impossible. The operating department had all of the work under its charge and was thus enabled to handle it with the least possible interruption and delay of traffic. No serious accidents or congestion which might have been directly attributed to this reconstruction occurred while it was going on and the benefits derived from the increase in train load which was made possible were felt almost from the beginning. Where trains had formerly been limited to 1,390 tons between Newport and Little Rock, they were increased to 1,600 tons, and south of Little Rock to Texarkana, the increase was from 890 tons to 1,600 tons. The heavy grade over the summit between De Soto and Piedmont was also materially reduced and the entire line was reballasted with rock and gravel, many of the lifts through the swamp lands being made with gravel alone to a depth of 4 ft. and even more. New 75-lb. rail was laid, permanent culverts put in to replace timber trestles and all of the bridges put in good condition for carrying heavy engines. Yards were increased and sidings lengthened at the same time so that when the improvements were entirely completed, the line from St. Louis to Texarkana, some 490 miles, was in fine shape to handle any amount of business within the restricted limits of a single-track road. The total cost of the work north of Little Rock was approximately $230,000, and about $840,000 for the improvements south of that point.

While these changes were being made on the main line of the Iron Mountain, a reduction of grades was also being made on the Valley Division between Little Rock and Arkansas City, 114 miles. The grades between Pine Bluff and Little Rock were reduced from a maximum of 79 ft. per mile to 26 ft. per mile. Grades of 42 ft. per mile were used indiscriminately on the old line and this kept the train load down to about 900 tons for the 10-wheel engines which were used over this division. After the grade reduction the train load for the same class of engines was increased 400 tons. At the same time the bridges on the south end of this division between McGehee and Riverton, La., were changed to carry heavy engines, and most of the north end was ballasted up to standard. All of the sidings and passing tracks were lengthened out to accommodate longer trains and the whole line from Little Rock to the connection with the Texas & Pacific line to New Orleans was put in shape to handle heavy traffic. No heavy work was necessary on the south end since the road runs for most of the way through the low swamp lands and is almost level. After nearly two years' work the grade reduction between Pine Bluff and Little Rock was completed in 1902 at a total cost of about $170,000.

The general plans for grade improvements and reconstruction also included some heavy work at both ends of the line from Kansas City to Little Rock. This part of the system had been growing in importance rapidly with the development of southeastern Kansas and Indian Territory, and it was essential in order to hold the territory which it traversed from the inroads of active competitors, to place the entire line in satisfactory shape for economical operation. Surveys were made for a .75 per cent. grade line from Osawatomie, Kan., south to Coffeyville, which included three important detours from the old right-of-way, the most important being one about 8.5 miles along around Yates Center which eliminated much curvature and was made without heavy cutting. The detour around Mt. Ida, 3.5 miles long, reduced the grade from 1.5 per cent. and was made to avoid the heavy expense of cutting down the main line at that point which it was estimated would cost about $130,000 more than the detour. South of Coffeyville, the Kansas & Arkansas Valley, which is operated by the Iron Mountain, has no grades heavier than .75 per cent., and it needed little extra work aside from laying heavy rail, ballasting and lengthening sidings, to put it on a par with the north end of the line.




Condensed Profiles of Little Rock & Fort Smith Line Before and After Grade Adjustments.

By far the most extensive and complete reconstruction was done on the south end between Fort Smith and Little Rock. Although this line follows the Arkansas river for its entire length and might well have been built with a merely nominal ruling grade, it had been put through, apparently, with the least expense. The maximum grade was 92.5 ft. per mile, and grades of 80 ft. per mile were used indiscriminately. Of its entire length of 163 miles only 32 miles were level, and it was manifestly impossible to operate heavy trains over such a route until it had been rebuilt completely. It was decided to establish a ruling grade of .6 per cent. and to eliminate as much as possible of the rise and fall in the old line. Thirteen detours, aggregating about 43 miles, were surveyed and work was begun early in 1902. The line is now being ballasted and put in condition for carrying heavy traffic, new 75-lb. rails having been laid, bridges strengthened and additional sidings and yard facilities at both ends having been provided. This work was the most expensive which has been done, the Little Rock & Fort Smith improvements alone having cost nearly $3,500,000 to date. The work done north of Coffeyville on the Missouri Pacific lines cost about $750,000, bringing the total cost with miscellaneous expenditures on the Kansas & Arkansas Valley up to $4,500,000, or nearly $10,000 a mile. As on the main line recon-

struction on the Iron Mountain, all of this work was done under the direction of the operating department and with the least possible interruption of traffic.

The accompanying condensed profiles give some idea of the amount of grade reductions made. The changes have resulted in an increase in the tonnage rating of engines from 800 tons to 1,300 tons between Osawatomie and Leroy, 51 miles, from 1,000 tons to 1,450 tons between Leroy and Coffeyville, 76 miles, and from 775 tons to 1,300 tons between Fort Smith and Little Rock, 165 miles. The effects of these more recent improvements have not yet begun to show in reductions in operating expenses, but within the next year as the new grading settles and engines can be safely loaded to their full capacity a large decrease in expenses per ton mile will be shown, without doubt.

Most of the new construction which has been done within the last three years is confined to the territory lying between the main line of the Iron Mountain and the Mississippi river. It has for its ultimate object the completion of a new low-grade route from St. Louis to New Orleans, and the development of eastern Arkansas and Louisiana. An integral part of this scheme is the new White River line from Carthage, Mo., on the Missouri Pacific across northern Arkansas and the Ozark Mountains to Diaz on the Iron Mountain, thus giving another connection between the lines in Kansas and the Gulf.

As originally planned a new river-grade line was to be built south from St. Louis along the west bank of the Mississippi to connect at Jackson with a short branch line from Allenville on the Belmont Branch. South from Allenville the new line was to be run to Paragould, Ark., to connect with the Helena Branch, which was to be extended south to McGehee, from which point a line was already in operation through Louisiana to Alexandria on the Texas & Pacific. This scheme was considerably modified, however, by the project for a bridge across the Mississippi at Thebes, Ill., and the construction by independent interests of a low-grade line from East St. Louis to Thebes, following the east bank of the river. The Iron Mountain bought this line with its branches in the Big Muddy coal fields and trackage rights over the new bridge and secured trackage rights over the St. Louis Southwestern from Gray's Point at the west end of the bridge to Dexter on the Cairo Branch of the Iron Mountain, thus completing the connection at the south end. In Louisiana and Arkansas, the New Orleans & Northwestern from Vidalia, opposite Natchez, Miss., north to Bastrop, La., and the Mississippi River, Hamburg & Western, were also purchased and the plans for new construction were altered somewhat to fit the changed conditions. A new line, following the river was surveyed south from Helena and West Memphis through McGehee, Ark., to Clayton on the N. O. & N. W. to connect with a new line of the Texas & Pacific running north from Port Allen, La., and an extension of the Hamburg & Western to connect with the Camden Branch at Eldorado was also provided for. With the exception of a short stretch of about 30 miles between Poplar Bluff and Knobel on the main line this gives a parallel route all the way to New Orleans with no grades greater than .6 per cent., connected with the main line by branches at frequent intervals and traversing an exceptionally rich agricultural and timber country which through lack of railroad facilities has not heretofore been developed.

The new line through Illinois has a ruling grade of .25 per cent. except on the approaches to the Thebes bridge. It is laid with 85-lb. rail, is ballasted throughout with stone and chats and has extensive terminals in East St. Louis. Passenger trains from St. Louis are run over the Eads Bridge, but most of the freight consigned to or from St. Louis and points west is carried over the river on a car ferry running between Ivory, Mo., and Bixby, Ill., just south of St. Louis.

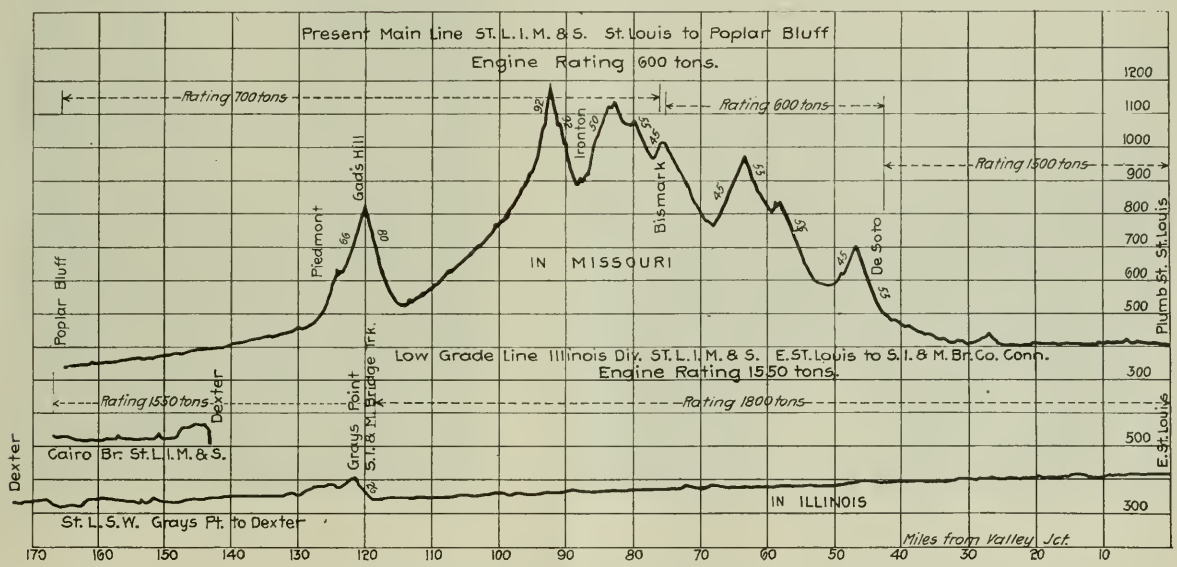
There were no particular difficulties encountered in the construction of the lines in Louisiana and Arkansas aside from the scarcity of suitable ballasting materials. Except where the land has been cleared on some of the plantations near the river, the country is virgin timber land and gumbo swamps which are under water for much of the year. Only one engineering problem of any importance was met with in the construction of these lines in the south, and that was at the crossing of the Eldorado & Bastrop over the Ouachita river. This required a 250-ft. draw span and 12,000 ft. of wooden trestle approaches across the bayou. Like most of the streams in this region, the Ouachita overflows its banks in times of high water and inundates the surrounding country with from eight to ten feet of water, and owing to the scarcity of suitable material for making the high fill required, a pile and timber trestle was built. The levels and surveys were made from platforms built in the tree-tops, the surveying party going from station to station in boats.

The new White River line from Diaz on the Iron Mountain northwest to Carthage, Mo., 271 miles, is still under construction. It traverses a sparsely settled mountainous country exceedingly rich in minerals and hard wood timber, and involves some very heavy work, including five tunnels, the longest of which is about half a mile. The ruling grade is .75 per cent. and the entire line will be finished up to the main line standards with stone and chats ballast, 75-lb. rail, heavy bridges, etc. This is the longest single piece of new construction which has been undertaken and will probably be the most important of the new lines in the future development of the system.

Little new construction has been planned or carried out in the territory occupied by the lines operated by the Missouri Pacific proper. The only work of any importance has been the completion of a low-grade route from Jefferson City to Kansas City following the Missouri river for the entire distance, and the building of the Carthage & Western, 18 miles long, from Carthage to a connection with the Kansas City Southern at Asbury, thus giving an outlet to the White River line into the region covered by the network of lines in southeastern Kansas.

The new low-grade line along the Missouri river involved the construction of 42 miles between Jefferson City and Boonville on the east end, heavy grade reductions on the old line of the Lexington Branch between Boonville and Lake City, including six short detour lines and the construction of about eight miles of new line at the west end from Lake City to the tracks of Atchison, Topeka & Santa Fe, over which trackage rights were secured for 8.5 miles to a connection with the Missouri Pacific main line just east of Kansas City. This gives a .3 per cent. grade line between Jefferson City and Kansas City as against a 1.4 per cent. grade line via the old route through Pleasant Hill and Independence, and increases the tonnage rating of engines from 900 tons to 1,800 tons.

The new line at the east end was built




Condensed Profiles of Iron Mountain Main Line and New River Division between St. Louis and Poplar Bluff.

during 1901 while the grade adjustment work was going on west of Boonville. For much of the distance the bluffs rise perpendicularly from the water's edge and this required some heavy cutting in rock and the construction of dykes to deflect the current and protect the banks from washing. Where the bluffs recede from the river the roadbed was made from the surplus rock excavated and the exposed slopes were protected with riprap. The entire line from Jefferson City to the connection with the Santa Fe has been laid with 75-lb. rail and ballasted with rock. It is now used almost exclusively for through freight to and from the West, all of the through passenger trains being run over the old line via Pleasant Hill.

*(To be Continued.)*

## An Efficient Telpherway.

The United Telpherage Company, New York, has installed at Milton, Mass., an overhead suspension electrical telpherage line for the Walter Baker Chocolate Company. This line is about one-sixth of a mile long and runs from the railroad freight house to the top floor of the company's mill. Before this line was installed, the company had to truck all materials by teams by way of a long and circuitous route. The portion of the track which passes over level ground is supported by bents 35 ft. high resting on concrete foundations. The supports for the portion of the track along the cliff are of 14-in. square Georgia pine ranging in length from 30 ft. to 40 ft. The foundations of these posts are cut out of the solid rock. The telpherway crosses the river adjoining the mill over a steel bridge having a span of 80 ft. The electric locomotive runs on the top of a single overhead rail and is controlled by an operator in an enclosed cab that is suspended from the telpherway directly beneath the track. The apparatus is fitted with a brake which is capable of stopping the train within its own length. The current is supplied through a trolley wire. The train is 30 ft. long and runs at an average speed of 700 f.p.m. The weight of the machine is 4,600 lbs. and with the three loaded trucks the total moving load on the structure is 12,000 lbs. It is claimed that the cost of power for running this machine for a day of 10 hrs. is but $1.00. The general appearance of the locality in which this line is situated is shown in the accompanying illustrations.

Trucks Crossing Telpherway on Bridge.

Telpher Train Suspended 50 ft. above the Ground.

## Lecture on the "19" and "31" Forms of Train Orders.*

So far as the order itself is concerned, there is no difference between the "19" form and the "31" form; but the "31" form requires that the signature of the persons addressed be transmitted to the despatcher, and the "19" form does not. The Train-Rule Committee of the American Railway Association will, doubtless, agree that there is no movement made by the use of the "31" form that cannot also be made with the "19." Any train order must be respected, without regard to whether it be on green or yellow paper, or whether it has or has not been receipted for. If through error, necessity, or bad judgment a train be deprived of its superiority by use of the "19" form, the order must be accepted and obeyed. And, while a train may thus lose right or have right conferred upon it by either form (and such orders must be respected without regard to whether given by "19" form or "31" form), ordinarily, the "31" form must be used when a train is to be made inferior, and the "19" form only used when, if not delivered, nothing worse than a delay would result. The possibility of delay, through failure in the delivery of such orders, should not, however, be seriously regarded, as there are so many advantages in the use of "19" orders to offset the very rare chance of failure—which, the records show, has only been about one in a hundred thousand orders. There has been a corresponding number of failures in the delivery of "31" orders.

A meeting point must not be made at a telegraph office, or a blind siding, by using "19" orders for all trains. The superior train must be given a "31" order and the inferior train may be given either a "19" or a "31." There is an exception to be made, however, when a train order is to be first given to the operator at the meeting station; then a "19" may be used for either train. Extra trains must not be met by using "19" orders, unless the order is first addressed to the operator where they are to meet and is issued for all extra trains concerned before they reach the place of meeting, as there are no "superior" extra trains. A "19" order may be addressed to a train at the train-order meeting point, changing the place of meeting to some station beyond, as such train cannot leave without the order, unless the train which it was previously directed to meet at such station has arrived. A "19" order may be used to authorize a train to run extra, or for one train to pass another, as, in the absence of notice, the train so passing must protect itself, if it stops or is delayed. This is a no more serious restriction than that provided for in Rule 93. It is an open question whether it is best to require any freight train to have an order to proceed ahead of a superior freight. The claim is made, and with good reason, that the order to run ahead makes the crew receiving it lax in their observance of Rule 99. The "19" form may be used for "slow" orders, where but one order awaits the arrival of a train at any station; or to notify trains of cattle on the right-of-way, or of a water-supply failure; or for train movements where no accident could happen through non-delivery of the orders. They must not fail to be delivered, however, nor must the impression prevail that it is unnecessary to display the train-order signal at "stop" for such orders, or that their delivery is not as important as the delivery of "31" orders; failure in either case deserves equally severe censure.

In the event of a broken rail, a burned bridge, a washout, or other defect of track, where trains must reduce speed to less than 30 miles an hour, the "31" form is the proper one to use for the purpose of notifying them. The "19" form was framed with the view to helping trains without stopping them, as they are generally delivered to trains while they are in motion, unless they happen to be standing at a station waiting for orders. As the "19" order does not of itself clear a train, so long as the order signal indicates "stop" and the operator must not change the signal to "proceed" until the order is delivered to both the engineman and conductor, a clearance card must be delivered with such orders, stating over the operator's signature that there are no further orders for the train, except when he can deliver the order to both the engineman and conductor and change the signal to "proceed" within their view. A "19" order should not be issued to a superior train, directing it to take the siding and meet an inferior train, even

*From a forthcoming book on "Rights of Trains on Single Track," by H. W. Forman, to be published by the *Railroad Gazette*.

though the same order be issued to the operator at the meeting station, as in case of failure in the delivery of the order to the superior train before it reaches the meeting point, it would then hold the main track as far as the order signal, with the possibility of collision with the inferior train.

As far as possible, despatchers should avoid issuing both "19" and "31" orders for the same train at the same station, since a train can be cleared by clearance card on delivery of either order, with the signal at "stop," or the same result would follow if either be delivered, and the order signal then be changed to "proceed." The train must be stopped anyway, to get the acknowledgment of a "31" order; so no time would be saved by issuing other orders on the "19" form, with the chance of the operator's delivering only the "19" order and then clearing the train. Operators should be instructed to guard against the danger of delivering "19" orders to enginemen, with or without a clearance card, when they also have a "31" order for the same train. An engineman having received a "19" order might see the train-order signal changed to "proceed," although, without his knowledge, a "31" order had been delivered to the conductor, and, should an unauthorized starting signal be given, he might proceed before the conductor could reach him with the "31" order; while this would not be likely to happen if no orders were prematurely delivered to him. In cases where orders on both forms are awaiting the arrival of a train, operators must not deliver anything to the engineman until the conductor has acknowledged the "31" orders.

When a meeting or waiting point is fixed, by addressing the order to the operator at the meeting or waiting station, say, at C, as well as to both trains, one on each side of it, say, at B and D, respectively, the operator at the meeting point (C) must deliver copies of the order to the enginemen and conductors of all trains affected until he is positive that all trains moving in the same direction have arrived (and, in case the inferior train arrives first, until it is clear of the main track). He must then change his order signal to "proceed," unless the order is also addressed to a train, or there are other orders in effect at that station. If it is a meeting order, the operator will display both order signals; if a time order, he will display only that signal which will stop the train which is to be held. When the time given in a waiting order has expired the operator will change the order signal to "proceed," without regard to whether the train to be waited for has arrived or not; provided, always, that the order is addressed only to the operator. If his clock is not reliable, he should obtain correct time from the despatcher before restoring the order signal to "proceed."

It is proper and often necessary to issue a "31" order for one or both trains and to address the same order to the operator at the meeting point on the "19" form. It is also proper to address a "31" order to an operator and to trains at his station; the same order may also be issued on the "19" form for trains which have not yet reached his station.

Should a train reach a station and find the order signal at "stop," and an order addressed only to the operator should be delivered to it, a copy of which it had not previously received, stating that the train will meet or wait for some other train at that station, or wait for a work extra until a certain time has elapsed, such order must be accepted and understood as holding the train thus notified, as there may have been a failure in the delivery of orders to the superior train before reaching such station. It must be understood, however, that an order, when only addressed to the operator, simply holds the train. Orders conferring right must be addressed to the trains that are to execute them, as prescribed by Rule 204.

A "19" order is sometimes as safe as a "31" order when but one order is issued; but when more than one is to be given a train at the same station, the "31" form is the safer, for the reason that an acknowledgment of all the orders is obtained from all concerned. The single "19" is theoretically as safe as the single "31," as the train addressed cannot pass the order signal without an order while it indicates "stop," and the "19" form of order can reach it just as well as any other.

On the question of extending the use of the "19" form of train order and addressing it to operators at meeting points, and to trains interested in the movement, the author wishes to record his unqualified endorsement of the practice, having successfully used it for twenty-five years on a single-track road where seventy or eighty trains were moved daily with entire safety and with considerable advantage in the matter of time saved. The fact that several of the largest roads in the Middle West have adopted rules requiring meeting orders to be addressed to the operator at the meeting point, in addition to the superior train before it reaches such station, would seem to indicate that there is something lacking in the Code rules in this respect, or that meeting points are likely to be overlooked by train and enginemen if this precaution is not taken. It must be evident to every one that two order signals against trains are safer than one. If a "31" order be issued and the crew forget the meeting point, a collision is possible; but give the same train a "19" order addressed also to the operator at the meeting point, and the safeguards against accident are greatly increased, for even should the superior train forget the order, the operator's signal at the meeting point is displayed at "stop," and remains so displayed until all the trains going in one direction have arrived.

In meeting freight trains, much time can be saved by using "19" orders. It requires from ten to twenty minutes to get signatures to "31" orders, and on grades there is also further delay in getting under headway. This can be avoided by using "19" orders to fix meeting points, addressing them to all trains and in duplicate to operators at places of meeting. Something can also be saved in expense of operation, as it costs from 25 to 40 cents to stop a freight train to get acknowledgment of orders. In connection with this plan of using "19" orders, the semaphore form of train-order signal should be used, and despatchers must not be tied down too closely by instructions. Should it be necessary in certain rare cases to instruct operators to allow a train to pass an order signal by changing it to "proceed" for a brief interval of time, the despatcher should be allowed to so instruct them. The Code rules now permit operators to do this, without instructions from any one, when the normal position of such signals is at "stop."

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The part of the railroad up the Jungfrau known as the Eiger Tunnel reached a point 9,840 ft. above sea level about July 1. The fears that men would not be able to work at that elevation proved groundless; the men soon became acclimatized and there was very little mountain sickness. It is expected that this tunnel will be completed to the point on the south side of the mountain, where it comes to the surface, 10,824 ft. above the sea, about the end of this year. Work is to be prosecuted in the winter.

## Progress in Railroad Bridge Building.*

BY F. C. M'MATH.†

Nowhere in the world has the art of bridge building progressed faster than in the United States. Previous to 1860 practically all of the truss bridges were of timber construction—mainly of the Howe truss type. About this date the building of spans with cast-iron compression members and wrought-iron tension members became the fashion, and a few metal bridge-building establishments sprang up; each concern usually adhering to some particular type of construction, such as the Fink truss or Bollman truss. The old Detroit Bridge and Iron Works was one of these pioneer companies and built bridges under the Bollman patents. Metal bridges were somewhat expensive in those days, the old records of the Detroit Bridge and Iron Works showing prices from 8 to 10 cents per lb. Not many railroads could afford metal structures at such figures, and combination wood and iron bridges began to be largely used, especially by the railroads in the West.

About 1880 bridges constructed entirely of wrought iron began to be commonly used. Seven or eight years later, steel eyebars were substituted for wrought-iron tension members, and about 1890 the iron compression members had to give way to those of steel. The change from iron to steel was opposed by many engineers, but steel won the day on account of its lower cost.

During the period of change in the materials of bridge building, a very great change took place in the weight of rolling stock. In 1860 an ordinary locomotive and tender would weigh about 40 tons; in 1880 a 66-ton engine was thought a monster. In 1890 engines of 100 tons were believed to be about the limit, but now there are plenty of engines weighing, with tender, 140 to 150 tons. These radical increases in loads naturally have had a marked effect on the bridge-building industry. A bridge built for the loads of 1860 needed renewal about 1880 and structures designed for 1880 conditions had to come out before 1900. This is an understatement rather than an exaggeration. I know of one structure in Michigan that has been renewed no less than three times by one company. It is doubtful whether the limit in loads has yet been reached.

Pin-connected spans have been the favorite type in the United States from the earliest days of metal bridge building. Some years ago quite a controversy arose between American and English engineers as to the relative merits of pin and riveted spans, the latter being the distinctly English type. American engineers apparently had the best of the argument, the pin structures being unquestionably lighter in weight and cheaper to erect. In recent years, however, a strong tendency has set in toward the use of riveted structures for spans of short or moderate length. Most bridge engineers would not now use pin designs for spans less than 125 ft.; and a few railroads, such as the New York Central Railroad, have practically abandoned pin bridges altogether and are now making the riveted bridge their standard type. In Canada the riveted bridge has been in favor for some time by the leading railroad companies, being used quite generally for all spans up to 200 ft., whether single or double track. The English engineers were nearly right in their old contention in favor of riveted bridges—at least for spans less than 200 ft., which cover the bulk of ordinary railroad structures. American engi-

*Extracts from an address delivered at the 10th annual banquet of the Detroit Engineering Society. Reprinted from the Journal of the Association of Engineering Societies.

†President of the Detroit Engineering Society.

neers, however, have by no means copied English designs, even if they are coming around to the English type.

American designs use longer panels and much deeper trusses, and on this account our structures are lighter, stiffer, better and cheaper than the English. For some unknown reason the English engineer feels that the slope of his diagonal truss members must be exactly 45 deg., if possible, and that the depth of truss must not exceed one-eighth the span length. His adherence to these thumb rules makes his designs heavy and expensive, and, for short spans, often defective in their top chord bracing. He uses difficult details, apparently taken from shipbuilding practice, where probably there are good reasons for their use, for it must be admitted that the English are masters of the art of shipbuilding.

During the past few years a marked improvement has been made in bridge floors. Timber floors are still in general use, but cross ties and guards are now much more substantial than formerly, and the space between the ties has been reduced from 8 in. or more, down to 4 in. Some of the trunk lines are abandoning timber floors altogether, and are using solid metal floors carrying gravel or rock ballast. These floors are exceedingly satisfactory in actual use, their great weight and rigidity reducing impact and vibration to a minimum. The only objection to such floors lies in their higher first cost and liability to deterioration by rust. The most common type of solid floor is the trough floor, but it is expensive and very difficult to protect against rust. One of the cheapest and best types of solid floor is in general use on the Michigan Central, and is being used to an increasing extent by other roads. It is known as the Douglas solid floor.

In the last two decades great progress has been made by the bridge builders. General methods and processes have shown no radical changes; but better system, more powerful machinery, pneumatic and electric handling devices, have reduced costs. Bridge shops have greatly increased in number and in capacity. Fifteen years ago no single concern had a capacity exceeding 2,000 tons of bridge work per month. This output at the present time is far exceeded by many shops, and there is now a single plant with an estimated monthly capacity of 20,000 tons. This is the new plant recently completed by the American Bridge Company, at Ambridge, near Pittsburg. Some idea of the magnitude of the concern will be gained when it is known that provision has been made in the office for upward of 500 draughtsmen. Single pieces weighing 80 tons can be made and handled in this shop. Eyebars 16 in. wide can be made in the forge department.

Structures can be built to-day that would have been impossible a few years ago. This is the day of big things in bridge building, as well as in other lines of work. More huge bridges are under way than ever before. A 671-ft. cantilever span is being built over the Mississippi River at Thebes, Ill. The Wabash has completed two cantilevers—one of 700 ft. span over the Ohio, and one of 812 ft. over the Monongahela River. At Quebec a cantilever span is being built over the St. Lawrence River, with a record-breaking span of 1,800 feet. At New York a 1,600-ft. wire cable suspension bridge over the East River has been completed, and contracts have been let for a second bridge of cantilever construction, with a span of 1,182 ft. Plans are under way for a third bridge of 1,470 ft. span, suspension type.

In the Blackwell's Island cantilever bridge nickel-steel eyebars are to be used. The specifications for this bridge require full-sized annealed nickel-steel eyebars to have an ultimate tensile strength of not less than 85,000 lbs. per sq. in., whereas the minimum permitted for ordinary steel eyebars is only 56,000 lbs. It is thus apparent that the nickel-steel is about 50 per cent. stronger than the ordinary steel, a gain of enormous importance in bridge building. If nickel-steel can be supplied at reasonable figures, it will be widely used, especially in long spans. The Orford Copper Company is now arranging for the rolling of a quantity of nickel-steel plates and angles with a view to having bridge shops try them under the ordinary processes of construction. If no unforeseen difficulties are encountered, it should be feasible to use nickel-steel for compression members as well as for eyebars in long spans.

Progress in bridge building has certainly been great in the past, but there is still plenty of opportunity for further development and improvement. Some of the advocates of concrete-steel are prophesying the substitution of concrete-steel in place of steel girders for short railroad bridges, but the metal bridge builders are not yet particularly worried over prospective loss of this business.

There is yet much to be done in the way of standardizing bridge specifications. Various opinions are still held by engineers regarding the quality of steel to be used, loads to be provided for, and permissible unit strains. Prof. Heller, of the Ohio State University, has recently made an interesting comparison of railway bridge specifications. He made a detailed comparison of about 30 railroad specifications, and found a surprising lack of uniformity. Selecting a certain member of the bottom chord of a 134-ft. span, he found, under a given loading, the total stress to be 270,000 pounds. Using the averages of unit stresses of 28 different specifications, he found 25.4 sq. in. of metal required to resist this strain. The area required by the lightest specification was 11.4 per cent. below the average, whereas the heaviest specification required 18.6 per cent. more area, the total variation thus amounting to 30 per cent. He made similar calculations for the stringers of the same span, and found a total variation of 55 per cent. from the average.

Bridge designing is supposed to be one of the exact sciences, but it is very evident that there is no reason for bridge engineers to brag of exactness when their opinions of unit stresses vary to the extent shown above. It is to be hoped that, at some not very distant day, they will get together and adopt a standard specification. Strong efforts are now being made in this direction, and it is the devout wish of the bridge builder that they may be successful.

## Hansel's Pipe Carriers and Foundations.

Mr. Charles Hansel has designed a pipe carrier for supporting the rods connecting signals and switches with interlocking machines, which fastens to the foundation without the use of screws or bolts; and, in connection therewith, an iron top for the concrete foundations usually used for supporting switch and signal connections. This top is made round to facilitate fitting, and a similar top has been designed for supporting bell cranks and compensators. These fixtures are illustrated in the accompanying engravings, and Mr. Hansel has applied for patents on them.

Fig. 1 shows all of the parts which it would be necessary to carry in stock for pipe carriers and foundations complete, except the concrete pillar; and Fig. 2 shows these parts assembled in an eleven-way pipe carrier foundation, carrying, also, four wire pulleys.

Fig. 3 shows the foundations for a lazy jack compensator. Four or six piers may be used in the foundation if necessary. The piers are 2 ft. 6 in. long, six inches longer than the usual oak foundation. For a bell crank or any smaller part the piers can be set nearer together than in Fig. 3.

The pipe carrier, Fig. 2, is similar to the "E. Z." carrier made by the Pneumatic Signal Company, except that the foot of the standard 4 (Fig. 1) instead of being flat

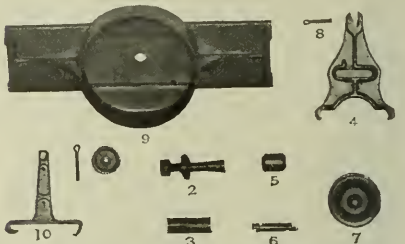


Fig. 1—Iron Cap and Details of Carrier.

and provided with holes for lag screws, has the foot curved inward, to fit cap 9, the principle being the same as that employed by Mr. Hansel in the design which he got out in 1898 (*Railroad Gazette*, Jan. 7, p. 9). The unit of the foundation is a six-way, but it may be any number of ways desired.

The setting up of one of these carriers is simple. After planting the concrete pier, the short piece of split pipe 3 is slipped over the bolt 2, and dropped into the hole in the

Fig. 2—Hansel's Pipe-Carrier.

center of the top of the pier, the parts 2 and 3 forming a simple expansion bolt. The cap 9 is then placed on the pier and after it is adjusted to the proper angle with the rail the expansion bolt is tightened and the cap drawn firmly down on the pier.

The assembling of the pipe carriers on this foundation can be done rapidly, and tie piece 6 fastens the whole and forms an axle for the top roller 5. In Fig. 2 the two units

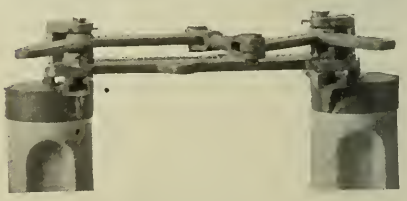

Fig. 3—Foundation Caps for Compensator

are held together by wedge clamp 12, which is driven on from the side.

It will be seen that the number of parts necessary to be carried in stock to provide the fixtures named is small. Mr. Hansel has tested his devices and believes that he can promise a saving of 10 per cent. or more in the cost of foundations. The pillar can be firmly fixed in the ground without carefully adjusting its position to that of the rail. The cap, being circular, can be easily turned to the proper position in relation to the track. He proposes to provide hinged cast-iron moulds in which to make the concrete pillars. Such moulds could be easily transported from place to place, thus enabling the signal department to make its pillars at the points where they are to be used.

## SINGLE PHASE MOTORS.

It can be shown mathematically and proved experimentally that the weight of copper required to transmit a given amount of power by electricity, is inversely proportional to the electromotive force or voltage employed. Inasmuch as high pressures cannot be used with direct-current motors, it has been the aim of designers of electrical apparatus to perfect a motor that will operate satisfactorily with alternating current. The necessity for such a motor is particularly urgent for railway service which requires the transmission of great power over long distances. While electricity has been gradually entering the field of traction, its fullest development will not be reached until the alternating-current motor is assuredly a commercial and practical success. American designers have been working chiefly toward perfecting the single-phase motor, although in Europe, three phase systems, notably the Ganz, appear to be in successful operation. In the *Railroad Gazette*, April 8, last, was a description of the single-phase, alternating-current motor developed by the Westinghouse Company. In this issue is a description of a similar type of motor developed by the General Electric Company. It is not our intention to discuss the relative merits of the two motors. Future experience will settle that point. It is of interest, however, to know that two of the largest American electrical companies have developed a single-phase motor, which at least gives a measure of assurance that many of the limitations hitherto preventing the more extended application of electricity to long distance railroading, will shortly be overcome. It is by no means intended to convey the impression that the direct-current motor will be relegated to the scrap heap. For many classes of railway service the direct-current motor is, and always will be, the best type of apparatus. For example, the New York Central has decided to use direct current for operating its trains at the New York terminal. The principal consideration in making this decision was the necessity of specifying a tried and proven system. A road like the New York Central could not afford to take any chances with systems that have not been thoroughly tried. The movement of trains is paramount to economy in first cost or cost of operation. Furthermore, the use of alternating current would have made necessary the use of overhead conductors which would have involved the road in legal difficulties, owing to the fact that it has no so-called "air rights" over the Park avenue viaduct. Of course, the third rail could be used for the transmission of high potential alternating current, but it would be a constant source of danger to employees of the road and to passengers in case of derailment. Both the Westinghouse and the General Electric motors will operate by direct current, so that interurban cars can pass over the tracks of local electric railway lines which are operated by direct current.

The alternating-current motor will greatly simplify the operation of long-distance electric railways. Power can be transmitted from a central station at 30,000 or 40,000 volts over a comparatively small and inexpensive conductor. Transformer sub-stations can be placed at intervals and the power stepped down to 2,000 or 3,000 volts, which is the working pressure on the trolley line. Transformer stations do not require constant attendance, one man taking care of several. Where direct current is used, the power is transmitted from the central station at high voltage to the sub-stations, the same as above noted. Each sub-station, however, must contain step-down transformers and rotary converters. The converter changes the alternating current into direct current, the usual working pressure on the trolley line being from 500 to 600 volts. Rotary converters require constant attendance and get easily "out of step." They also add to the first cost of an installation.

## COMPARATIVE LOCOMOTIVE TESTS IN GERMANY.

From February 8 to March 31 continuous tests were made on a level section of the Prussian State railroads (the Moselle Railroad) of three kinds of freight locomotives, all with the same number of driving and trailing wheels. One was what is called a twin engine, another a compound, and a third a superheater. In all cases the trains hauled consisted of 120 axles, that is, in nearly all cases, of 60 four-wheel cars. The result of the tests was that the compound consumed 11.12 per cent. less water and 9.75 per cent. less coal than the twin engine, while the engine using superheated steam consumed 25.33 per cent. less water and 15.25 per cent. less coal than the twin engine, and 16 per cent. less water and 6.08 per cent. less coal than the compound. The expenditure for lubricants, which has been an objection to the use of superheated steam, was in the proportions of 48 for the twin, 51 for the compound, and 60 for the superheater. The oil required for the latter cost a little more than twice as much per gallon as that used on the other two. The cost of lubrication was one of the points which the tests were intended to establish.

A second series of tests with two locomotives of each of these kinds was conducted during the whole of the month of March on a line over the hilly country between Karthaus and Coblenz. The highest permissible load here for the new superheater engines was 110 car axles (in earlier experiments only 100 were hauled), and with this load the time-table speed of 21 miles an hour on the open road was readily maintained. The other two kinds of engines could haul only 90 axles over this section. The superheater here consumed 29.9 per cent. less water and 20.46 per cent. less coal than the twin engine, and 19.78 per cent. less water and 11.40 per cent. less coal than the compound. The cost of lubrication was in the proportions of 58, 62 and 68 for the twin, compound and superheater, respectively. The temperature of the superheated steam reached a maximum of 608 degrees, with a pressure of 178 lbs. in the valve chest. On grades, 35 per cent. cut-off usually sufficed, rising exceptionally on curves and with head winds to 40 and 45 per cent. There was always abundant steam and water in the superheater boilers at the summit of long grades, where they were usually exhausted in the other engines. A special advantage of the superheater on this line was that it required no helper over one of the steep grades. Its movement was remarkably smooth. The screwing of the piston-head upon the piston-rod is noted as a defect, as almost all pistons became loose after considerable service.

The result of these experiments is considered so important that the Minister of Public Works has called the attention of all the directories to them.

The Germans have been pioneers in the application of superheated steam to locomotives, and apparently with success. The Prussian State Railways are using superheated steam on both freight and passenger locomotives. The engines are fitted with both Schmidt and Pielock superheaters. One of the latest Atlantic type locomotives fitted with the Pielock superheater is exhibited at St. Louis. In the early attempts to use superheated steam the principal difficulty was in maintaining continuous and effective lubrication of the moving parts exposed to the high temperature of the steam. This difficulty seems to have been overcome, however, by using a mineral oil. It has also been necessary to redesign the valve and valve chests of engines using superheated steam. Some tests have already been made in this country with locomotives fitted with a superheater, notably on the Canadian Pacific, while other roads intend to experiment along this line. There has never been much doubt as to the thermo-dynamic efficiency of engines using superheated steam. In fact, data is plentiful showing that the cylinder efficiency of both stationary and locomotive engines having simple cylinders and using superheated steam is higher than that realized from compound engines using saturated steam. The perfection of the superheated steam locomotive will settle an important problem in locomotive engineering, making it possible to obtain all the advantages of compounding without introducing the objectionable features. Of course, the addition of the superheater adds to the complication of the boiler, but experience so far shows that the superheater is not expensive to maintain nor unduly liable to failure in service.

## THE FRANCHISE IN CAPITALIZATION.

In the last Legislature of Massachusetts a measure which received its *quietus* near the end of the session a few weeks ago quite failed to attract the outside attention merited both by the novel points which it raised and by its character as a proposed inversion of the Massachusetts policy in regard to capitalization of public service corporations. The bill was reported favorably by the Committee on Street Railways, though, as it appears, after somewhat hasty and inadequate consideration, was then strenuously opposed by the Railroad Commission of the State, as represented by its chairman, but was passed by the Senate; and, finally, after considerable discussion pro and con in the press of the State, was defeated by a considerable majority in the lower House. Not until almost at the last was the significance of the bill fully measured.

It was styled a bill "for an extension of

the corporate powers of the Western Massachusetts Street Railway Company," under which title it was sought to build up in the western part of the State a great street railway system which, potentially, might include the street railways of Springfield and other cities. But the special charter—which the bill in effect was—went in its gift of power and privilege far beyond mere geographical plans of merger and consolidation. In the first place, the new company could buy out the stocks and bonds of other railways—at market value—giving its own stocks and bonds in return; it could condemn, under rulings of the courts and its appraisers, the minority shares of dissenting stockholders apparently without any ruling on the public interest, as required by the new Connecticut law; and the corporation could go into the business of supplying heat, light and power to corporations and persons. Massachusetts has stoutly and consistently opposed capitalization of steam and electric roads on any other basis than replacement value; this bill proposed to let a new corporation capitalize on a basis of market value of absorbed companies, and then, to a large degree, capitalize the franchises and what may be called "non-physical" elements. Massachusetts has also, thus far, refused to let street railway companies supply heat, light and power to other corporations and persons, though, we believe, they can sell electricity *en bloc* to a municipality; this bill allowed the street railway company to cross the old barrier and establish a precedent that would certainly be followed by a general demand of other street railway corporations for the same privilege.

But the most interesting point was raised in the debate by the advocates of the bill. The State of Massachusetts, it was said in substance, allows a prosperous street railroad to pay dividends which carry the stock up to, say, $180 or $200 a share. Has not such a company, in effect, capitalized its franchise along with its other assets of earning power? Again, with what consistency can it require—under its law of sale of new issues of stock at market value—new buyers to pay a higher price for the "franchise" factor, whatever it may be, than the original investor; or, if that original investor takes his new stock, to pay an enhanced price as a result of his own good judgment and the presumptive good management of his corporation? Ought the State thus to fix indirectly two values for franchises and, in a sense, penalize successful street railway administration? And, if it does so, does it not at least sacrifice consistency? In the case of the Western Massachusetts bill the theory of the State as to replacement value advances a step further in paradox and forbids an outside company to invest on the same basis of market value which it insists upon in the case of the individual. It proposes one rule for the corporative shareholder, another for the private stock owner. This was one of the arguments in the debate and it certainly had a theoretical force.

It can be met, in part at least, by the counter pleas that, in relation to public interest an investing corporation undoubtedly stands on a different plane from an individual; that the corporation has special powers that the individual has not; that, if the State fixes different and varying franchise values the original investor knows it when he enters a street railway or steam railroad enterprise, and the principle of *caveat emptor* applies; and, finally, that perhaps some inconsistency in an occult financial question can be pardoned in State policy if the end of restraining over-capitalization is gained, to the benefit of public interest. Massachusetts, in the case of this particular bill, is the first State, we believe, to raise in her legislature and in concrete shape this question of variable valuation of franchises as a basis of capitalization. Most of our commonwealths either dodge the principle entirely or leave the whole subject in so obscure a form in their statute books that it loses all practical value in application and, under either general or special acts—or both—corporations in fixing capital accomplish their ends without much legislative resistance or controversy.

The theories of primary or secondary capitalization of the public service corporation in the main can be reduced to three. There is (1) the replacement value, or, what is substantially the same, capital based on actual and honest outlay. It is the conservative plan, subject only to the minor criticism of variation of cost at different periods and of penalty paid to virtue by some loss of enterprise in a State which, like Massachusetts, adopts it. There is (2) capitalization based on earning power, a variable quantity, subject to mutation and abuse and going largely on the theory of absolute corporative ownership of the franchise; and (3) a combination of the two foregoing theories, with net earnings divided so as to pay a fair return on original investment and the rest capitalized into a franchise value and returned as a percentage to stockholders or the State or the municipality, according to the idea of franchise ownership. The last theory, in which Michigan to some extent has been a pioneer, is pretty academic and we shall hardly find it realized on a large scale. What we do see, however, in the complicated question of franchise values, is the constant and increasing effort both of trained economists and more callow lawmakers to reach out to the subject, albeit in a blind and groping way. Sometimes the object is taxation, sometimes lower fares, sometimes improved public service. It is the result, doubtless, of that closer and more intense relation—compared with the steam road—created by the street railway and the larger concession and value which its franchise on the highway and city street usually represents. The Massachusetts example is a case somewhat novel to-day, but which may be typical to-morrow.

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While the Erie has greatly increased the number of its locomotives in the past few years, it has not increased its shop facilities in the same ratio, and hence cannot put its engines through the shops as frequently as the conditions require. Plans are under way for the construction of new shops and the enlargement of old shops, but it will take at least several years to increase the facilities so as to adequately handle the equipment. For this reason, the road has found it necessary to have some work done in outside shops, and with this end in view, arrangements have been made with several contract shops to repair engines at the rate of one a day for the next two years. In all, about 600 engines will be repaired in other than the railroad company's shops. The letting of this contract is understood to have no special significance other than above noted, as the road expects ultimately to handle all its equipment in the company's shops. However the case may be, the above mentioned contract calls to mind discussions which have frequently taken place, as to the advisability of railroads having heavy repairs made by contract. Under ordinary conditions the roads can probably repair locomotives cheaper and more satisfactorily in their own shops, but when conditions are such that contract shops are not overtaxed with new work, it is reasonable to expect that repair work can be done cheaply. Most contract shops have modern tools designed specially for certain classes of work. Comparative figures are not at hand, but it would seem that even if the actual cost of contract repairs were somewhat greater than the cost at the railroad company's shops, it might pay a road to have at least a part of its work done by contract. The road would save the interest on a large investment in tools and machinery. In any event, the success of contract repairing would depend largely on the thoroughness with which the railroad company's inspectors do their work.

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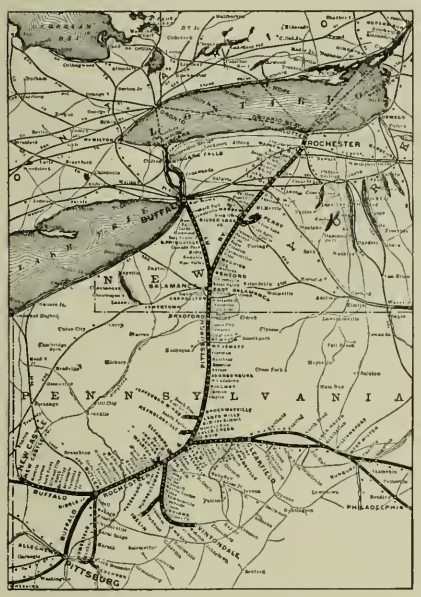
### Buffalo, Rochester & Pittsburg.

The report for the fiscal year ending June 30, 1904, shows gross earnings of $7,529,958, an increase of $232,039 over last year, on a mileage worked of 499 miles, as against 472. Of the increase in gross, passenger earnings contributed $110,483, and freight earnings $134,443. The gain in the latter case is especially noteworthy, because it was made on a decreased revenue tonnage, caused by the failure of connecting carriers to promptly receive the freight offered during the winter months, on account of the severity of the weather. The ton-mile revenue increased, amounting to 5.4 mills; .1 mill more than in 1903. The average distance each ton was hauled was 147.8 miles, an increase of 2.2 miles.

The same factor, the extremely severe winter, which materially lessened the traffic of the company, also helped to swell the maintenance charges. Operating expenses for the year were $4,408,807; $331,218 more than in 1903. The largest part of this increase is credited to the maintenance of equipment and conducting transportation accounts, in which the expenses were respectively $146,224 and $113,332 more than in 1903. The ratio of operating expenses to earnings was 58.5 as compared with 55.8 in the previous year. Following the large increase in operating expenses, net earnings showed a decrease for the year of $99,179. After payments on account of interest, rentals, taxes and sinking fund, there remained $1,513,264 net income, as against $1,781,594 last year. But from the net income, an increase of $185,000 in dividends was paid on the common stock, the rate being increased from 4½ to 6 per cent. For extraordinary expenses and improvements, $92,389 was charged to net income, as against $42,015 last year, and in addition, $405,000 was appropriated for special purposes. The item of special appropriations represents the principal of the car trust bonds paid off during the year amounting to $81,000, and $324,000 of construction expenditures. Last year $908,734 was appropriated for like purposes.

Equipment obligations show the same

large increases which have been so constant a feature in the reports of this company for the last three years. During the past fiscal year a total of $974,000 equipment bonds were issued, and $2,000,000 additional were authorized. The net increase in bonded debt was $893,000, as $81,000 of car trust bonds were paid off and cancelled. The balance sheet now shows car trusts at $4,535,000, as compared with $3,642,000 in 1903, and $2,579,000 in 1902. The number of locomotives owned increased 12 during the year, and an addition of 953 cars was made to freight car equipment. The average car capacity showed a fair gain and now stands at about 32½ tons as against 31¾ tons last year. The average freight train load decreased, being 439.1 as compared with 441.5 in 1903, and the percentage of loaded cars in freight trains also showed a slight decrease, from 58.05 in 1903 to 57.91 in 1904. On August 1, 1903, 28 miles of the Indiana branch from Ernest, Pa., to Indiana Junction, were opened for traffic. Fifteen miles of second




Buffalo, Rochester & Pittsburg.

track between Ashford, N. Y., and Punxsutawney, Pa., were also placed in operation during the year, and extensive improvements were made on the yards and buildings at Buffalo Creek and Elk Run Junction, Pa. In addition a new yard was built, at East Salamanca, N. Y.

The surplus of the Rochester Coal & Iron Company amounted to $598,872, and after payment of dividends a sum of $320,000 was left to be added to the profit and loss account. The Adrian blast furnace, at Falls Creek, Pa., was finished during August, 1903, at a cost of $613,498. To provide for this expenditure, $250,000 4½ per cent. sinking fund gold bonds were issued, leaving in the treasury $750,000 of the $2,000,000 bonds which were authorized last year, half of which were issued at that time. The accompanying table gives the more important statistics of operation:

| | 1904. | 1903. |
|---|---|---|
| Total mileage worked | 499 | 472 |
| Passenger earnings | $1,038,172 | $927,689 |
| Freight earnings | 6,446,365 | 6,311,922 |
| Other earnings | 11,983 | 10,076 |
| Total earnings | 7,529,958 | 7,297,919 |
| Maintenance of way | 589,412 | 532,744 |
| Maintenance of equipment | 1,134,748 | 988,524 |
| Conducting transportation | 2,516,643 | 2,403,311 |
| Total operating expenses | 4,408,807 | 4,077,589 |
| Net earnings | 3,121,151 | 3,220,330 |
| Net income | 1,513,264 | 1,781,595 |

## The Uganda Railroad.

The Uganda Railroad Committee appointed by Lord Salisbury in September, 1895, to supervise building the railroad from Mombasa, on the east coast of Africa near the fourth degree of latitude south, to the upper part of Lake Victoria Nyanza through the southern part of British East Africa, has now presented its final report. After the greatest difficulties, both foreseen and unforeseen, the road was finished, so far as essentials for operation are concerned, early in 1903, although traffic was moved on such portions of the line as were ready for use, several years previous. The present report gives a general resumé of the entire situation and compares the actual results, both as regards expenses and as regards profits, with the preliminary estimates, in a highly interesting manner.

The motives that led to this remarkable project and the early progress made in the work have been quite fully discussed in previous issues of the *Railroad Gazette*. Comment was made (April 27, 1894,) to the effect that, following the advice of the late Sir Gerald Portal, the British Government had avowed its purpose of establishing a protectorate over Uganda and that Africa had far more to gain than England from such a protectorate, inasmuch as the occupation of the Central African country, so far as any commercial profit could come to England for a generation or two, at least, was a great waste of human energy. But the British Government felt that obligations had been placed upon it which could not be ignored and a government was set up in the interior of Africa, 700 miles from the coast by the shortest caravan route through the hostile wilderness between Lake Nyanza and the Indian ocean. At that time, it was estimated that the carriage of goods between these points cost from $1,200 to $1,500 a ton.

Following the reconnaisance survey in 1891 and 1892, during which a total party of nearly 500 persons, of which seven were Europeans, marched over 4,280 miles of African wilderness and surveyed 2,724 miles, the committee finally recommended that the gage should be one meter, that the road should be laid with 50-lb. steel rails and steel ties, with grades in no case steeper than 2 per cent., although these recommendations changed quite radically the character of the railroad from that originally proposed in the McDonald-Pringle report of 1892. As a matter of fact, the engineering difficulties, pure and simple, were much less formidable than the difficulties of organization of labor, supplies and the commissariat. The troubles of the East African railroad builder are well portrayed in the comment made by the committee on some of the situations which had to be met. The population of the districts traversed is so sparse, amounting to from eight to twelve persons per square mile, of whom only one-sixth are males of working age (and these highly unwilling to work) that the hope of securing native labor had to be entirely abandoned. Even under the pressure of famine in 1898 and 1899, nothing would persuade them to work continuously or systematically, and had any attempt been made to bring laborers from Uganda or elsewhere in the British sphere, it would have failed, for the fear of the slave policy was fresh in the minds of the natives and they were unable to discriminate between contract labor and slave labor.

It was decided, therefore, to bring in laborers from India; but difficulty at once arose with the Indian Emigration Act relative to the departure of laborers from India to work for hire, and, although in 1896 an amendment was passed scheduling East Africa as a country to which emigration might be permitted, the terms of the amendment were highly onerous. It was provided, for example, that the term of service was not to exceed three years, that the remuneration was to include free rations, besides payment far higher than that customary in India, where the natives provided their own food supplies in contract work. Pay was to begin not later than from the date of embarkation from India, and the laborer had to receive full protection and support from the company and "an indefeasible right to a return passage to the place of recruitment, not merely to India, at the expense of the company"—whether he worked or not. In a word, life was made so pleasant for these laborers that they scarcely worked at all, and the outturn was reported at an average of 16 cu. ft. of earth work per man per day. After another modification was made, permitting the use of task, or piece work, the railroad builders were troubled by the outbreak of plague in India and the closing of ports to emigration.

With the labor problems disposed of, there remained the exceedingly unhealthy climate; the great difficulty in obtaining water and provisions; hostile tribes, and the tsetse fly. The tsetse fly reigns supreme in the belt of country extending inland for a distance of about 250 miles from the coast, and it was frankly impossible to make use of animal transport in this belt. When the work was first started, this was attempted; but, after an aggregate loss of about 60 per cent. of the bullocks, 20 per cent. of the donkeys and 50 per cent. of the camels, it was given up. Then two special traction engines and trains of wagons were tried, and these were subsequently doubled in numbers and did much useful work, connecting with a mule service beyond the fly belt.

So, overcoming the old difficulties and solving new ones, the work gradually progressed with the rail head as a base, and the advance gangs, together with the commissariat, working out ahead in extended order, in arms always against sickness and against hostile tribes, as they made their way through the wilderness. From the coast terminus at Mombasa to Port Florence on Victoria Nyanza, the northwestern terminus of the line, right under the equator, the distance is 584 miles by the route built, and the paying traffic, so far as it exists, consists of copra, beans, grain, hides and skins, and ivory, besides which, from Lake Nyanza, there is rubber, oil seed and coffee. The only traffic figures on hand are those for the year 1902-1903, when the steamer service now established on Lake Nyanza did not exist. The committee compares the actual returns for this year with the preliminary estimates made ten years earlier and submitted to Parliament; and, on the whole, the closeness of this early estimate with the results actually obtained is quite surprising. The comparison is shown in the following table:

| | Anticipation. of 1893. | Actuals, 1902-03. |
|---|---|---|
| Passengers (coaching), parcels etc. | £25,375 | £24,303 |
| Mail subsidy | 1,000 | 2,761 |
| Exports, i. e., down traffic, 3,511 tons | 16,500 | 6,612 |
| Imports, i. e., up traffic, 12,694 tons | 19,075 | 53,652 |
| Total | £62,000 | £87,328 |

It will be seen that the passenger business was very close indeed to the estimate; that the mail subsidy was higher than estimated, and that, although exports were considerably less, the imports were far greater than preliminary figures. It is to be feared that the 12,694 tons of up traffic represent to a large degree what we are accustomed to account as company business and that this was

charged up at commercial figures. Nevertheless, the government business done in carrying stores to the capital of the Protectorate was undoubtedly very considerable, and it is evident that the same government business done by the old caravan method would have cost vastly more.

It is pleasing to note that one of the prime objects of the railroad, that of stopping the slave trade of the interior, has been fully accomplished, and the committee reports that slave caravans and the transit of slaves to the coast has entirely ceased since the railroad was built. The squadrons engaged in watching that sea traffic consisted of five small cruisers, costing some $500,000 a year to maintain, and the reduction in this police work will apparently by itself go far to turn the operating deficit of the road into profit for the government. It is, of course, still too early to tell what the road is going to do commercially. The total expenditure out of parliamentary grants up to the time the committee ceased to control the outlay was $25,840,620, and the cost of the line per mile, built, bridged and ballasted throughout, with 2 per cent. ruling gradients, complete work shops and a full complement of rolling stock was approximately $46,190. By way of comparison with other African lines, the following table of costs per mile is given:

| | |
|---|---|
| Uganda Railroad, complete | $46,190 |
| Lagos Railroad (estimated) | 34,020 |
| Gold Coast | 38,880 |
| Congo (2 ft. 6 in. gage, heavy gradients) | 48,600 |
| Cape | 51,117 |
| Natal | 53,460 |

The report is signed by John Kirk, Chairman, and F. L. O'Callaghan, managing member of the committee.

A rare opportunity to study the interaction of politics upon government owned and controlled industries is offered by the frequent discussions on the State railroads in the Prussian Diet. Complaints are constantly made of the way the government railroads treat the agricultural East. Minister Budde is frequently obliged to champion the government's railroad policy and to prove that the section of each complaining representative is receiving its proper attention from the government. The government is careful not to go too fully into the matter of railroad tariffs, but is always glad to emphasize the increasing surplus derived from its management of the railroads. It also has much to say about its large orders for railroad equipment, which it claims is an untold blessing to the German iron and steel industries.

In reply to the attacks of the representatives, Minister Budde is doing his best to prove that the government is not falling behind in the construction of new railroads. The question seems chiefly to involve the construction of branch lines, in themselves unprofitable, but important as feeders to the main lines, a familiar state of things in the United States. We obtain a rather comical picture of representatives of various sections appearing before the Minister pleading for new railroads, or a change in the rates. The Minister appreciates fully that each representative thoroughly and sincerely believes the extension of the railroads of his district is the most important question of the day. When deputations paint in glowing colors the prospective traffic available to a new road, the Minister—who evidently has a strong sense of humor—urges them to hurry home and build the railroad themselves.

One gathers that government ownership and control of railroads in Germany has solved the railroad question no more effectively than private ownership has done in Great Britain and the United States.

## NEW PUBLICATIONS.

*Rights of Trains on Single Track;* by Harry W. Forman; 477 pages 4¼ x 7 in.; pocket book, bound in leather, with round corners. The *Railroad Gazette*, New York, Chicago and London. Price, $2.50.

This book is an exhaustive commentary on the Standard code of train rules of the American Railway Association, and is a thorough study—so much more thorough and complete than anything of the kind which has been attempted before as to put it beyond comparison. Mr. Forman, who is a chief despatcher on the Denver & Rio Grande, has been an examiner of trainmen and operators on that and other roads for many years, and one needs to read but a few pages of his book to see that he is an accomplished doctor in this work. Every page shows the fruit not only of experience, but of study and reflection. As will be readily appreciated by anyone familiar with the Standard code, and the process by which it has been developed in the American Railway Association during the past fifteen years, a study of this kind, by such a man, produces a most interesting treatise. Discussions of these rules in the Association have been either fragmentary and incomplete, or else so long and tedious, as to be of but moderate value to those who read them after they come out in cold type; and the reports of the committees have often been unsatisfactory because of their brevity, or of the necessity of keeping silent on disputed points. The independent individual writer is free from the restraints of a committee, and he avoids the pitfalls that surround a speaker in a convention, so that Mr. Forman's book is really the first comprehensive and satisfactory study of the Standard code that has ever been written.

The book is made up in the form of questions and answers, like the "Catechism of the Locomotive." These questions number nearly twelve hundred, covering in the most painstaking manner all of the intricate questions that come up in making examinations. Where the answer is long and is susceptible of treatment in the shape of a little lecture, such a lecture is given. Every standard rule is considered and the most common supplementary rules such as additions to 83, 104, etc., are fully discussed. Extracts from the book were given in the *Railroad Gazette* of August 19 and in several earlier issues. From these and from special articles by Mr. Forman which have lately appeared in these columns, it will readily be seen that we have here a train-rule expert who, while possessing the patience and close application necessary to plod through the interminable details of train order forms and hair-splitting rules, at the same time does not lose sight of the broad general principles. And the reader will not only like the author's literary style—the book is agreeable reading—but will also agree with him, we think, in most of his opinions.

## TRADE CATALOGUES.

*The Locomotive Appliance Company*, St. Louis, Mo., issues a pamphlet describing the Allfree valve gear and valve for the Allfree-Hubbell locomotive. This valve mechanism is an addition to the link motion and can be supplied to any locomotive. It is claimed that this valve movement delays the opening of the exhaust port at all parts of the cut-off, thereby increasing the ratio of expansion and decreasing the terminal pressure, thus getting more work out of any given quantity of steam admitted to the cylinders. Detailed illustrations and a description of the mechanism are given, including indicator diagrams, etc.

*Angus Sinclair Company*, New York, publisher of Railway and Locomotive Engineering, sends a framed copy of its educational chart No. 7. This is a half-tone reproduction of a finely executed transparent wash-drawing of an Atlantic type locomotive, with each part numbered, and an index on the margin. The chart is very helpful to the layman who desires to familiarize himself with locomotive nomenclature.

*Riehlé Brothers Testing Machine Company*, Philadelphia, Pa., sends a pamphlet describing a 600,000 lbs. standard vertical-screw power testing-machine with dial screw beam. This machine was made for the University of Illinois, and is to be used for general testing purposes. A brief description of the machine is given, together with a large plate drawing showing two views.

*The Nernst Lamp Company*, Pittsburg, Pa., is distributing a pamphlet descriptive of a street lighting system which it has installed at Berwyn, Ill. Illustrations are given of the power plant, street scenes and a plan of Berwyn showing the distribution of the Nernst lamps. About 250 lamps of 60 c.p. each are in use at the present time.

*The Newton Machine Tool Company*, Philadelphia, Pa., is distributing Catalogue No. 39, relating to cold saw cutting-off machines. The machines which are illustrated and described are adapted to the cutting of round and square stock, I-beams, channel bars, armor plates, nickel steel and gates or risers on steel castings.

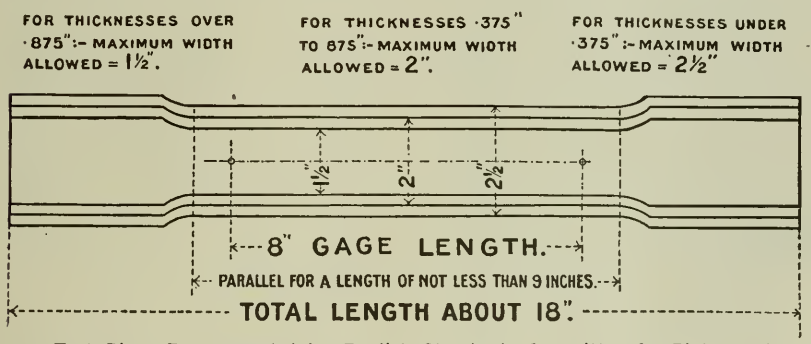
## Standardization of Specifications for Iron and Steel.*

The desirability of bringing about greater uniformity in specifications governing iron and steel is generally recognized, and has found expression within recent years in the efforts of numerous technical societies in that direction. When the International Association for Testing Materials was organized at Zurich in 1895, a committee was appointed, charged as follows: "On the basis of existing specifications, to seek methods and means for the introduction of international specifications for testing and inspecting iron and steel of all kinds."

The American representation on this international committee consisted originally of five and now of eight members. In view of the magnitude and importance of the subject, the Executive Committee of the American Section of the International Association for Testing Materials, since incorporated as the American Society for Testing Materials, appointed a committee of 34 members, including the American members of the above-named international committee, to frame standard American specifications for iron and steel. This committee reported on specifications for (1) structural steel for bridges and ships; (2) structural steel for buildings; (3) open-hearth boiler-plate and rivet-steel; (4) steel rails; (5) steel splice-bars; (6) steel axles; (7) steel tires; (8) steel forgings; (9) steel castings; (10) wrought-iron. These specifications were designed to be fairly representative of the best current American practice, and were adopted by let-

*From a paper by W. R. Webster and Edgar Marburg, read at the last meeting of the American Institute of Mining Engineers. This subject has been discussed editorially in *Transport and Railroad Gazette*. A reprint of the editorial will be found in the General News Section, so as to avoid having it appear again in the English edition.

ter-ballot of the society in August, 1901. The leading engineering societies have participated at various times in the discussion of these specifications and have lent valuable assistance through the appointment of special committees on like or closely related subjects. The American Society of Civil Engineers discussed the specifications for structural steel for bridges and ships, and appointed a committee on steel rails to report on sections, methods of manufacture, specifications, and methods of testing and inspection. The American Society of Mechanical Engineers discussed the specifications for boiler-plate and rivet-steel, steel forgings and steel castings, and a committee of that society presented last year a report on these specifications, subject to revision, recommending certain modifications. The American Railway Master Mechanics' Association appointed a committee to report on the specifications for steel axles and steel forgings. This committee made a preliminary report last year, and has the matter still under consideration. The American Railway Engineering and Maintenance of Way Association appointed separate committees to report on specifications for bridge materials and steel rails. These specifications, which differ somewhat from those of the American Society for Testing Materials, were adopted by vote of the association, the


FOR THICKNESSES OVER ·875":- MAXIMUM WIDTH ALLOWED = 1½".
FOR THICKNESSES ·375" TO 875":- MAXIMUM WIDTH ALLOWED = 2".
FOR THICKNESSES UNDER ·375":- MAXIMUM WIDTH ALLOWED = 2½"
1½"
2"
2½"
8" GAGE LENGTH.
PARALLEL FOR A LENGTH OF NOT LESS THAN 9 INCHES.
TOTAL LENGTH ABOUT 18".

Test Piece Recommended by English Standards Committee for Plates and Structural Material.

*Widths given above, being maxima, do not exclude the use of the usual* 1½ *in.* × 8 *in. test piece.*

former in 1903 and the latter in 1902. The committee on steel rails has been instructed, however, to consider certain proposed modifications. The American Institute of Mining Engineers has co-operated in this work by discussing the specifications for steel rails, steel forgings and steel castings, and is now asked to assist again by including in the discussion on the "Physics of Cast-Iron" the specifications proposed by the committee on standard specifications for cast-iron and finished castings of the American Society for Testing Materials. These specifications, which will be presented at this meeting by the chairmen of the sub-committees concerned, comprise (1) specifications and grading of pig-iron; (2) cast-iron water and gas-pipe; (3) cylinder castings; (4) car wheels; (5) malleable iron; (6) general castings and methods of testing.

The above presentation covers in brief outline the recent history of the movement on the part of technical societies in this country in the direction of the standardization of specifications for iron and steel. The desirability of arriving at some uniform basis of reasonableness in specifications governing iron and steel products is too obvious for extended argument. The ordering of material which is to be subjected to similar or identical conditions of service under a great multiplicity of specifications, differing often more in the letter than in the spirit, is harassing to the manufacturer and of no real advantage to the consumer. The latter should recognize that any unnecessary burden imposed on the manufacturer must necessarily react in the end upon the consumer, and increase the average cost of the product without attendant gain in average quality. On the other hand, the manufacturer should recognize his obligation to spare no reasonable effort or expense to ensure a high-grade product of uniform quality, and should evince a willingness to provide adequate facilities for testing.

The existing differences between the leading specifications framed within recent years are in the main on matters of minor importance, and what has been done has resulted in a considerable clearing of the atmosphere. That further efforts will be put forth to reconcile the remaining differences as far as possible cannot be doubted. If the task be approached in a fair and open spirit of compromise between interests whose divergence, broadly viewed, is more apparent than real, all parties will be the gainers. If this work be promptly initiated, it is not too much to hope that American standard specifications approved by the leading technical societies, and covering the principal iron and steel products, will be available for presentation at the seventh session of the International Railway Congress to be convened in Washington, D. C., in May, 1905, and that they will prove an important step towards the ultimate realization of international standard specifications.

Turning now to a brief review of the present situation in England, it will be seen that much the same agencies have been set at work there, and that the outlook is in some respects even more auspicious than in America.

The movement in England had its origin in the appointment by the Institution of Civil Engineers of a Committee on Engineering Standards, which began its labors in 1901. The Institution of Civil Engineers secured the co-operation of the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute and the Institution of Electrical Engineers, and the appointment by these several societies of representatives on the committee. According to a recently published announcement these "five leading technical institutions are thus actively and financially supporting and controlling the operations of this important movement."

In recognition of the great national importance of this undertaking, the British Government has lately authorized a grant of $15,000 towards the necessary expenses, and the India Government has agreed to contribute an additional sum of $5,000.

The War Office and Admiralty Departments, who are among the largest users of iron and steel, are actively co-operating in this work, and there are now more than 24 representatives of the Government on the various sub-committees. Representation on these committees has also been accorded to numerous engineering, scientific and trade organizations, to the International Association for Testing Materials, as well as to the leading manufacturing and consuming interests.

The scope of the field which this Committee on Engineering Standards proposes to cover may be judged from the following list of committees and sub-committees:

1. Sections used in ship building (11 members).
   (a) Sub-committee on tests for iron and steel material used in the construction of ships and their machinery (23 members).
2. Bridges and general building construction (12 members).
3. Railroad rolling-stock underframes (13 members.)
4. Locomotives (28 members).
   (a) Sub-committee on component parts and tires (14 members);
   (b) Sub-committee on steel plates (seven members);
   (c) Sub-committee on tires, axles and springs (six members);
   (d) Sub-committee on copper and its alloys (six members).
5. Rails (22 members).
   (a) Section on railroad rails (11 members);
   (b) Section on tramway rails (four members).
6. Electrical plant (22 members).
   (a) Sub-committee on generators, transformers and motors (13 members);
   (b) Sub-committee on temperatures of insulating materials (five members);
   (c) Sub-committee on cables and conduits (11 members);
   (d) Sub-committee on telegraphs and telephones (seven members).
7. Screw-threads and limit-gages (26 members).
   (a) Sub-committee on screw-threads (26 members);
   (b) Sub-committee on limit-gages (17 members).
8. Pipe-flanges (12 members).
9. Cement (17 members).

Three of the above-named committees have considered independently the question of "Standard Sections for Rolled Iron and Steel," and have held joint meetings and have agreed upon standard sections which have been adopted and published.

It will be seen from the foregoing that the English Engineering Standards Committee is operating on lines quite similar to those adopted by the American Society for Testing Materials. Both have recognized the desirability of giving fair representations on their committees to all parties in interest, including the manufacturers. The work is divided among numerous sub-committees whose reports are submitted to the parent committee, which in turn makes its report to the technical societies which it represents.

The work in England is much facilitated, however, first from the fact that the five leading technical societies are co-operating through the medium of a single, jointly-appointed committee; and second, by reason of the liberal financial support which the Government has lent to the undertaking.

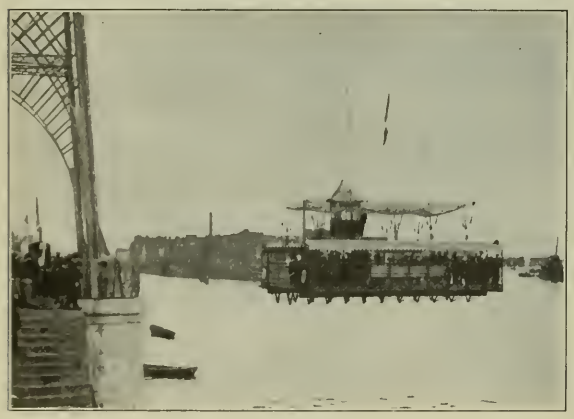
Notwithstanding certain disadvantages, however, the progress that has been made in this country during the past few years towards the standardization of specifications is distinctly creditable; and it is confidently expected that the moral and financial support for continuing this work along broader lines will be duly forthcoming.

## Suspension Ferry Over the Loire River at Nantes, France.

BY B. H. RIDGELY.*

The suspension ferry, or Pont Transbordeur, which has recently been built over the Loire river at Nantes, France, is a simple means for crossing a river where a strong current interferes with regular ferry boats. Although there are several other overhead ferries in existence, the most important of which are at Bilbao, Spain; Tunis, Bizerte, and at Rouen and Martrou, France, the one at Nantes is especially interesting, as it involves a new principle of construction and is the only one operated by electricity.

The Pont Transbordeur is built high up over the channel of the river and leaves the waterway free, without requiring vessels to signal or change their speed. It has no difficult approaches and lands close to the quay, or pier, thus allowing traffic to come aboard directly from the street. As it is built on an air line, it realizes the smallest possible distance for the crossing. The motive power for operating is comparatively light and the cost of construction is relatively small compared to the heavier bridges. The ferry at Nantes fully equipped cost about 800,000 francs ($160,000).



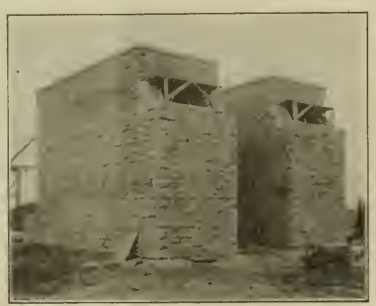
Suspension Ferry at Nantes, Showing Car in Action.

Work on this ferry was begun in September, 1902, and was finished in October, 1903. It is a graceful structure, consisting of two tall steel towers, one on each bank of the river joined together by a horizontal cantilever suspension bridge, 490 ft. long and 165 ft. above the surface of the water, anchored by cables at the ends. An inverted steel carriage travels along rails laid on the bridge and the car or ferry is suspended from this by steel cables. This car has two divisions, one for horses, vehicles and railroad cars and the other for foot passengers. Each of the four legs of the towers rests upon a separate masonry base. The heigth of each tower above the water is 250 ft., and they are capped by steel saddles weighing 8,800 lbs., over which the steel cables supporting the structure are carried. Two stationary motors at the left end of the bridge develop the power necessary for moving the traveling carriage. The watchman who directs the movement of the ferry occupies a place in a small tower on the top of the car where he can keep a lookout for passing ships. The *nacelle*, or ferry car, is built to carry a dead weight of 30 tons, and the crossing is made in about one minute. The average power necessary for operating the Transbordeur is 10 h.p. This may be reduced to 5 or 6 h.p., when there is an absence of wind. Each motor, however, has a capacity of 25 h.p. on account of occasional violent winds, which require a force of about 18 h.p. to successfully operate the car. The Pont Transbordeur at Nantes was built at the works of Mr. Arnodin, at Chateau-sur-Loire, France.

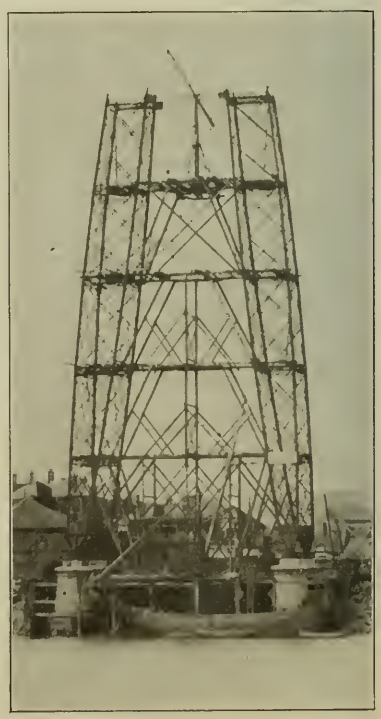
*U. S. Consul at Nantes.

Suspension Ferry at Nantes, France.

In connection with the above description of the suspension ferry at Nantes, our English office sends some interesting photographs and data of a similar ferry which is now being built at Newport, England. The center span of this ferry will be 640 ft. long and 177 ft. above high water mark. The towers are of open lattice steel work and are solidly anchored to the masonry piers by steel bolts and shackles. Each tower will be fitted with a stairway carried to the level of the bridge platform. The estimated weight of steel in a tower is 275 tons. The suspension cables are 16 in number, four inside and four outside. They are connected by steel shackles to the main spindles or pins on the expansion saddles on the top of each tower, the anchoring cables being similarly connected. Diagonal cables are introduced over a portion of the span. The weight of cables and suspension parts is 293 tons. The stiffening girders are 16 ft. deep, being spaced laterally at central distances of 26 ft. 3 in. The weight of the girders and wind bracing is 539 tons. On each side of the web of the bottom boom of each girder a line of rails will be laid; on these rails will run a truck 104 ft. long, furnished with 60 wheels, 15 inside and 15 outside, on each side, with horizontal wheels engaging laterally on the edges of the flange plates. From this truck the car or plattorm is suspended by 30 steel cables which are crossed so as to form a trussing in order to prevent swinging motion either laterally or longitudinally. The car is 33 ft. long by 40 ft. wide. It is designed to carry a test load of 66 tons in addition to its own weight (51 tons) making a total of 117 tons in all. The car when at rest is housed in the bases of the towers, and does not project into the river. Spring buffers will be provided at each pier to arrest the motion of the car. The motive power will be electricity, the motors being controlled from the moving car. The anchorages are massive blocks of masonry built on pile concrete foundations. They are pierced with galleries for the passage of the anchor cables. The weight of masonry above and in front of the blocks taking the reaction is 1,100 tons, the calculated effort 911 tons. The total weight of each anchorage is approximately 2,000 tons. The foundation piers, eight in number, are masonry wells 20 ft. in diameter. They have been sunk by compressed air through the alluvial deposit to the marl underlying the river bed. A steel shoe, with cutting edge covered in with an



Piers for Suspension Ferry.



Suspension Ferry at Newport, England.

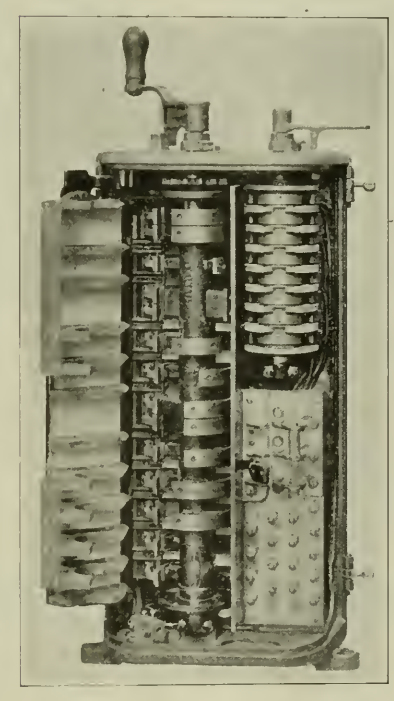
Ballston Line—Schenectady Railway Company.

General Electric Alternating Current Motor Car—Ballston Line.

armored concrete dome forming a working chamber and fitted in the crown with the usual air shaft, was first placed in position, the sinking being performed in the usual way, the walls being carried up as the sinking proceeded. Comparatively little trouble has been experienced in sinking, though the extremely tenacious nature of the clay on the western bank presented some difficulties. The sinking has proved the accuracy of two sets of borings, taken independently by different persons. On the eastern bank the upper portion of the marl proved somewhat softer than the borings indicated, and necessitated a descent of 3 ft. lower than the contract depth in the three piers already sunk on that side. The maximum depth of foundation below the river bank is 86 ft., or 71 ft. below high water mark of ordinary spring tides. The total load per square foot of foundation is 5½ tons.

### General Electric Single Phase Alternating Current Compensated Motor.

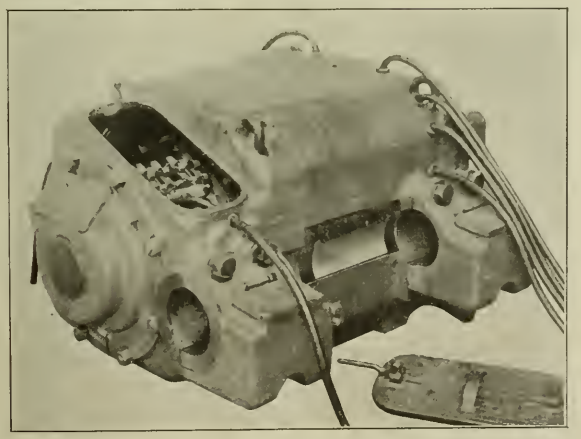
Electric railroad motors in general use throughout the world are operated, as is well known, by direct current with a trolley voltage of about 600 volts. For heavy service and extended systems the cost of copper required at 600 volts becomes a serious item, and for some time there has been felt the need of a higher trolley voltage. The use of alternating current for the trolley would admit of a higher voltage than is possible with direct current. The development of large power stations and transmission systems has been principally with alternating current, requiring rotary converters, or other commutating devices for changing the alternating current into direct current suitable for the operation of electric railways. Obviously there would be a great advantage in a railroad motor equipment that could be operated from an alternating current high voltage trolley and without the necessity of intermediate commutating devices. Such an alternating current equipment would offer a further advantage if it could be operated both on alternating extensions of existing systems, and also, on the direct current trolley where the latter is already installed.



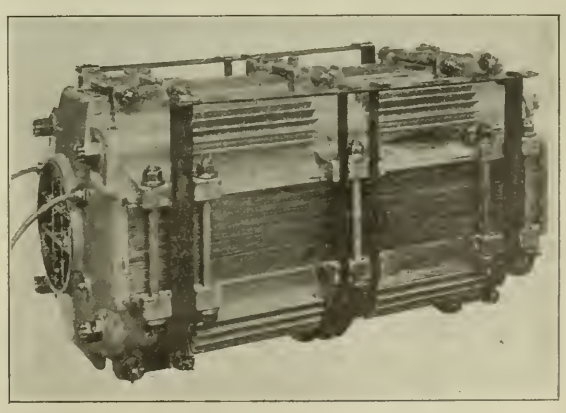
General Electric K-28 Controller.

For several years the engineers of the General Electric Company have been working on this problem, and have developed a type of alternating current equipment suitable for general traction work.

The activity displayed in Europe in adapting the three phase alternating current motor to the conditions of railroad service has never been fully shared by American engineers due to the limitations of the multiphase induction motor. The development of the single phase commutator motor and its inherent fitness for traction work has created very wide attention among railroad interests, and work of a practical nature has been actively pushed on both sides of the Atlantic. Considerable interest therefore attaches to the operation in regular service by the Schenectady Railway Company of single phase alternating current motors on its Ballston extension. This is the first instance in this country of an a.c. road in regular service carrying passengers, and its commercial possibilities are largely due to the fact that the motors operate with a.c. power out-



The General Electric Compensated Alternating Current Railway Motor.



Step-Down Transformer on Car.

side city limits and with d.c. power within the city limits.

The alternating current motor as developed by the General Electric Company and installed on the Ballston line is the "compensated" type, so named on account of the character of the field winding which fully neutralizes or compensates for the armature reaction. Both the compensated motors and control are adapted for operation on the 2,000 volt a.c. trolley between cities and the standard 600-volt d.c. trolley in Schenectady. This ability of the compensated motor equipments to run over tracks equipped with either a.c. or d.c. trolley makes their field of application very broad, as the cars can secure all the benefit of running over existing city tracks without in any way sacrificing their running qualities upon suburban sections equipped with a.c. trolley.

The compensated motor is essentially a variable speed motor differing in this respect from the multiphase induction motor whose constant speed characteristics proved so serious a handicap to its successful adoption in railroad work. The speed-torque characteristic of the compensated motor is very similar to that of the direct current series motor, while its commutating qualities and method of control prove equally satisfactory.

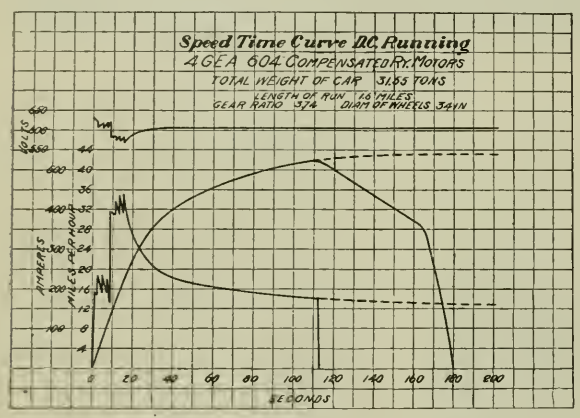
On the Ballston extension of the Schenectady Railway advantage is taken of the ability of the compensated motor to operate with either alternating or direct current. The extension is 15.5 miles long, including 3.9 miles of city running in Schenectady over tracks equipped with d.c. trolley. The interurban section is double track on private right of way, 60 ft. wide, laid with 75-lb. T rail, gravel ballast with maximum grade of 1.8 per cent. Special attention has been given to the high speed possibilities of the road and no curve exceeds 4¼ degrees.

Center pole bracket construction is used, there being two brackets supporting the two 600 volt d.c. trolley wires and a cross arm supporting the two 2,200 volt a.c. trolley wires. The Ballston extension has been operated for several months with direct current equipments, and their operation being continued in part necessitated an additional set of trolley wires for the a.c. equipments which would not interfere with the d.c. trolleys. The center poles are 34 ft. long and are spaced 100 ft. apart, the a.c. and d.c. trolley wires being No. 000 grooved section with no feeders for the a.c. trolley and with a 500,000 c.m. feeder reinforcing the d.c. trolley. The d.c. trolley conforms to standard bracket construction and presents no unusual features, while the a.c. trolley wire is suspended from a ⅜ in. steel catenary. The a.c. trolley is clipped to the catenary midway between poles and the catenary in turn is hung over porcelain insulators on wooden cross arms, the whole forming a construction of great flexibility with the further advantage of providing excellent insulation with standard porcelain insulators and eliminating the span wires adjacent to the trolley wire, thereby preventing the pole catching should the trolley wheel leave the wire. This method of trolley construction is well adapted to high potential high speed work in both its electrical and mechanical features.

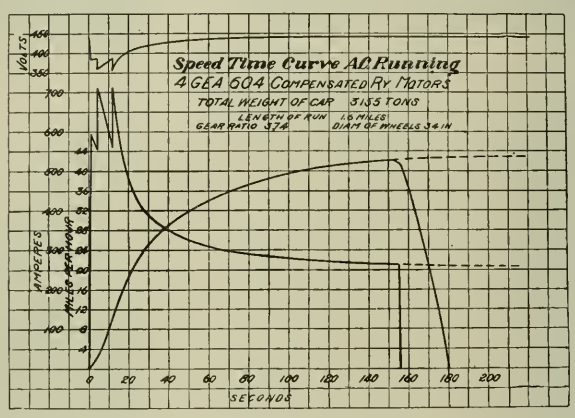
With the a.c. system using a trolley and track return there is an inductive drop in the trolley and rails with an additional loss in the latter case due to eddy currents and hysteresis. Measurements made upon the Ballston line indicate an apparent trolley resistance of 1.3 times the ohmic resistance, and a rail resistance 6.55 times the ohmic resistance.

5 ft. apart and 16.5 ft. above track, while the four 75-lb. track rails are tied together every 1,500 ft. The increased resistance with a.c. current is a serious factor in low voltage a.c. city systems, but since the compensated motor operates perfectly with the d.c. current of our city systems, no general necessity exists for a low voltage a.c. trolley.

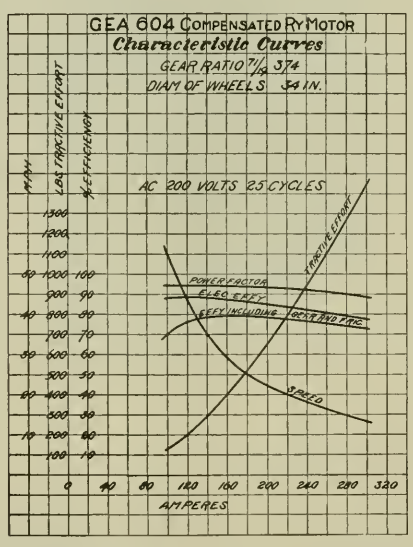
The form of a.c. trolley adopted for the Ballston line is well adapted to the requirements of steam roads where the local service is taken care of electrically and through passenger and freight handled by steam locomotives, pending a complete change to electrical operation. The trolley wire and insulators being off-center are not exposed to the gases of the locomotive, and furthermore a catenary construction placed off-center can be hung much lower than a standard center wire without interfering with brakemen on freight cars. A low running trolley at the side of the car is also preferable in main line operation, as it conforms better to the clearance diagram of such roads without



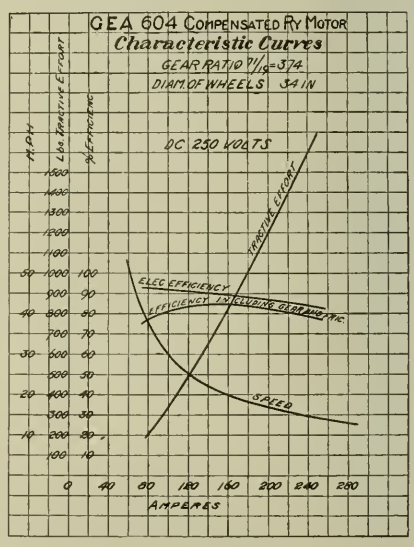

Speed Time Curve of General Electric Motor Car Using Direct Current.




Speed Time Curve of General Electric Motor Car Using Alternating Current.




Characteristic Curves When Using Alternating Current.




Characteristic Curves When Using Direct Current.

*Comparative A.C. and D.C. Resistance of Trolley and Track Per Mile of Circuit.*

| | d.c. Resis. | a.c. Resis. 25 Cycles. | Ratio A.C. D.C. |
|---|---|---|---|
| Two trolleys in series | .318 ohms. | .417 ohms. | 1.31 |
| One trolley and double track | .167 " | .259 " | 1.55 |
| Two trolleys and double track | .088 " | .155 " | 1.76 |
| Double track alone | .0174 " | .114 " | 6.55 |

The resistance of the a.c. trolley wire is somewhat reduced by the steel catenary in parallel with it. The a.c. trolley wires are

calling for too great a change in height of the trolley wheel or bow.

The present sub-station of the Schenectady Railway is temporarily located at Ballston Lake. This sub-station is operated from the distributing system of the Hudson River Power Company, but owing to the fact that this system operates at 40 cycles it became necessary to introduce a frequency changing device, and an inverted converter operated from the sub-station d.c. bus bars afforded the most ready means of obtaining 25 cycle current. The permanent sub-station will be built at Ballston and the inverted converter will be replaced by a motor generator set which will give better regulation than can be obtained from an inverted rotary converter. The sub-station feeds directly into the trolley circuit at 2,200 volts with no outside transformer sub-stations.

Owing to the fact that 25-cycle three-phase generators are almost universally used to supply rotary converters in existing interurban railway systems, the General Electric Company has adapted both the design of the compensated motor and the a.c. distributing system to operate from existing 25-cycle generating stations. As the alternating current motor is single phase, a single phase generating and distributing system commends itself on account of its simplicity. The step down transformers may be tied together on the low tension side through the trolley with consequent reduction in amount of copper required. Each sub-station acts as a reserve to the adjacent one and a transformer may be cut out without shutting down a trolley section.

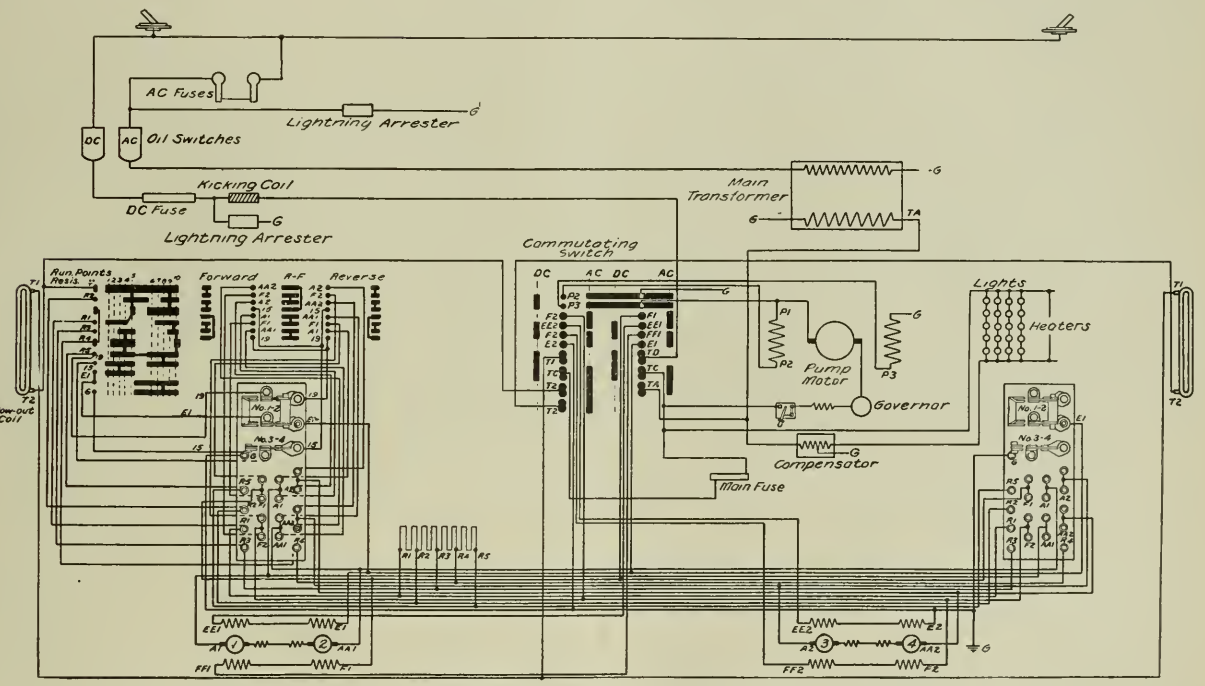
When it is desired to make use of or install a three-phase generator to take care of the operation of rotary converters, induction motors, etc., the preferred arrangement to balance the load at each sub-station is to install three-phase, two-phase transformers connected two-phase on the secondary side and feeding separate trolley sections from the two phases.

The car equipped with the compensated motors weighs 30.4 tons total without passengers and is geared for a maximum speed of about 43 miles per hour on level. The car is made by the J. G. Brill Company and has a 32 ft. body, is 43 ft. over all, and has a seating capacity of 44 passengers. The body is mounted upon Brill No. 27 trucks having 6 ft. wheel base, each truck carrying two compensated motors, each motor equivalent to a 50 h.p. direct current motor, standard railway rating.

The General Electric a.c. compensated motor consists of an annular laminated iron field with a distributed winding similar to that of an induction motor, and an armature provided with a commutator similar in general mechanical construction to a d.c. railroad motor armature. These motors are wound for 200 volts, are permanently connected two in series, and are fed from the 400 volt secondary of an 80 k.w. air blast step down transformer carried on the car. The distributed character of the field winding fully compensates for the armature reaction, so that power factors are relatively high throughout the range of operation. This type of motor is designed so that at the free running speed of the car, which is the condition most frequently met with in suburban work, the power factor and efficiency are nearly at their maximum values. A high power factor is desirable as it reduces the capacity and cost of the generating and distributing systems, and more especially effects a material improvement in the regulation of the a.c. generators. Unlike a d.c. system which has a practically constant potential at the sub-station bus bars, irrespective of the load, the drop in an a.c. railroad system is accumulative up to and including generator and engine regulation. It is desirable therefore to maintain as good a power factor as is consistent with good motor design in order to limit the total drop of the system to a reasonable amount.

A set of motor characteristics is shown in accompanying prints for both a.c. and d.c. running respectively. It will be noted that the speed-torque characteristics for a.c. running are equal to d.c. running in meeting the requirements of railroad work. Unlike the multiphase induction motor with its practically constant speed characteristic, the compensated a.c. motor varies its speed with the load and is thus better adapted to operate trains over an irregular profile. The commutation of the compensated motor is equally satisfactory when running a.c. or d.c., and this good commutation is secured by careful electrical and mechanical design without resorting to high resistance leads or other expedients liable to give trouble in case of sustained heavy overloads.

Our city railroad systems have so expanded and cover such a large territory as to make it very objectionable, both on the score of first cost and complication, to install a separate a.c. trolley at reduced potential in order that cars equipped with a.c. motors may benefit from running over city streets at termini and en route. There is a comparatively small additional expense required to adapt alternating current equipments to run either a.c. or d.c., and in the case of the Ballston line this is accomplished with the use of a standard K-28 direct cur-




Car Wiring Diagram for K-28 Controllers with Four G. E. A.-604 Motors for Alternating and Direct Current.

rent series parallel controller used in connection with a commutating switch to change field connections, cut out step down transformer, change line fuses, etc. The time required to operate the commutating switch is but a few seconds.

The commutating switch is interlocked with two main oil switches, one being in the high tension a.c. and the other being in the direct current circuit; this interlocking being so arranged that only one switch can be closed at a time and the commutating switch can only be thrown when the oil switches are in the off position. Owing to the fact that the a.c. trolley construction is off-center, while the standard city and suburban trolleys are directly overhead, it has been necessary to provide double sets of trolleys, one for a.c. and the other for d.c., hence the necessity of interlocking the oil switches and commutating switch to prevent trouble should both trolley poles accidentally be up at the same time. Where center wire construction is used on both the city and suburban sections, the a.c. and d.c. trolley wires may be overlapped for a short distance to

facilitate changing from one trolley to the other.

With equipments operating with both a.c. and d.c. power it is preferable to utilize the standard series parallel controller in order to minimize weight of controlling apparatus. Such a method of operation will not give quite so high efficiency when accelerating with alternating current as could be obtained with potential control. This difference in efficiency, however, is very small due partly to the infrequency of stops occurring upon those sections of the road equipped with a.c. trolley, but principally due to the flexible character of the speed-torque curve of the a.c. motor which gives a high efficiency of acceleration with series parallel control.

With modern suburban cars, especially those equipped with train control, air-brakes, air compressors, etc., there is some difficulty in suitably locating the proper apparatus, even when equipped for d.c. running only. With cars equipped for both a.c. and d.c. running, using series parallel controller, there will be required but slightly more space and weight than for d.c. running only. Should, however, advantage be taken of the slightly better efficiency of a.c. potential control, such cars must be operated a.c. upon both suburban and city sections with the resulting disadvantages, or the installation of two separate controlling systems must be considered, necessitating a considerable increase in weight and difficulty in providing room for the necessary apparatus.

The efficiency of the potential control is not over 2 or 3 per cent. higher than that of the series parallel control, but the use of the latter, permitting operation both a.c. and d.c., secures the advantage of the higher efficiency of the motors when running d.c. over city streets.

For locomotive or other service where no necessity exists for operation over city d.c. systems, the potential method of control may offer advantages sufficiently great to warrant its adoption.

The 80 k.w. step down transformer is air cooled, forced draught being obtained by motion of the car itself, although in the Ballston line the forced draught has been found unnecessary. The transformer is suspended below the car floor and all primary leading in wires are carried in brass tubing which is grounded. Car lighting and heating is effected from the d.c. trolley in the standard manner, and from the a.c. trolley from the secondary of the transformer. Trolley poles and wheels are standard design, the a.c. trolley pole being somewhat shorter as this wire is lower than the d.c. trolley. The base of the a.c. trolley is treated with vacuum compound and further insulated from the car body by composition insulators. The air compressor for the brakes and whistle is operated by a compensated motor which operates from both a.c. and d.c. circuits.

It is instructive to compare the performance of the compensated motor equipment when operated with a.c. and d.c. current. A set of speed-time runs is shown herewith taken over the same stretch of track with a.c. current and repeated with d.c. current. The d.c. speed-time and ampere-time curves are typical and require no particular comment. The a.c. run taken under exactly similar conditions over the same track illustrates what can be expected from series parallel control with compensated motors. The rate of acceleration is somewhat lower in the a.c. run, hence requiring the application of power up to the moment of braking. The shape of the speed-time curve also is characteristic of alternating current motor work, that is a comparatively short time on the controller with a large amount of motor curve acceleration. The short period of fractional voltage running of alternating current motors makes the method of their control of secondary importance and largely minimizes the economy of potential control over series parallel control.

All speed-time runs taken on the Ballston line were made over a distance of 1.6 miles on tangent level track at an average speed of 32 m.p.h., or a schedule speed of 29.5 m.p.h., including 15 second stops. The compensated motor equipment has thus demonstrated its ability to make as high schedule speed as any suburban road now operating direct current equipments under like conditions. The following constants apply to both sets of runs:

| *Comparative A.C. and D.C. Runs.* | d.c. | a.c. |
|---|---|---|
| Length of run, miles | 1.6 | 1.6 |
| Weight of car, tons | 31.55 | 31.55 |
| Time, seconds | 180 | 180 |
| Average current, power on, amperes | 229 | 346 |
| Average voltage | 606 | 425 |
| Volt amperes, full speed on level | 98 | 110 |
| Volt ampere hrs. per ton mile of given run | 86.3 | 125.5 |
| Average speed, m. p. h. | 32 | 32 |
| Schedule speed, including 15 sec. stop. seconds | 29.5 | 29.5 |

The lower volt-ampere hours per ton mile of the d.c. run is partly due to the better efficiency and power factor of the compensated motor when run d.c., and partly due to the somewhat higher rate of acceleration, permitting some coasting and resulting in a more efficient speed-time curve. The difference in volt-amperes a.c. and d.c. depends upon the length of a given run and the values approach each other more nearly with a run of greater length. It will be noted that the compensated motors run the car at practically the same speed with 200 volts per motor a.c. and 300 volts d.c. This uniform speed is obtained by series paralleling the fields as shown in diagram of connections.

The operation of the Ballston compensated motor equipments will be watched by railway engineers with much interest, as their success will demonstrate the fitness of the alternating current motor for heavy suburban and interurban mixed service. The compensated motor, having demonstrated its fitness for traction work, opens up possibilities in converting main line steam roads which were closed to the d.c. motor and rotary converter combination on the score of first cost and cost of operation. The form of trolley suspension used on the Ballston line is capable of being operated at more than 2,000 volts, which together with its excellent mechanical construction helps to solve the question of current collection of heavy units at high speeds.

## Sampling, Analyses and Preparation of Coal.

BY F. R. WADLEIGH.

Although our knowledge of the qualities of different coals through chemical analyses has greatly increased in the last four or five years and much more attention is being paid now to this subject both by consumers and producers, yet the value of many analyses to the user of coal for steam making purposes is greatly lessened, first by the lack of proper knowledge as to what proportions of the different ingredients should be looked for in a good steam coal, and second by the fact that comparatively few of the interested persons know how (or else they purposely fail) to sample coal for analysis properly. As a result of the latter fact, many analyses are entirely valueless because they do not fairly represent the coal analyzed. In many cases the samples are picked to show the best possible analyses; while in other cases (especially where there is an object in so doing) samples are purposely taken that will give an unsatisfactory analysis.

The above remarks regarding the value of coal analyses do not, of course, take into consideration the ability of the chemist who makes the analysis. Any good chemist should be able to make an accurate analysis of coal; but, on the other hand, no analysis should be considered of any value unless made by a well-trained chemist. The methods of sampling coals for analysis are as follows.

*Sampling Coal from the Seam Inside the Mine.*—The mine map should be examined and the sampling points selected so as to represent the average of the coal. All of these points should be near places where the coal is being mined and not in worked out portions of the mine. Before sampling, have the face of the coal stripped so as to clear away any smoke deposited from the powder used in mining. Place a cloth on the floor to catch the coal and then make a cutting about 3 in. wide and 1 in. deep from top to bottom of seam, leaving out such impurities in the seam as are rejected in mining and preparing coal for the market. Break up the coal on the cloth into pieces not to exceed ¼ in. cubes, then quarter down the sample and put the remaining quarter into a glass jar or bottle and seal it so as to exclude air and moisture.

The above is, in general, the method recommended by the American Chemical Society for taking samples from a mine. Getting at the fuel value of coal from mine samples taken as above is satisfactory from a geological standpoint or for the purpose of showing a prospective buyer of the mine the quality of the coal. But if the object of the analysis is to give the possible user of the coal information as to the value of the coal as shipped for steam making, then this method is open to this serious objection; that a sample taken from the mine, which leaves out any impurities that are supposed to be rejected in mining and preparation, does not necessarily represent the average of the coal as shipped to the market, because the miners are usually paid by the car or ton, and as impurities such as slate, bone and sulphur band take up as much space as and weigh more (generally) than the coal, the miners are not at all particular, unless very closely watched, to leave out the impurities when loading the mine cars. It is just as much work to them to mine impurities as to mine the coal, and consequently if they can load impurities as well as coal without being detected they will certainly do so. It will be readily seen, therefore, that analyses made of samples taken from the mine are quite likely to show better than analyses of samples taken from the coal as shipped.

In this connection, the following description of some methods used in cleaning and preparing bituminous coal for shipment will be of interest.

*Inside Inspection.*—This method consists in doing all of the cleaning inside the mine, using a system of mining that will best keep the impurities from getting mixed with the coal and seeing that the impurities are not loaded in the mine cars.

*Outside Inspection.*—In loading coal for shipment by this method, practically all of the cleaning is done on the outside, either

by the use of picking tables and conveyors or else by cleaning coal as it goes into the railroad cars. Where coals are high in ash and sulphur, it is generally found necessary to wash them, especially when such coals are to be used for making coke. Washing may reduce slate from 20 per cent. in coal to 8 per cent. or 10 per cent. in coke.

*Outside and Inside Inspection.*—This has proved the best plan for getting out the impurities and for maintaining an average standard of analysis. The method as used in the Pocahontas field of West Virginia is as follows.

All coal is *mined*, that is, undercut by picks or machines, and not shot down "from the solid."

Mining inspectors see that the above is carried out, that the shots are properly fired, and that impurities are not loaded by the miners.

If it is found, when a mine car is to be dumped at the tipple, that it contains an undue amount of impurities, the miner is either docked of the car or else it is taken back into the mine and the miner who loaded it has to unload it.

At the bottom of the tipple chute, where the railroad car is loaded, is placed a gate moved by hand or steam by which the flow of coal into the railroad car is regulated. The inspector stands on a platform at the opposite side of the car and allows a certain amount of coal to run into the car. His helpers—or "bone pickers," as they are called—then go through this coal, raking it with long picks, and throw out any impurities they may find. The inspector is required to make a daily report of each car he loads, showing the car number, percentage of lump coal in car, and the condition of the coal as it comes from the mine cars, whether it is clean or not. If he finds that the coal comes from the mines with too much slate, he reports at once to the mine foreman who knows by the check numbers on the mine car which miner loaded it. By this method, every pound of coal loaded for shipment is cleaned by the inspectors, who are held responsible for seeing that the coal is in proper condition before they accept it. In addition to having one or more inspectors at each mine, there are also a chief inspector and two assistants, the duties of the latter being to go from mine to mine, instructing the inspectors and seeing that they perform their duties properly, besides making reports to the chief inspector of the general condition of the coal at each mine. The work of these inspectors is checked by the chief inspector making occasional trips to various plants using the coal, seeing it unloaded and used in furnaces, and by occasionally having analyses made of samples taken from the railroad cars after being shipped.

The above is probably the most elaborate and rigid system of inspection used in any coal field in this country, and has been found to be very successful in keeping the coal up to a certain standard of analysis.

*Sampling Coal as Used Under Boilers or When Testing Coals at a Stationary Boiler Plant.*—A few representative shovelsful should be taken from various points in the pile of coal, or from each barrow or boiler-room car, the whole spread out and broken into ¼ in. cubes. Then it should be quartered down until about 6 oz. is left.

When a regular boiler test is being made of any coal, the best method of sampling is that adopted by the A. S. M. E. in its code of rules for boiler tests. This, in substance, is as follows.

From each barrow load or fresh portion of coal taken from coal pile select a representative shovelful and put it in a barrel or box in a cool place, keeping it until end of trial. Mix all of the samples, break them to 1 in. in diameter, quarter and crush until a final sample of 5 lbs. is obtained, all of which will pass through ¼ in. meshes. From this sample fill two 1 qt. air-tight glass jars. The coal contained in these jars is to be used for the chemical analysis.

*Sampling Coal by Railroads to Determine the Average Analysis of Coal as Used on Their Locomotives.*—For this purpose, samples should be taken at the coaling stations from the coal after being unloaded from the cars. Care should be taken to get a fair average of the coal from each car from which sample was taken, and a record kept of the car number, date, and mine from which coal came. The samples should be quartered and crushed as in methods given above. Unless for a special purpose, or during a test, samples should not be taken from coal loaded on locomotive tenders, as such samples will not always fairly represent the average of the coal as received from the mines; and if the railroad uses coal from different mines it is generally impossible to tell the car or mine from which such coal came.

From the above it will be seen that correct analyses of coal should represent the coal as mined and shipped to the open market. Such analysis will be of great value to the consumer as well as to the miner or shipper.

*Kinds of Analyses.*—The proximate analysis is the form generally used, and gives the percentage of the following substances contained in the coal: Moisture; fixed carbon; volatile matter; sulphur; ash. This kind of analysis is enough for all practical purposes and will give anyone with a little knowledge of chemistry and combustion a fair idea of the quality and kind of coal analyzed, although it will not always show the exact practical value and efficiency of the coal under all conditions of its use.

Moisture in coal has, of course, no value as fuel and is a dead loss. The amount of volatile combustible matter shows the kind of coal, whether anthracite, semi-bituminous or bituminous, whether the coal will make much smoke or not, and for what purposes and under what furnace conditions it will give the best results. As a general rule, coals that contain about 20 per cent. of volatile matter will give the most heat under ordinary conditions.

Fixed carbon is the main combustible in coal, and under ordinary conditions the steam making value of the coal is in proportion to the percentage of fixed carbon it contains. The fixed carbon is the least volatile constituent of the combustible part of the coal, remains in the furnace longest, and it is easiest to mix with approximately the amount of oxygen necessary for its complete combustion. Sulphur, while it will burn and make some heat, is detrimental to the coal, as a coal high in sulphur will generally clinker badly. Ash in coal is, of course, an entire loss as far as heating value is concerned; and, generally speaking, the value of a coal to the user is lessened as the percentage of ash is higher.

The various losses from ash may be given as follows: From the unconsumed carbon it contains, which may run from 10 to 60 per cent. Losses due to ash stopping up grates and retarding combustion. Loss from cleaning fires, as the greater the percentage of ash the more often the fire must be cleaned. Loss due to the handling of ash and taking it out from boiler room.

It sometimes happens, however, that a coal containing a certain amount of ash will have a greater final efficiency than another coal with less ash. For instance, a coal with 6 per cent. ash may make very little clinker, while a coal with only 3 per cent. ash may make a very troublesome clinker. The writer knows of one case of the kind, where two coals were up for examination, which contained about the same amount of iron, lime

PROXIMATE ANALYSES.

*Anthracite Coals.*

| Name of Coal. | Authority. | $H_2O$. | Fixed Carbon. | Volatile Matter. | Sulphur. | Ash |
|---|---|---|---|---|---|---|
| Jeddo | Pa. Geol. Survey | 3.862 | 85.319 | 3.242 | .533 | 7.044 |
| Spring Mountain No. 4 | Pa. Geol. Survey | 3.756 | 84.727 | 3.376 | .331 | 7.410 |
| Spring Brook | Pa. Geol. Survey | 3.652 | 87.569 | 3.116 | .451 | 5.212 |
| St. Nicholas | Pa. Geol. Survey | 2.494 | 80.288 | 4.040 | .604 | 12.574 |
| Turkey Run | Pa. Geol. Survey | 3.510 | 79.660 | 3.622 | .584 | 12.624 |
| Panther Creek No. 3 | Pa. Geol. Survey | 2.930 | 88.181 | 4.290 | .556 | 4.043 |
| Panther Creek No. 5 | Pa. Geol. Survey | 3.040 | 83.706 | 4.656 | .542 | 8.056 |
| Panther Creek No. 11 | Pa. Geol. Survey | 2.706 | 77.986 | 4.684 | .884 | 13.740 |
| Lehigh | Peabody & Miller | 1.97 | 86.49 | 4.35 | .64 | 7.19 |
| Lykens Valley | Peabody & Miller | 1.50 | 81.07 | 7.84 | .50 | 9.59 |
| Drifton | Peabody & Miller | 1.37 | 89.11 | 3.59 | .56 | 5.93 |

*Semi-Bituminous and Bituminous Coals.*

Alabama.

| Name of Coal. | Authority. | $H_2O$. | Fixed Carbon. | Volatile Matter. | Sulphur. | Ash |
|---|---|---|---|---|---|---|
| Pratt | Proc. A. I. M. E., 1895 | 1.51 | 61.60 | 31.48 | .918 | 5.42 |
| Pratt | Proc. A. I. M. E., 1895 | ... | 56.89 | 28.28 | 1.52 | 13.77 |
| Pratt | Proc. A. I. M. E., 1895 | ... | 56.91 | 26.89 | 4.65 | 11.55 |
| Cahaba | William Kent | 2.00 | 53.08 | 32.90 | 0.68 | 11.34 |
| Cahaba | Ala. Geol. Survey | 1.098 | 59.632 | 34.670 | 1.275 | 4.60 |
| Cahaba | Ala. Geol. Survey | 1.609 | 54.879 | 30.541 | 1.141 | 12.911 |
| Corona | Hawley Furnace Co | 0.83 | 50.69 | 41.12 | ... | 7.36 |
| Gamble | U. S. Navy Reports | 1.88 | 61.96 | 25.57 | 0.435 | 10.59 |
| Montevallo | Ala. Geol. Survey | 1.858 | 54.002 | 36.592 | 1.726 | 7.548 |

Arkansas.

| | | | | | | |
|---|---|---|---|---|---|---|
| Bonanza | U. S. Navy Report | 0.63 | 80.61 | 15.35 | .365 | 3.41 |
| Denning | St. Louis Samp. & Test. Co. | 1.07 | 78.01 | 11.21 | 1.58 | 8.13 |
| Huntington | St. Louis Samp. & Test. Co. | 1.33 | 77.83 | 15.21 | ... | 7.09 |
| Huntington | R. R. Gazette, 1/3/99 | 1.99 | 72.87 | 17.27 | 2.69 | 5.18 |
| Jenny Lind | St. Louis Samp. & Test. Co. | 0.94 | 76.73 | 13.64 | 1.57 | 7.12 |
| Jenny Lind | W. B. Snow | 1.26 | 72.48 | 17.64 | 2.11 | 8.62 |
| Eureka | St. Louis Samp. & Test. Co. | 1.22 | 75.64 | 9.44 | 3.36 | 10.14 |

California.

| | | | | | | |
|---|---|---|---|---|---|---|
| Black Diamond | Mineral Res. U. S. | 13.15 | 34.235 | 42.15 | ... | 10.60 |
| Livermore | Mineral Res. U. S. | 16.00 | 34.00 | 41.75 | ... | 8.25 |
| Shasta | Mineral Res. U. S. | 9.50 | 46.25 | 37.50 | ... | 6.75 |
| Eel River | Mineral Res. U. S. | 8.14 | 38.67 | 45.54 | ... | 7.66 |

Colorado.

| | | | | | | |
|---|---|---|---|---|---|---|
| Lenox | William Kent | 2.92 | 45.36 | 41.18 | 1.39 | 10.54 |
| Rouse | Min. Res. U. S. | 2.48 | 50.78 | 36.29 | 0.72 | 10.45 |
| Huerfano Seam | Min. Res. U. S. | 6.74 | 49.70 | 36.36 | 0.64 | 7.20 |
| Crested Buttes | Min. Res. U. S. | 0.72 | 71.91 | 23.44 | 0.36 | 3.93 |
| Victor | William Kent | 1.26 | 53.10 | 36.40 | 1.11 | 9.24 |
| Sopris | Min. Res. U. S. | 0.40 | 57.80 | 30.30 | 0.59 | 11.50 |
| El Moro | John Fulton | 0.95 | 56.41 | 29.82 | 0.41 | 12.82 |
| Porter | William Kent | 0.63 | 57.30 | 34.70 | 0.74 | 7.37 |

and sulphur, but one contained only 3 per cent. ash and clinkered badly, while the other coal, with 7 per cent. ash, gave practically no clinker. Evidently, as reported by the chemist in this case, in the latter coal the fusible or clinker-forming material was diluted with the larger amount of ash and rendered inert.

An ultimate analysis is more elaborate, more difficult to make and more costly than the proximate. It gives the elementary constituents of coal as follows: carbon; hydrogen; oxygen; nitrogen; sulphur; ash. From this analysis the total heating power of the coal may be quite accurately calculated by the use of Dulong's formula, as follows:

Heating power $= 14{,}500\ C + 62{,}100 \left(H - \frac{0}{8}\right)$.

Or, as used by Prof. Lord

Heating power $= 8{,}080\ C + 34{,}462 \left(H - \frac{1}{8}\ 0\right) + 2{,}250\ S$.

in which

14,500 = heat of combustion of carbon in B. T. U.

8,080 = heat of combustion of carbon in calories.

62,100 = heat of combustion of hydrogen in B. T. U.

34,462 = heat of combustion of hydrogen in calories.

$H - \frac{0}{8}$ = the amount of hydrogen less that supposed to form water with the oxygen.

2,250 = heating power of sulphur in calories.

The heating power of coal calculated from ultimate analyses by use of the above will vary but little from its actual value as determined by a calorimeter test, provided the analysis is an accurate one.

In the experiments of Profs. Lord and Haas on the calorific value of certain American coals, which are probably the most accurate and elaborate ever made in this country, it was found that the maximum difference in heating values between those calculated from analyses and those obtained by actual calorimeter tests was 2.0 per cent. and the minimum 0.1 per cent.

*Calorimeter Tests.*—Under the subject of coal analyses may properly be considered the determination of the heating value of coals by the use of the calorimeter. The calorimeter is an instrument used for the purpose of determining the actual calorific value of any coal, whatever its nature. It usually consists of a combustion chamber and a bath of water surrounding it, the temperature of which can be measured. The combustion takes place in oxygen.

There are several different kinds of calorimeters, but the only type that will always give accurate results, when properly handled, is the "bomb" calorimeter, Mahler's being the most used and giving the most accurate results. An improved form of bomb calorimeter similar to the Mahler, but made with the view of remedying the defects of the latter, has been made by Mr. H. J. Williams. This calorimeter is generally considered to be the best now in use in this country. The Barr calorimeter, used largely by railroads, is reported as giving too low results when compared with the Mahler and Williams calorimeters, the difference being about 500 units as reported by the West Virginia Geological Survey. The calorimeter test gives the number of heat units contained in a pound of coal and, taken with the analysis, will give the true value of the coal and also show how the coal will act when used.

The following table, taken from a paper on "The Valuation of Coals" presented by

| Name of Coal. | Authority. | $H_2O$. | Fixed Carbon. | Volatile Matter. | Sulphur. | Ash |
|---|---|---|---|---|---|---|
| **Georgia.** | | | | | | |
| Dade County | William Kent | 1.20 | 60.50 | 23.05 | 0.84 | 15.16 |
| **Illinois.** | | | | | | |
| Big Muddy | Peabody and Miller | 5.79 | 55.79 | 30.11 | 1.03 | 8.31 |
| Big Muddy | Engrs. Club, of St. Louis | 7.39 | 53.87 | 28.28 | 0.98 | 10.36 |
| Collinsville (Av. 4) | Engrs. Club, of St. Louis | 9.20 | 45.89 | 31.57 | 5.34 | 13.34 |
| Du Quoin | Engrs. Club, of St. Louis | 11.3 | 49.9 | 30.3 | 0.90 | 8.50 |
| Danville | Min. Res. U. S. | 9.60 | 44.56 | 31.20 | ... | 14.64 |
| Gillespie | W. B. Snow | 12.61 | 45.27 | 30.58 | 1.45 | 11.54 |
| Mt. Olive | W. B. Snow | 10.38 | 46.10 | 36.68 | 3.53 | 6.84 |
| Wilmington Lump | William Kent | 15.5 | 39.9 | 32.8 | ... | 11.8 |
| Wilmington Screenings | William Kent | 14.0 | 34.2 | 28.0 | ... | 23.8 |
| Wilm'ton Screen'gs Washed | William Kent | 14.5 | 42.9 | 29.5 | ... | 13.1 |
| Mt. Carbon | John Fulton | 2.08 | 53.47 | 38.20 | 3.66 | 5.14 |
| Steator (Av. 5) | William Kent | 9.9 | 42.2 | 33.2 | ... | 14.6 |
| Girard | W. B. Snow | 8.90 | 42.89 | 32.25 | 8.10 | 15.96 |
| **Indiana.** | | | | | | |
| Brazil Block | Poole | 8.98 | 50.30 | 34.49 | 1.39 | 6.28 |
| New Pittsburg | Poole | 5.89 | 40.40 | 42.23 | 5.88 | 11.48 |
| Lorimer | N. W. Lord | 8.70 | 43.70 | 43.10 | 1.86 | 4.50 |
| **Indian Territory.** | | | | | | |
| Alderson | U. S. Navy Reports | 2.30 | 57.34 | 33.36 | 0.21 | 7.00 |
| McAllister | William Kent | 1.80 | 53.40 | 37.17 | 0.90 | 6.73 |
| McAllister | R. R. Gazette 1/3/99 | 4.00 | 53.00 | 34.00 | 1.50 | 7.50 |
| Lehigh | William Kent | 4.32 | 48.47 | 40.51 | 2.60 | 8.10 |
| Choctaw | William Kent | 1.59 | 66.85 | 23.31 | 1.18 | 8.25 |
| Atoka | W. B. Snow | 6.66 | 51.32 | 35.42 | 3.73 | 6.60 |
| **Kansas.** | | | | | | |
| Pittsburg No. 3 | R. R. Gazette, 1/3/99 | 2.30 | 53.08 | 34.97 | 4.97 | 9.65 |
| Litchfield | R. R. Gazette, 1/3/99 | 1.29 | 53.97 | 35.72 | 5.00 | 9.02 |
| Leavenworth | R. R. Gazette, 1/3/99 | 6.70 | 52.74 | 33.18 | 3.09 | 7.38 |
| Weir | R. R. Gazette, 1/3/99 | 8.91 | 53.38 | 25.14 | 1.76 | 12.57 |
| **Kentucky.** | | | | | | |
| Peach Orchard (Av. 2) | U. S. Govt. Reports | 4.60 | 53.28 | 35.70 | 1.08 | 6.42 |
| Vanderpool | U. S. Govt. Reports | 4.00 | 54.60 | 34.10 | ... | 7.30 |
| Manchester | W. B. Snow | 1.20 | 60.70 | 38.10 | 1.793 | 5.80 |
| Providence | U. S. Navy Reports | 4.04 | 56.74 | 32.40 | 0.807 | 6.76 |
| Hawesville | W. B. Snow | 3.30 | 50.50 | 39.00 | 3.373 | 7.20 |
| McHenry | U. S. Govt. Reports | 3.24 | 54.95 | 36.56 | 1.19 | 5.24 |
| **Maryland.** | | | | | | |
| Cumberland | Md. Geol. Survey | 1.23 | 73.51 | 15.47 | 0.70 | 9.09 |
| Cumberland | U. S. Navy Reports | 0.99 | 74.87 | 16.81 | 0.14 | 7.32 |
| Cumberland | | 0.69 | 70.701 | 18.29 | 0.934 | 9.96 |
| Georges Creek | Peabody and Miller | 0.59 | 74.31 | 18.52 | 0.81 | 6.58 |
| Georges Creek | A. S. McCreath | 0.96 | 72.71 | 19.14 | 0.79 | 6.41 |
| Georges Creek | Proc. A. S. M. E. | 0.94 | 73.15 | 18.40 | 0.80 | 6.69 |
| Georges Creek | U. S. Navy Reports | 1.08 | 75.954 | 17.31 | 0.25 | 5.41 |
| **Michigan.** | | | | | | |
| Saginaw | Wickes Boiler Co. | ... | 50.73 | 37.895 | 0.99 | 3.77 |
| Standard | Wickes Boiler Co. | 10.67 | 53.80 | 33.59 | 0.93 | 1.94 |
| Pere Marquette | Wickes Boiler Co. | 10.15 | 53.95 | 31.14 | 1.11 | 2.76 |
| St. Charles | Wickes Boiler Co. | 7.79 | 52.58 | 34.74 | 0.82 | 4.98 |
| **Missouri.** | | | | | | |
| Marcelline | R. R. Gazette 3/13/99 | 11.00 | 48.65 | 33.42 | 3.98 | 6.93 |
| Ardmore | R. R. Gazette 3/13/99 | 3.69 | 51.31 | 41.24 | 1.14 | 3.76 |
| Bevier | R. R. Gazette 3/13/99 | 4.39 | 52.50 | 36.66 | 1.80 | 6.45 |
| Rich Hill | W. B. Snow | 2.54 | 41.14 | 42.62 | ... | 13.70 |
| **Montana.** | | | | | | |
| Sand Coulee | John Fulton | 2.26 | 54.47 | 33.60 | 1.85 | 7.82 |
| Belt Mountain | John Fulton | 2.98 | 53.31 | 28.71 | 1.65 | 13.34 |
| Bridger Lump | Proc. Mont. Engrs., 1902 | 7.67 | 54.00 | 26.55 | ... | 11.78 |
| Red Lodge | Proc. Mont. Engrs., 1902 | 9.23 | 52.39 | 26.24 | ... | 12.14 |
| **Ohio.** | | | | | | |
| Briar Hill | C. W. Houghton | 4.80 | 56.30 | 34.60 | ... | 4.30 |
| Pittsburg Seam | Greene Eng. Co. | 1.58 | 53.48 | 37.85 | 1.51 | 7.09 |
| Salineville | N. W. Lord | 2.80 | 52.80 | 36.30 | 3.00 | 8.10 |
| Cambridge | N. W. Lord | 2.43 | 50.36 | 37.79 | 3.01 | 9.42 |
| Hocking (Av. 10) | Proc. A. S. M. E. | 6.95 | 51.30 | 36.15 | 0.66 | 5.66 |
| Hocking (Av. 10) | Lord & Haas | 6.65 | 49.54 | 34.14 | 1.67 | 9.67 |
| Hocking (Av. 10) | William Kent | 6.59 | 48.85 | 34.97 | 1.59 | 8.00 |
| Hocking (Av. 10) | Geol. Surv. O. | 5.00 | 53.15 | 37.80 | 0.44 | 9.05 |
| Jackson (Av.) | Lord & Haas | 8.17 | 52.78 | 35.79 | 1.13 | 3.25 |
| Steubenville | Lord & Haas | 2.40 | 49.30 | 39.20 | 3.00 | 9.10 |
| Palestine | Lord & Hass | 1.65 | 51.32 | 37.45 | 1.75 | 9.58 |
| Yellow Creek | Lord & Haas | 1.23 | 50.88 | 38.72 | 3.89 | 9.17 |
| Wellston (Av. 18) | Greene Eng. Co. | 6.96 | 52.63 | 34.68 | 0.89 | 5.73 |
| **Oregon.** | | | | | | |
| Coos Bay | William Kent | 15.45 | 34.95 | 41.55 | 2.53 | 8.05 |
| **Pennsylvania.** | | | | | | |
| Turtle Creek | Lord & Haas | 1.75 | 53.00 | 36.20 | 1.66 | 9.05 |
| Ocean | U. S. Navy Reports | 1.58 | 62.26 | 29.96 | 0.22 | 8.20 |
| Carnegie | Lord & Haas | 1.08 | 52.00 | 37.67 | 2.54 | 9.25 |
| N. Mansfield | Lord & Haas | 2.10 | 52.65 | 36.20 | 1.77 | 9.05 |
| Loyal Hanna | U. S. Navy Reports | 0.70 | 65.838 | 24.387 | 1.28 | 7.886 |
| Irwin | William Kent | 1.41 | 54.44 | 37.66 | 0.64 | 5.86 |
| Greensburg | J. K. Adams | 1.1 | 57.88 | 34.9 | 1.52 | 4.60 |
| Youghiogheny | W. B. Snow | 2.02 | 58.96 | 32.14 | 0.88 | 6.88 |
| Youghiogheny screenings | R. C. Carpenter | 1.77 | 56.10 | 31.34 | ... | 10.79 |
| Pittsburg | A. S. McCreath | 1.42 | 55.89 | 36.14 | 0.94 | 5.59 |
| Pittsburg | William Kent | 1.37 | 52.21 | 35.90 | 1.80 | 8.02 |
| Pittsburg | Peabody and Miller | 1.36 | 59.14 | 32.00 | 1.26 | 7.50 |
| Connellsville | A. S. McCreath | 1.26 | 59.62 | 30.11 | 0.784 | 8.23 |
| Connellsville | Peabody and Miller | 0.94 | 64.06 | 27.39 | 1.07 | 7.61 |
| Connellsville | John Fulton | 1.26 | 59.79 | 31.80 | 0.53 | 7.16 |
| Reynoldsville | Barrus and Dean | 0.45 | 59.46 | 32.63 | 1.07 | 7.46 |
| Reynoldsville | Min. Res. U. S., 1895 | 0.983 | 60.96 | 30.933 | 1.06 | 6.103 |
| Reynoldsville | U. S. Navy Reports | 1.14 | 61.92 | 28.40 | 1.96 | 8.54 |
| Reynoldsville | A. S. McCreath | 1.11 | 55.80 | 36.02 | 2.593 | 4.47 |
| Eureka | U. S. Navy Reports | 0.48 | 71.632 | 21.61 | 1.96 | 4.324 |
| Eureka | Peabody and Miller | 0.44 | 73.15 | 18.76 | 1.02 | 7.65 |
| Clearfield | A. S. McCreath | 1.186 | 69.27 | 23.17 | 0.933 | 6.44 |
| Pardee | U. S. Navy Reports | 0.606 | 74.165 | 15.24 | 0.693 | 9.29 |
| Morrisdale | U. S. Navy Reports | 0.83 | 70.036 | 18.98 | 1.416 | 8.729 |
| Powellton | Mills & Rowan | 0.60 | 68.709 | 22.60 | 2.691 | 5.40 |
| Moshannon | U. S. Navy Reports | 0.43 | 67.968 | 23.261 | 1.09 | 7.251 |
| Summerhill | Professor Gale | 2.46 | 69.37 | 20.52 | 1.50 | 9.15 |
| Bennington | John Fulton | 1.20 | 68.77 | 23.68 | 0.62 | 5.73 |
| Johnston | John Fulton | 0.72 | 73.84 | 16.49 | 1.97 | 7.97 |
| South Fork | Mills & Rowan | 1.10 | 73.145 | 17.24 | 2.352 | 6.163 |

Pennsylvania.

| Name of Coal. | Authority. | $H_2O$. | Fixed Carbon. | Volatile Matter. | Sulphur. | Ash |
|---|---|---|---|---|---|---|
| Broad Top | John Fulton | 1.28 | 71.12 | 18.40 | 1.70 | 7.50 |
| Antrim | Hawley Furnace Co. | 1.46 | 65.12 | 21.60 | 2.82 | 9.00 |
| Fall Brook No. 2 | A. Hardt | 0.45 | 69.67 | 19.40 | 0.31 | 10.48 |
| Morris Run | John Fulton | 0.160 | 70.78 | 19.12 | 0.731 | 8.91 |
| Bloss | A. Hardt | 1.06 | 73.79 | 18.88 | 0.69 | 6.27 |

Tennessee.

| | | | | | | |
|---|---|---|---|---|---|---|
| Coal Creek | Hawley Furnace Co. | ... | 58.80 | 34.20 | 0.79 | 6.93 |
| Aetna | Tenn. Geol. Survey | 0.94 | 63.94 | 23.72 | 1.19 | 11.40 |
| Roane | Min. Res. U. S. | 1.750 | 60.110 | 26.62 | 1.049 | 11.520 |
| Glen Mary | W. B. Snow | 2.15 | 61.63 | 31.47 | 0.94 | 4.75 |
| Suwanee | William Kent | 1.60 | 61.00 | 29.30 | ... | 7.80 |

Texas.

| | | | | | | |
|---|---|---|---|---|---|---|
| Eagle Pass | J. Fulton | 5.27 | 44.46 | 37.48 | 2.57 | 10.22 |
| Ft. Worth | W. B. Snow | 14.42 | 42.53 | 30.03 | 1.47 | 13.02 |
| Thurber | U. S. Navy | 3.35 | 49.43 | 35.15 | 0.639 | 12.07 |

Utah.

| | | | | | | |
|---|---|---|---|---|---|---|
| Pleasant Valley | H. B. Hodges | 5.40 | 44.06 | 44.66 | 0.79 | 5.88 |
| Pleasant Valley | H. B. Hodges | 6.02 | 47.84 | 47.94 | 0.69 | 3.20 |
| Scofield | H. B. Hodges | 5.20 | 46.00 | 44.96 | 1.06 | 3.84 |
| Castle Gate | U. S. Navy | 2.30 | 48.63 | 37.91 | 0.20 | 9.36 |

Virginia.

| | | | | | | |
|---|---|---|---|---|---|---|
| Looney Creek | A. S. McCreath | 1.40 | 58.365 | 33.660 | 0.705 | 5.87 |
| Big Stone Gap | U. S. Geol. Survey | 1.40 | 59.15 | 33.85 | 1.14 | 4.99 |
| Tom's Creek | A. S. McCreath | 0.86 | 57.37 | 34.88 | 0.90 | 5.66 |
| Tom's Creek | St. Louis S. & T. Co. | 2.22 | 59.66 | 29.56 | 0.56 | 8.56 |

Washington.

| | | | | | | |
|---|---|---|---|---|---|---|
| Roslyn | Stirling Boiler Co. | 2.42 | 56.69 | 27.37 | 0.16 | 13.36 |
| Franklin | U. S. Navy Reports | 3.66 | 50.78 | 34.63 | ... | 10.93 |
| Skagit Cumb. | U. S. Navy Reports | 0.25 | 77.41 | 7.46 | 0.22 | 14.88 |
| Black Diamond | U. S. Navy Reports | 3.11 | 45.11 | 47.19 | ... | 4.58 |

Wyoming.

| | | | | | | |
|---|---|---|---|---|---|---|
| Lignite | Peabody and Miller | 5.75 | 47.63 | 39.98 | 0.21 | 6.64 |
| Rock Springs | U. S. Navy Reports | 6.65 | 53.27 | 35.79 | 0.399 | 4.29 |
| Glen Rock | W. B. Snow | 10.20 | 51.11 | 34.40 | ... | 5.29 |
| Sheridan | W. H. Williams | 21.20 | 46.40 | 26.78 | ... | 5.62 |

West Virginia.

| | | | | | | |
|---|---|---|---|---|---|---|
| Elk Garden | U. S. Navy Reports | 1.059 | 71.287 | 21.963 | 1.47 | 5.54 |
| Elk Garden | U. S. Geol. Survey | 0.76 | 72.99 | 19.39 | 0.88 | 6.86 |
| Elk Garden | W. Va. Survey | 0.46 | 71.23 | 21.11 | 0.43 | 7.20 |
| Fairmont (Av. 51) | W. Va. Survey | 1.43 | 53.83 | 37.47 | 2.59 | 7.27 |
| Kanawha, Coalburg | W. Va. Survey | 0.56 | 56.58 | 36.63 | 0.51 | 6.43 |
| Campbell's Creek | W. Va. Survey | 1.12 | 55.05 | 36.63 | 1.16 | 7.20 |
| Kanawha Splint | W. Va. Survey | 0.41 | 57.36 | 34.13 | 1.07 | 8.10 |
| Winifrede | W. Va. Survey | 1.07 | 55.69 | 35.79 | 0.77 | 6.45 |
| Junior | W. Va. Survey | 0.81 | 61.98 | 28.73 | 1.07 | 8.48 |
| Funnelton | W. Va. Survey | 0.62 | 57.66 | 31.00 | 3.41 | 10.72 |
| New River | Peabody and Miller | 0.77 | 72.69 | 21.70 | 0.77 | 4.84 |
| New River | U. S. Navy Reports | 1.02 | 71.054 | 19.86 | 0.275 | 7.976 |
| New River | U. S. Navy Reports (Hohenstein test) | 0.49 | 72.99 | 21.79 | 0.46 | 4.73 |
| New River | Barrus and Denton, "Power," 1901 | 1.09 | 70.26 | 23.75 | 1.07 | 4.90 |
| Thacker | Lord and Haas | 1.38 | 56.67 | 35.68 | 1.28 | 6.27 |
| Tug River | U. S. Navy Reports | 0.80 | 74.90 | 17.17 | 0.295 | 7.13 |
| Poca (Av. 14) | U. S. Navy Reports | 1.25 | 78.94 | 14.93 | 0.26 | 4.14 |
| Poca (Av. 14) | U. S. Navy Reports (Hohenstein test) | 0.79 | 75.78 | 19.53 | 0.71 | 3.90 |
| Poca (Av. 14) | Peabody and Miller | 0.54 | 77.28 | 16.70 | 0.79 | 5.48 |
| Poca (Av. 14) | Proc. A. S. M. E. | 1.20 | 76.15 | 18.45 | 0.60 | 4.00 |
| Poca (Av. 14) | Lord and Hass. | 0.76 | 74.84 | 18.51 | 0.59 | 5.89 |

ULTIMATE ANALYSES.

| Name of Coal. | Authority. | C. | H. | O. | N. | S. | Ash. | $H_2O$. |
|---|---|---|---|---|---|---|---|---|
| Georges Creek, Md. | Peabody and Miller | 81.05 | 4.91 | 4.57 | 2.15 | 0.70 | 6.62 | 0.59 |
| Brazil, Ind. | Poole | 70.50 | 4.76 | 16.29 | 1.36 | 1.39 | 6.28 | 8.98 |
| Big Muddy, Ill. | Peabody and Miller | 71.81 | 4.85 | 11.52 | 2.04 | 0.96 | 8.82 | 5.79 |
| Jackson, O. | Lord and Haas | 70.05 | 5.43 | 17.09 | 1.49 | 1.84 | 4.10 | 8.26 |
| Hocking, O. | Lord and Haas | 66.50 | 5.16 | 15.57 | 1.43 | 1.67 | 9.67 | 6.65 |
| Clearfield, Pa. | Peabody and Miller | 80.17 | 5.08 | 4.69 | 1.46 | 0.91 | 7.69 | 0.44 |
| Pittsburg, Pa. | Peabody and Miller | 76.47 | 5.19 | 8.10 | 1.45 | 1.19 | 7.60 | 1.36 |
| Pittsburg, Pa. | Lord and Haas | 75.24 | 5.18 | 8.24 | 1.51 | 1.79 | 8.02 | 1.37 |
| Thacker, W. Va. | Lord and Haas | 78.90 | 5.14 | 6.88 | 1.42 | 1.16 | 6.50 | 1.40 |
| New River, W. Va. | Peabody and Miller | 83.57 | 4.69 | 4.51 | 1.63 | 0.72 | 4.88 | 0.77 |
| New River, W. Va. | Barrus, Dean and Main, 1901. | 83.84 | 4.72 | 3.77 | 1.65 | 1.07 | 4.95 | 1.09 |
| New River, W. Va. | U. S. Navy (Hohenstein test) | 83.60 | 4.85 | 4.87 | 1.41 | 0.46 | 4.81 | 0.49 |
| Pocahontas, W. Va. | U. S. Navy (Hohenstein test) | 84.96 | 4.07 | 5.46 | 0.90 | 0.71 | 3.90 | 0.79 |
| Pocahontas, W. Va. | Proc. A. S. M. E., 1903. | 87.39 | 4.27 | 2.87 | 0.87 | 0.60 | 4.00 | 1.20 |
| Pocahontas, W. Va. | Lord and Haas | 85.40 | 4.39 | 3.94 | 0.85 | 0.62 | 4.80 | 0.85 |

CALORIMETER TESTS.

| Name of Coal. | Authority. | B. T. U. Per Lb. Coal. | B. T. U. Per Lb. Combustible. |
|---|---|---|---|
| Huntington, Ark. | Proc. A. S. M. E., 1899 | 12935 | ..... |
| Tom's Creek, Va. | H. J. Williams | 13873 | ..... |
| Glen Mary, Tenn. | W. B. Snow | 13167 | ..... |
| Jellico, Tenn. | J. W. Hill | 13846 | 14299 |
| Georges Creek, Md. | G. H. Barrus | 14217 | 15140 |
| Wellston, O. | J. W. Hill | 12506 | 14080 |
| Cambridge, O. | Lord & Haas | 12658 | 14578 |
| Jackson, O. | Lord & Haas | 12515 | 14270 |
| Jackson, O. | G. H. Barrus | 12139 | 12832 |
| Hocking, O. (R. O. M.) | Lord & Haas | 11695 | 13972 |
| Hocking, O., Lump | Lord & Haas | 12388 | 14166 |
| Streator, Ill. | W. B. Snow | 11403 | ..... |
| Big Muddy, Ill. | W. B. Snow | 11781 | ..... |
| Reynoldsville, Pa. | W. B. Snow | 12981 | ..... |
| Reynoldsville, Pa. | Barrus & Dean | 14342 | 15372 |
| Eureka, Pa. | G. H. Barrus | 13640 | ..... |
| Eureka, Pa. | G. H. Barrus | 13043 | ..... |
| Sonman, Pa. | G. H. Barrus | 13326 | ..... |
| Pittsburg, Pa. | Lord & Haas | 13557 | ..... |
| Pittsburg, Pa. | R. C. Carpenter | 13025 | 14895 |
| Pittsburg, Y'g'y. | G. H. Barrus | 13493 | 14603 |
| Elk Garden, W. Va. | G. H. Barrus | 13180 | 14295 |
| Thacker, W. Va. | Lord & Haas | 14071 | 15376 |
| New River (Av. 8) | G. H. Barrus | 14081 | 14779 |
| New River | William Kent | 14631 | 15320 |
| New River | Barrus & Dean | 14934 | 15696 |
| Pocahontas | William Kent | 15070 | 15700 |
| Pocahontas (Av. 5) | Lord & Haas | 14589 | 15829 |
| Pocahontas (Av. 10) | G. H. Barrus | 14084 | 14926 |
| Pocahontas (Av. 5) | Proc. A. S. M. E., 1903. | 15186 | 15772 |
| Pocahontas (Av. 2) | L. & W. Boiler Co. | 15779 | ..... |

Prof. Lord before the American Association for the Advancement of Science in 1898 shows the comparatively close correspondence between the results obtained by calorimeter trials and those actually obtained under boilers. It also shows that a semi-bituminous coal, "like Pocahontas, high in carbon and low in hydrogen, gives higher evaporative duty in proportion to its calorimeter value than those coals higher in hydrogen and oxygen, as was, of course, to be expected."

*Relative Values of Coals (Hocking Coal = 100.)*

| Coal. | By Calorimeter. | By Boiler Test. | Calculated Evaporation. |
|---|---|---|---|
| Hocking | 100 | 100 | 100 |
| Pocahontas | 122 | 127 | 131 |
| Thacker | 116 | 117 | 116 |
| Freeport | 109 | 106 | 109 |
| Darlington | 112 | 105 | 109 |
| Pittsburg | 113 | 113 | 114 |

*Analysis of Ash.*—Where still further knowledge of a coal is desired, an analysis of the ash should be made. It is possible to determine from such an analysis to what degree the ash is fusible, what kind of clinkers will be formed and their nature—i.e., whether the clinker will be such that it will not stick to the grate bars and may be easily removed or whether it will adhere closely to the grates and run down through the air spaces.

Typical analyses of ash are given below, together with analyses of the coals which gave the ash.

| No. 1 Coal. | Per Cent. | No. 1 Ash and Clinker. | Per Cent. |
|---|---|---|---|
| Water | 0.496 | Silica | 34.80 |
| Fixed carbon | 73.53 | Alumina | 23.30 |
| Volatile matter | 19.139 | Oxide of iron | 11.64 |
| Sulphur | 0.475 | Carbonate of lime | 23.50 |
| Ash | 6.360 | Magnesia | 3.65 |
| | | Undetermined | 3.11 |

This coal made a readily fusible ash, and the clinker formed covered the grates with a thin, reddish black, glassy coating. It stuck closely to the grates and ran down through the air spaces, with thin black hangers extending from grate to ashpit. The fusibility is explained by the large percentage of iron, lime and magnesia.

| No. 2 Coal. | Per Cent. | No. 2 Ash. | Per Cent. |
|---|---|---|---|
| Water | 0.39 | Silica | 23.23 |
| Fixed carbon | 62.24 | Alumina | 23.79 |
| Volatile matter | 25.29 | Carbonate of lime | 10.76 |
| Sulphur | 1.17 | Magnesia | 5.38 |
| Ash | 10.08 | Oxide of iron | 28.33 |

This coal made a very thick, heavy, reddish brown clinker, with black knobs, which was formed so quickly that on a locomotive test, with a light passenger train, the fire had to be cleaned every 25 miles. It would be hard to find a worse ash than this.

| No. 3 Reynoldsville Coal. | Per Cent. | No. 3. Ash. | Per Cent. |
|---|---|---|---|
| Water | 0.39 | Silica | 40.32 |
| Fixed carbon | 58.07 | Alumina | 39.02 |
| Volatile matter | 33.00 | Oxide of iron | 17.81 |
| Sulphur | 2.28 | Lime | 2.65 |
| Ash | 8.93 | Magnesia | 0.7 |
| | | Sulphur trioxide | 0.46 |

It has been often stated that if the ashes and clinkers formed from any coal were of a reddish color it showed the presence of a large percentage of iron and, therefore, that such coal would clinker badly and was inferior to coals with a white ash. This statement is misleading. At least two of the best semi-bituminous coals in this country, as well as some of the best Welsh coals, give reddish brown ashes or clinkers, whereas some of the very poorest coals, from an economical standpoint, give a white ash. Of much more importance than the color of the ashes or clinkers is their quality—that is, whether the clinker will stick to the grates and furnace walls and be difficult to remove, or whether it may be easily pulled out by the fireman. Some coals will make a clinker that has to be chipped off the grates with hammer and chisel after the fire is out. Such clinker is usually thin, but entirely covers the grates. Other coals may make

much more clinker in quantity, but it will not be much trouble to get it out of the furnace.

It will be readily seen, then, of what practical value to the buyer of coal correct and accurate analyses of coal may be. The cost of such analyses is very small when their ultimate value is considered. In the opinion of the writer, the time is coming when many large contracts for coal will be based on the average value as shown by analyses, especially on the percentage of fixed carbon, sulphur and ash.

If this view is correct, it would seem to be the wisest policy on the part of the coal operators to see that their coal is properly prepared and their standards maintained. The maintenance of a certain standard analysis for any coal is to a certain extent now (and it will be still more so in the future), a very important factor in increasing and keeping up the output and sales of such coal.

Below will be found both proximate and ultimate analyses of various coals from different parts of the United States, together with results of some calorimeter tests.

## Tensile Impact Tests of Metals.*

The author has investigated the relative behavior of materials under impact and gradual loading in tension. A vertical tensional impact testing machine was construct-

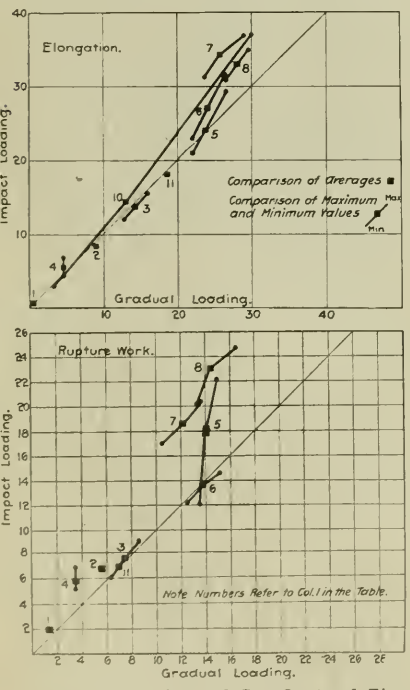



Fig. 1—Comparison of Per Cent. of Elongation and Unit Rupture Work under Gradual and Impact Loading in 100 Ft.-Lb. Units.

ed in 1897 and since that year experiments have been carried on in the laboratory for testing materials of Purdue University. The results lead to the conclusion that the ductility and shock-resisting capacity of metals of normal quality are not less under impact loading than those disclosed by the static test.

The paper includes description of machines and methods; comparison of static and impact tests; effect of gage length; effect of number of blows; effect of speed of delivery of energy; effect of temperature; effect of condition of surface. There are 15 tables and 15 figures in the paper, giving full details of the tests.

*Definitions*: The term "rupture-work" is taken to mean the work done in deforming a body to rupture. The area between the ordinary stress-strain diagram and the axis of deformation is a measure of this rupture-work. The latter term has often been replaced by the term "total resilience." Strictly speaking, the term "resilience" refers to the elastic energy stored up in a body at any stage of deformation. "Unit rupture-work" is the rupture-work per unit of volume. Thus if a bar of steel ½ in. in diameter and 8 in. long is ruptured in tension as the result of a blow of a 512-lb. hammer falling from five feet, thereby bringing the hammer to rest, the total rupture-work will be 2,560 foot-pounds, and the unit rupture-work will be 1,630 foot-pounds per cubic inch of metal.

*The Impact Machines*: Two different machines, both vertical, have been used in these tests. For the tests on the specimens of steel wire 9 ft. long (Nos. 1 to 4 in the table) a temporary wooden machine was constructed. This apparatus for producing longitudinal impact in tension was modeled after an apparatus used at Cornell University by Mr. Charles W. Comstock in impact tests of steel wire-rope during 1898.† The principle therein employed, by which the hammer is hung on the specimen and impact is effected by sudden arrestment, during the fall, of an upper moving head, also fixed to the specimen, has been used in France in certain foundries.

The writer improved this form of apparatus by supplying a rotating drum, upon the surface of which a pencil, attached to the hammer, records a curve during the impact. The vertical ordinates to this curve, called a "velocity-displacement curve," are the movements of the hammer; and the horizontal abscissæ are proportional to the speed of the surface of the drum. The latter speed is known from the record of a vibrating tuning fork, held against the drum. The velocity of the hammer may be computed from the drum record at any stage of descent.

In operation, the system, consisting of hammer, specimen, and upper head, is raised. Upon release, and subsequent descent, the upper head has impact upon a stop on bridge, and the energy of the moving hammer thereby ruptures the test specimen. The pencil attached to the hammer is automatically released before the impact occurs, and the above mentioned record is thereby written on the surface of the drum. The energy remaining in the hammer after the rupture of the test bar is computed from a measurement of the velocity of the hammer at the time of rupture. This latter velocity is obtained from the slope of a tangent in the

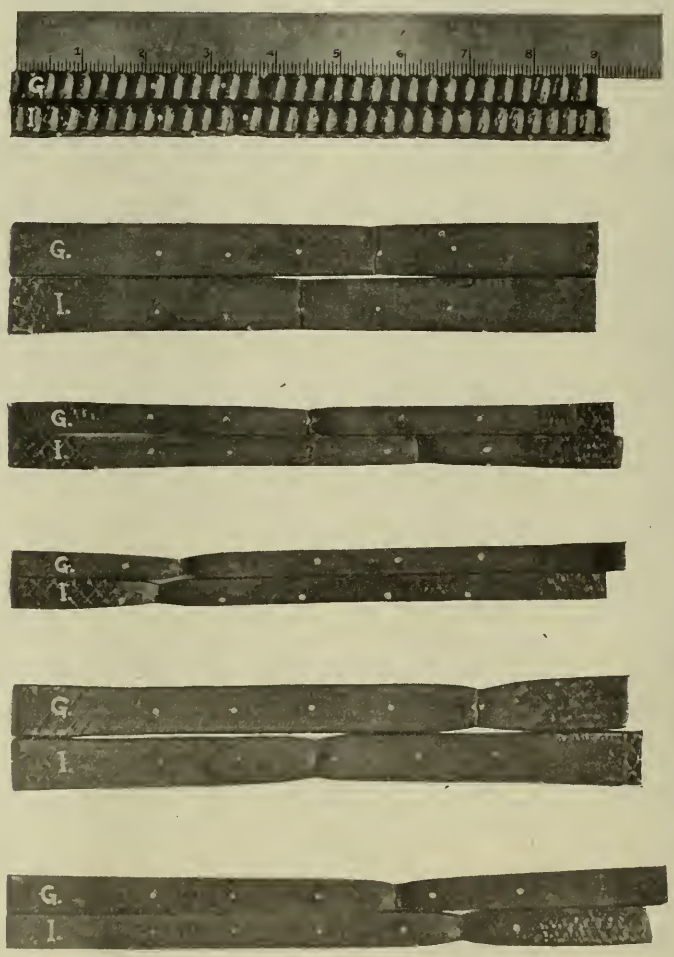



Fig. 2—Bars Broken by Impact and Gradual Loading.
*Lower bar of each pair broken in .01 second. Upper bar broken in about 10 minutes.*

*Abstract of a paper by W. Kendrick Hatt, read at the Atlantic City meeting of the American Society for Testing Materials.

†Trans. Cornell Soc. C. E., Vol. 189.

velocity-displacement curve. The weight of the hammer varied from 845 to 1,230 lbs., and the greatest length of fall was 7 ft.

The experiments performed on this temporary apparatus include the following: (1) A series of comparative tests of long steel and iron rods under slow and impact-loading —1898. (2) A series of tests of steel wire of different lengths, and the determination of the effect of temperature on tests of wrought iron—1899.

In the accompanying table the material under the reference numbers 1, 2, 3, 4 and 10 was tested on this temporary apparatus. The experiments performed on the temporary apparatus were successful enough to encourage the construction of a more permanent machine in metal. This machine has been described elsewhere in detail.‡ The weight of the hammer varied from 515 to 870 lbs., and the greatest height of fall was 6 ft.

In the paper there is a mathematical discussion of the principle of the action of these machines, and of the energy lost in the parts of the machines. The work performed with the aid of this machine includes the following: Tests of nickel steel and soft carbon steel in tension under gradual and impact loading; effect of speed of application of a given amount of energy; effect of temperature on the resilience of soft and nickel steel—1900; tests of steel castings in tension and flexure; tests of cast iron in flexure; tests of concrete under impact and compression—1901.

*Comparison of Impact and Static Tests*: One of the first matters of interest to an investigator is the relative behavior of material under impact and slow loading. It is also important to know how far the ordinary static test will yield information of the relative shock-resisting capacity of various metals. In the table is a tabulation of results of such comparative tests.

It appears from the results given that in the case of normal soft material in bars of circular cross section of lengths from 9 ft. to 8 in., tested at ordinary temperatures, there is little difference in the total elongation and unit rupture-work whether the bar is ruptured in ten minutes or in from one to two-hundredths of a second. The only marked point of difference in the static and impact tension test of soft materials of greater lengths is that any lack of homogeneity of material is brought more into evidence in the latter species of test. There is a tendency in non-homogeneous materials under impact to localization of the elongation of a test bar at various points in the gage length, so that the latter consists of nodes of ductility. After rupture the bar may have a number of incipient necks. In many cases two distinct necks are formed. The effect may be noticed in static tension tests, but not, in the author's experience, to the same degree as in impact tests. There is also a tendency under impact to localization of elongation near the wedges.

A marked difference between the results of gradual impact tests may be noticed in case of short bars of steel castings and tire steel and coupons from boiler plate. There is a greater elongation and unit rupture-work under impact in the case of soft steel castings. But in the case of the harder steel, like tire steel, the increase in unit rupture-work is disproportionate to the increase in elongation. This is partly due to the fact that there is considerable metal between the gage marks and the wedges in these steel castings, whereas the unit rupture-work is computed on the basis of the volume within gage-marks.

The tests cover a range of soft steel castings to hard tire steel, and a range of gage length from 2 in. to 9 ft. All comparisons, however, made between static and impact tests of any one material are based on bars of the same gage length for the two kinds of tests, and represent tests in which the bars were broken in one blow, except as where noted. The table shows the quality of the material and the average, as well as the maximum and minimum values observed.

The comparison of the two kinds of tests is graphically shown in Fig. 1, in which both axes are equal scales of the same kinds of quantity. If there were no effect of speed the plotted points would lie on the 45 deg. line drawn on Fig. 1. The comparison of averages is plotted as a point, and also the comparison of the maximum values and the comparison of the minimum values. The elongation is always that obtained by measurements on the broken ends of the test bars. The rupture-work for the gradual tests was worked up from observations taken on specimens. In the case of long rods and very short rods this was done by direct measurement, and in the case of specimens of 8-in. gage length the rupture-work was obtained by the use of the Henning pocket recorder. An exception must be made in the case of tire steel.

In the case of long rods there was a noticeable difference between the elongation of the rods as shown on the drum record and the elongation as determined by laying the broken ends of the specimen together and measuring the increase of length between the gage marks. The difference is no doubt due to the elastic strength at rupture and subsequent recoil upon the breaking of the bar.

Information is given in the paper more in detail concerning the properties of steel castings and locomotive tire steel under impact.

A photograph of bars of various metals is given in Fig. 2, one of each pair of which was ruptured under impact, and the other under gradual loading.

*Effect of Change of Temperature of Test Bar*: To determine the law controlling the variation of resistance in change of temperature under impact, the writer used specimens of soft steel and nickel steel (Nos. 5 and 6 in the table). The results of this investigation are shown in Figs. 3 and 4. It appears from these results that in the case of ordinary soft steel there is a diminution of elongation and unit rupture-work as the

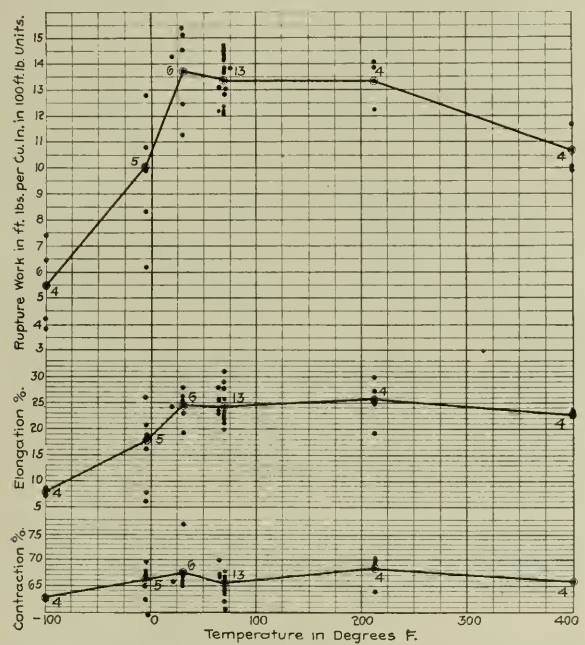



Fig. 3—Effect of Temperature on Soft Steel under Tensional Impact Loading.

*½ in. in diameter, 8 in. long, one blow.*

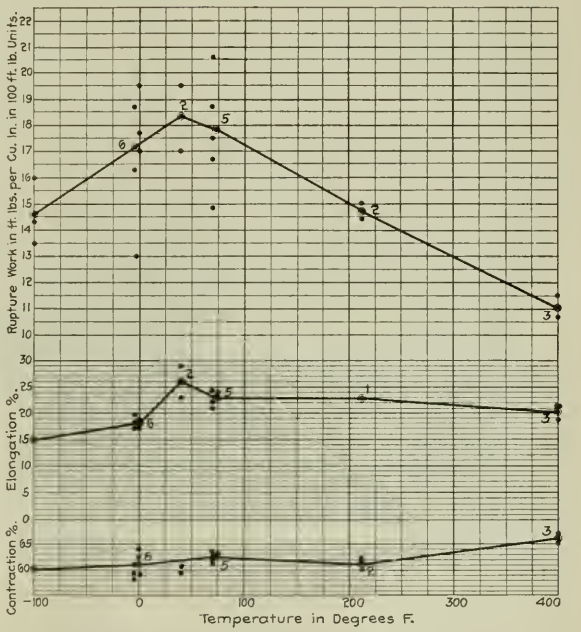



Fig. 4—Effect of Temperature on Nickel Steel under Tensional Impact Loading.

*½ in. in diameter, 8 in. long, one blow.*

‡Nouveaux Appareils d'essai-Congres. Intern. des Meth. d'essai, Paris, 1900. Vol. I., p. 507, or *Eng. News*, Jan. 4, 1901.

temperature goes below 32 deg. F. or above 212 deg. F. In the case of nickel steel this diminution is apparent when the temperature goes below 32 deg. or above 70 deg. The contraction seems not to be much

forge against one-half that essential for the double forges, which is 262 sq. ft., leaving 113 sq. ft. in favor of each forge placed back to back, or 225 sq. ft. in favor of each double forge as against two single forges. Should

to tuyere and the fire prepared with fine wet slack well tamped around a stake the fire will, with possibly the throwing out now and then of a small clinker, last from 7 o'clock a.m. until noon, and with this

Showing Comparative Tests Under Gradual and Impact Loading in Tension.

*Except where noted impact tests were made with one blow at atmospheric temperature on test bars of the same length as used in gradual tests. Elongation is that after rupture. Rupture work is that up to rupture.*

| Number. | Material. | Diameter, in. | Gage length, in. | Ultimate strength lbs. per sq. in. | No. Tested. | Elongation per cent. Maximum. | Elongation per cent. Minimum. | Elongation per cent. Average. | Rupture work, ft. lbs. per cu. in. Maximum. | Rupture work, ft. lbs. per cu. in. Minimum. | Rupture work, ft. lbs. per cu. in. Average. | Kind of Test. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Steel wire | 0.16 | 48 | 115,000 | 2 | 0.71 | 0.48 | 0.59 | 144 | 130 | 136 | Gradual |
| | | ... | 108 | ..... | 4 | 1.00 | 0.42 | 0.70 | 208 | 165 | 186 | Impact |
| 2. | Steel wire annealed | 0.16 | 48 | 83,000 | 1 | ... | ... | 9.30 | ... | ... | 566 | Gradual |
| | | ... | 108 | ..... | 5 | 11.0 | 8.7 | 9.8 | 803 | 648 | 772 | Impact |
| | | ... | 48 | ..... | 2 | 8.0 | 6.0 | 7.0 | 534 | 534 | 544 | Impact |
| 3. | Steel wire | 0.30 | 72 | 71,800 | 5 | 15.8 | 12.8 | 14.1 | 865 | 690 | 742 | Gradual |
| | | ... | 108 | ..... | 6 | 15.6 | 12.0 | 13.6 | 903 | 515 | 765 | Impact |
| 4. | Steel wire | 0.26 | 108 | 109,000 | 2 | 4.64 | 4.62 | 4.63 | 349 | 347 | 348 | Gradual |
| | | ... | 108 | ..... | 15 | 7.0 | 4.0 | 5.10 | 699 | 443 | 556 | Impact |
| | | ... | 69 | ..... | 5 | 7.0 | 5.0 | 5.80 | 673 | 596 | 626 | Impact |
| 5. | Nickel steel | 0.50 | 8 | 85,000 | 6 | 26.7 | 22.1 | 23.6 | 1505 | 1360 | 1414 | Gradual |
| | | ... | 8 | ..... | 8 | 29.4 | 20.7 | 24.0 | 2216 | 1203 | 1821 | Impact |
| 6. | Soft steel | 0.50 | 8 | 68,000 | 7 | 26.3 | 21.9 | 23.9 | 1532 | 1260 | 1376 | Gradual |
| | | ... | 8 | ..... | 13 | 31.6 | 23.1 | 27.0 | 1460 | 1208 | 1358 | Impact |
| 7. | Boiler plate steel | 1.0 | 8 | 60,000 | 19 | 29.0 | 23.2 | 25.7 | 1370 | 1047 | 1230 | Gradual |
| 8. | Soft steel castings | 0.5 | 8 | ..... | 4 | 36.9 | 31.3 | 34.4 | 2035 | 1690 | 1855 | Impact (2 blows) |
| | | 0.5 | 2 | 62,000 | 5 | 29.5 | 26.5 | 28.2 | 1666 | 1342 | 1450 | Gradual |
| 9. | Hard steel castings | ... | .. | 82,000 | .. | ... | 31.0 | 33.0 | 2467 | 2080 | 2315 | Impact |
| | | ... | ... | ..... | .. | ... | ... | ... | .... | .... | .... | ..... |
| | | ... | ... | ..... | 5 | 35.0 | ... | ... | .... | .... | .... | ..... |
| 10. | Locomotive tire steel | 0.62 | 3 | 140,000 | 30 | 30.0 | 3.0 | 13.1 | 2000 | 212 | 976 | Gradual |
| | | ... | .. | 60,000 | 30 | 37.0 | 3.0 | 14.3 | 5650 | 890 | 2918 | Impact |
| 11. | Norway iron | 0.305 | 72 | 63,000 | 1 | ... | ... | 18.7 | .... | .... | 649 | Gradual |
| | | ... | 108 | ..... | 3 | 19.4 | 16.7 | 18.1 | 727 | 550 | 656 | Impact |

affected by change of temperature. Even in case the bars cooled to (—) 100 deg. F. the fracture was so hot that the broken end of the bar felt uncomfortably hot.

## Ideal Blacksmith Shop and Equipment for General Railroad Work.*

We think the ideal blacksmith shop of today is the one built of structural iron encased in brick, the roof of which has been given due consideration, leaving a large factor of safety after the jarring from the large steam hammers and the support of the masts of the necessary jib cranes carrying from four to five tons each while working under a steam hammer has been satisfied. The altitude of the eaves from the floor line should be about 30 feet. The roof should be of the monitor design, with pivoted windows at each end and the sides. The three-sash windows in the walls are preferred, bottom sash to hoist and top sash pivoted; thus inviting a good current of air in the shop. The accommodations of ventilation and light should be at least 60 per cent.

The first consideration as to the necessary dimensions should be that of forges; the design and number necessary and the number of square feet of floor space required for the same. We think double forges preferable and most economical in floor space when placed on an angle of 45 deg., with 15 ft. from the wall to the center of the stack and 15 ft. from center to center of stacks, allowing 20 ft. from center of stack toward center of shop for working room. Two forges and their working room will occupy 525 sq. ft. of floor space, and placed at an angle of 45 deg. will be adapted to any class of work desired—aside from frames and furnace work. In placing single forges along the walls there should be at least 5 ft. between the wall and center of stack, and the space between centers of stacks and the working room should be the same as allowed for the double forges, 15 ft. and 20 ft., respectively, making 375 sq. ft. of floor space necessary for the single

*Extract of a paper by A. W. McCaslin read before the National Association of Blacksmiths held at Indianapolis, Aug. 16-18.

the single forges be placed tight against the wall, which would be an expensive position when convenience of handling the work is considered, for convenience in this case means output, the saving even then in floor space in favor of the double forges against the two single forges would equal 75 sq. ft., and the number of stacks in the single forge plan and the holes in the roof will be increased 100 per cent. If stacks are not employed you have not an ideal shop, but rather an ideal smoke-house.

In connection with railroad blacksmith shops the writer does not advise arranging the forges in groups of four if the best results are desired. The writer has visited two new shops where such mistakes have been made and feels it some one's duty to enter protest as to the propriety of a plan that will produce an atmosphere in the shop that will simply suffocate or stifle the men who are compelled to work in it.

In designing forges some thought should be given as to proper dimensions, heating qualifications, storage of fuel, convenience, cleanliness, economy in fuel and shop space. The large or generally termed big forges are preferably made circular, and should have sufficient space allotted to them for the convenient handling of the heavy work. The frame forge should be about 36 in. sq. and made to drop about 12 in. Such a forge can be dropped quickly and the slow process with the chain hoist avoided and the fire left in good condition for the succeeding heat.

In connection with the forge we find quite a difference of opinion as to the proper volume and pressure of blast productive of the greatest efficiency, many claiming great volume with a pressure of five to seven ounces will produce the best results, but the writer, through experience, has determined that any volume that will fully supply each forge with a constant pressure from 14 ounces to 16 ounces through an upright opening in the tuyere equal in area to 2 or 2½ sq. in. is about the proper thing for railroad smith shops.

For ordinary work in the railroad smith shop the tuyere should be at least ten inches below the top of the forge. With this depth

depth to tuyere the slag and clinkers do not drop down and clog it as they will at a less depth; besides, we have a body of fuel below the iron sufficient to produce and continue to produce the necessary heat for the best results, and lessen the demand for a new fire at 9.30 a.m. and 3.30 p.m.

The shop should be equipped with wrought iron steel-faced anvils weighing from 300 lbs. to 400 lbs. each, placed on portable cast-iron stands. Each forge should have a full equipment of tools. Fifty cents expended in the proper tool will earn dollars for the employer, if in the hands of a competent workman.

If the accumulation of good wrought iron scrap is sufficient to employ the reverberatory furnace a greater part of the time, its use from a money saving standpoint is absolutely necessary, and in many localities where refined hammered iron of large dimensions cannot be received on short notice its services are required aside from the money-making qualities accredited to it.

As the demands for furnaces in the smith shop are many there should be special furnaces for special classes of work as follows: The large reverberatory furnace and the billet furnace, which may be of similar design, which will also make it useful in heating material for small forgings, car work to be formed on the machines, etc. Then comes the case-hardening and spring furnaces, and special furnaces for the heading and bolt machines, flue welding furnace, etc. Some of these special furnaces for special classes of work will increase the output over that of the forge from 300 to 400 per cent. as far as heating advantages go, but this would be profitless were it not met by an equal shaping capacity of proper machines.

Any old steam hammer with special dies producing any number of duplicate forgings will show a saving of ten dollars and up each day over the same class of work produced by hand, and if a 1,200-lb. steam hammer can be installed for 1,500 dollars the interest in the investment would at 4 per cent. amount to 60 dollars per year, or about the profit earnings of the hammer for one week over hand work, and if kept in constant service would mean a saving or gain of

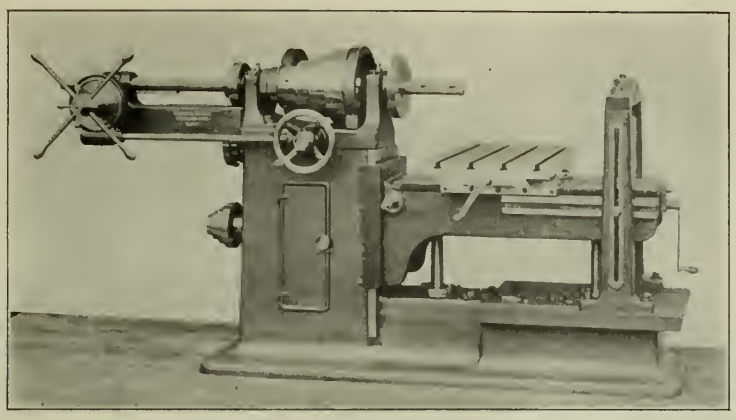


Fig. 1—The Warner & Swasey Horizontal Boring Machine.

about 3,000 dollars annually, and if operated only one hour each day would still be a profitable investment.

The number of cranes should be ample for all requirements, and when possible placed so as to interchange but not interfere with each other. The smith shop of to-day should be equipped with steam hammers, bull-dozers, heading machines, forging machines, bolt machines, punch and shears, etc.

Railroad companies that have built new shops in recent years have been lavish in the expenditure of money in the interest and comfort of the employee, and by the installation of improved machinery and appliances mentioned in this paper much of the laborious work formerly done through compulsion by man, is now cared for with little effort. But while the output is increased the demand for the man is not decreased, and being relieved of the laborious part which was formerly his, should he not feel like increasing his movement just a little?

## Railroad Shop Tools.

*(Continued.)*

HORIZONTAL BORING MACHINES.

The horizontal boring machine, Fig. 1, is made by the Warner & Swasey Company, Cleveland, Ohio. The table of this machine is 20 in. x 36 in. It has a cross movement of 29 in., a lateral movement of 26 in. and a vertical movement of 20 in. The table can be raised or lowered from either the end or the side of the knee. The elevating screws are geared together and provided with an adjustment by means of which the table can be kept parallel with the spindle. The spindle is 2½ in. in diameter and has a maximum feed of 20 in. The machine cone takes a 3-in. belt and with the back gears there are eight changes of speed and four changes of feed. The feed is worked by a hand wheel at the left of the knee or automatically after turning the friction knob. Quick motion to the spindle is given by the handle at the left. A 12-in. double friction countershaft for a 3½-in. belt is supplied with each machine. This should run at 150 revolutions per minute and will give spindle speeds of 278, 183, 122 and 80 revolutions per minute without the back gears, and 36, 24, 16 and 10 respectively with the back gears.

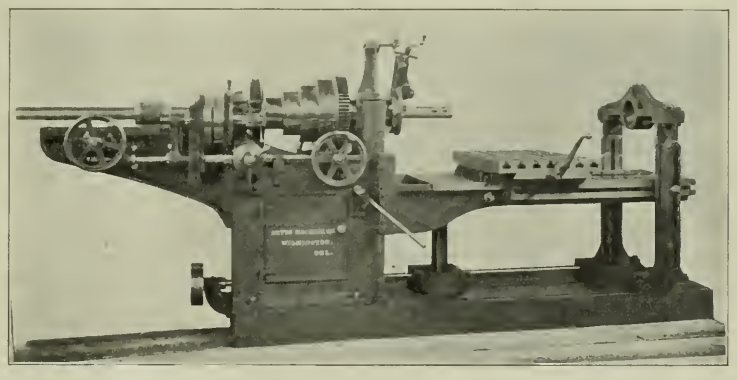


Fig. 2—The Betts Horizontal Boring Machine.

The horizontal boring machine shown in Fig. 2 is made by the Betts Machine Company, Wilmington, Del. The cone pulleys on this machine have four speeds for a 3½-in. belt. The machine is back geared and has eight changes of speed on the spindle. The spindle is cast steel 3 in. in diameter and has an adjustment of 24 in. through the cone. Provision is made for a 48-in. traverse of spindle if required. The steel spindle can be driven in either direction and it has a full bearing through the cast iron spindle at all times. It has a quick hand movement through a rack and pinion. Six changes of automatic feed are obtained by means of cut cone gearing. The spindle can be fed in either direction without reversing its direction of rotation. The table is 6 ft. long and is elevated by means of screws, worm wheels and worms, which are operated by power. The table carries a saddle which has a movement parallel with the main spindle. On this saddle is mounted a cross table 21 in. by 36 in. This is adjustable at right angles to the spindle and can be lowered until its top is 25 in. from the center of the spindle. Both the saddle and the cross tables can be removed when it is desired to increase the capacity of the machine. The maximum distance from the center of the spindle to the top of the main table is 30¾ in. The weight of the machine is 10,000 lbs. and the countershaft should run at 120 r.p.m. This machine was made for the Pittsburg & Lake Erie railroad shops at McKee's Rocks. It is equipped with a Crocker-Wheeler motor and the Morse Chain Company's silent chain drive.

The horizontal boring machine shown in Fig. 3 is made by the Binsse Machine Company, Newark, N. J. The boring bar is made of steel and is driven by two cast-steel keys. It has a No. 6 "Morse" taper hole in its ends and it is long enough to bore all holes larger than the bar diameter without using a stub bar. The bar is fed by worm gearing, with rack and pinion. The machine is driven by the Binsse patent triple gear drive. As seen in the illustration, with this arrangement, the pull of the belt does not come on the main spindle. The friction thrust has two hardened and ground steel, anti-friction rings, which can be adjusted to take up lost motion, or wear. The bar can be held at any point by a friction clamp; thus the bar can always be fed the full length of the feed at one setting. The bar has two hand feeds, one fine and one very coarse. The power feeds are nine in number, two for drilling, five for roughing and two for finishing. These feeds are obtained by means of spur-gearing. The carriage has central and side guiding surfaces, and it is held to the saddle by a solid gib. The carriage has six wearing surfaces, and it is bolted to the saddle and table by four clamps. In this way, the saddle, carriage and table are practically one piece, and no working strains come on the cross-feed screw. Adjustable index dials aid the accurate reading of the vertical and cross movements, and facilitate setting the work rapidly. All the sliding surfaces are at right angles to each other. The table is kept in line by the faces on the head, and is braced by the yoke.

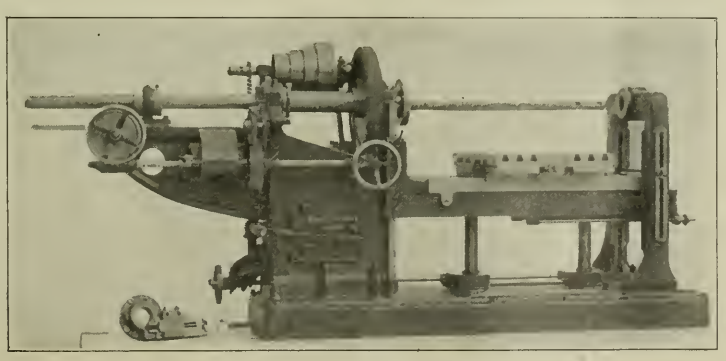


Fig. 3—The Binsse Horizontal Boring Machine.

When the gibs which bind the table to the head are tightened, the table is brought in correct alinement. The table has a power lift, which can be driven at different speeds, according to the load; the fine hand adjustment being made by the operator while calipering the cylinder. The yoke is a box frame. It carries two bushings, one fixed, and one turning with the boring bar. Therefore the wear is taken away from the bar to the bushings, which can be replaced easily. A hand power movement is provided for moving the yoke. The facing attachment furnished with this machine is shown in the lower left hand corner of the illustration. The hub is split which enables it to be attached to the boring bar at any point on the bar without disturbing the bar or the work.

*(To be Continued.)*

## How to Handle Freight Safely.*

The North Western advertises that it has the best of everything and that of course includes the men. It also claims to be the pioneer in this part of the country, and the officers believe that when the best lot of railroad men in the country understand the matter that they will see to it that what is necessary is done to make their company the pioneer in improving the handling of freight and so reduce the losses to a reasonable amount. The records for the 12 months ending May 31, 1898 and 1904, show:

| | 1898. | 1904. | Inc. | P.c. |
|---|---|---|---|---|
| [1] | $27,035,105 | $37,665,007 | $10,629,902 | 40 |
| [2] | 14,728 | 58,146 | 43,418 | 400 |
| [3] | 7,520 | 57,824 | 50,304 | 700 |
| [4] | 62,548 | 272,786 | 210,238 | 400 |
| [5] | 70,068 | 330,611 | 260,542 | 470 |

[1]Freight earnings; [2]number of claims; [3]freight lost; [4]freight damaged; [5]total amount paid for claims.

The increase in this account is partly the fault of the management of the company and partly the fault of the men who handle the freight traffic for the company. If you or I had an increase in our wages of 40 per cent. and increase in our cigar bill of 400 per cent. you know what would happen, and the same thing will necessarily happen on a railroad if this increase is not stopped; and we *must* stop it.

When the book of rules is silent, call for information on your superintendent, or the General Claim Agent or whatever official of the road ought to know and have him tell you. The man asked will be very glad the question is put to him, because it demonstrates to him that the agent making the inquiry tries to do right. It calls your officers' attention to the fact that you are trying to learn the right way to do the business. The men that get along in the railroad service are the men who do things right, men who were able to do things that are necessary in time of emergency. When everything runs smoothly there is no trouble, the thing runs itself, we don't need any officers then; but when an emergency arises or trouble comes up then is when the officer wants to get busy and earn his salary, and then is when you want to call on him. And by doing so you are calling attention to yourself and it may aid in bringing about your promotion. That is what we are all working for. Rule No. 3 instructs an agent to give courteously all information that is asked of him by our patrons so far as it does not interfere with the company's business or interests. We, however, are not to open our books for information or inspection to attorneys or any one else.

We had a short time ago a claim for $700 on a car of corn claimed misdelivered. When we sent out for information regarding that car we found that the attorney for the claimant had been there ahead of us and had been through the books and got all of the information he wanted. Now, that is the kind of information we don't want to give; if any one comes along and insists on getting such information refer him to your Superintendent, or to me.

We don't want to take any horses in less than carload lots going to points beyond our line unless there is somebody in charge of the horses. We are perfectly willing to accept such shipments for points local to the North Western because we have got our sign out to do any kind of business that it is proper for a railroad to do and we can't have too much of it—just at present we have too little. But our connections will not receive horses in less than carload lots unless there is some one in charge. Nearly every week we receive at Milwaukee, Chicago and other terminals such shipments that our connections will not accept because there is no one in charge. We have to pay for feeding the horses and we have got to take care of them, and I have got to get the other line to take the shipment or make some arrangement with the shipper and we have to make all sorts of concessions.

We don't want to accept shipments of returned machinery for repairs unless you receive an order from the shipper to take it back. We don't want to take shipments of agricultural implements, patent medicines or things of that kind for return shipment without such an order because the chances are that when it gets to destination there is a dispute and the original shipper says: I am going to sue the fellow up there for that stuff and I won't take it. And nine times out of ten we won't get our charges. We are under no legal obligations to advance charges to anybody. We don't have to loan our money to any one. While it has become customary to make proper advances on shipments from connecting lines, we never want to make any advances on shipments for more than one-half of what that shipment would sell for at forced sale. In determining the value of any article you want to base it on what you think you would pay for it if you wanted to make a purchase of that article.

Rule No. 15 says that freight must be properly marked with name of consignee and destination before being received for shipment. If it is so marked and should be carried by or go astray it can be promptly forwarded to proper destination under rule No. 94, if not marked we all know what becomes of it. I remember a claim of $800 or $900 on a shipment going from Parker to Amboy, Ill. There were 27 boxes shipped and when the gentleman came to ship them the agent said to him: "Why, you haven't got that stuff marked." The man goes out and marks it, the agent takes his word for it and bills it all right. But the man forgot to mark two boxes and left the old marks on them. The shipment came down on our road and was transferred with the exception of two boxes which were marked Morris. The shipment checked out 25 boxes and went along with the way-bill marked "2 short." When it got to destination it was two boxes short, of course. The stuff was valuable and we had a claim for it. The agent at the transfer point forgot to make an over report and left the two boxes in the car for Morris, Ill., on the Rock Island. They never reported it to us. They are poorer than we are and need all the boxes they can get more than we do. We traced those things up—I had to find it or lose my job. I can't afford to lose my job because I don't know anything else. We found that this shipment had been transferred and followed the original car which had gone to the Rock Island Road. We sent down to where the car went and there were the two boxes as big as life with the old marks on them but no new ones. Now if the two boxes had been marked we would have been saved all this trouble and expense as they would have been forwarded to proper destination by the Rock Island in accordance with the general understanding among railroads even if our agent at transfer point had made a mistake in the transfer.

Rule No. 23 says that before we receive property for shipment we must check it. We must know the condition of that property when delivered to us for transportation. The receipt is worth exactly what the property is worth as long as the North-Western Railway Company is good. If Mr. Smith gives me his note for $150 it is good just as long as he is good for it. Just so with the receipt; as long as the North-Western Company is good we either have to deliver the goods or pay for them. Last fall we had a claim of $578, the value of 98 bales of twine alleged to have been shipped from Ute to Omaha; when the car reached its destination it was under seal, was full, but short 98 bales from the billing. Our receipt was out for the twine and the agent issuing it claimed he had actually checked it into the car. It was up to my department to convince the holder of the receipt that it was a mistake, and we finally did it. Perhaps you think it was an easy job. A little while ago we had a claim for $1,600 shortage on a car of butter and eggs going from some point out in Iowa to New York City. The agent, of course, issued a clean receipt for it. I think it was invoiced at $2,100 and when it got there there was only $500 worth of property in the car. The man who got his receipt had taken it to the bank, draft had been drawn on it, he got $2,100 and Mr. North-Western got a claim. Don't receipt for a car load of freight loaded by the shipper unless you put on the receipt "Shipper's Load and Count." If you get a car of corn offered you, look and see if there is corn in the car. We had a claim the other day on a car of corn from Missouri Valley going up to Manitowoc and when it got to Manitowoc there wasn't a pound in it. Now, nobody had taken that corn out. It was simply an error of the man that was supposed to have her loaded out, yet the North-Western Company's clear receipt is out for that property, and what are we going to do about it? What would I do if you made a note for $700 and gave it to Mr. Lawson and he gave it to me or sold it to me for $350? When that note became due you would have to pay me $700. You might say that I only paid Mr. Lawson $350. That wouldn't make any difference. Here is your signature for $700 and you would have to pay the note if you were good. If we issue a receipt and it gets into the hands of an innocent holder we have got to pay for the stuff it calls for or deliver it. That is one of the things

*Extracts from an address by R. C. Richards, General Claim Agent of the Chicago & North Western, recently delivered to the agents of the company, at meetings held in Chicago, Boone, North Fond du Lac, Madison, Escanaba, Wasecа and Huron. For the benefit of agents who were not able to attend the meetings the address was printed in pamphlet form, with the following introduction by General Manager W. A. Gardner:

"Employees who were able to participate in the meetings, which this pamphlet records, will secure additional pleasure and profit in an opportunity for review. The large number whose duties would not admit attendance will find the first page so interesting as to require no other incentive for completing the reading. . . . Those who make rules are not infallible, and those who should observe regulations are not always keenly alive to the disastrous effect which may result from a trifling cause. The severest, most impartial, and always reliable teacher is Experience, and, whether we be machine-made from the University or hand-made from the Universal, no little portion of our success as individuals or corporations is to be attributed to our faculty for avoiding the difficulties which have jeopardized others. . . ."

which is happening all the time, and that is one of the reasons the damage account has increased 400 per cent. and the shortage 700 per cent.

We have a legal right in every instance to make a man who comes to us for freight give up the bill of lading. That is a legal right we have. Now, we don't want to do that with every man. We have a lot of people in this town receiving shipments every day and we ought to deliver their freight to them without the bill of lading unless shipped to *order* or *notify*. But if you have any doubt about the consignee or he is a stranger to you you say to him: The company requires me to take up the bill of lading, you are a stranger to me, and under the rules and regulations of the company I cannot make delivery without your surrendering the bill of lading. Tell him: There is a son-of-a-gun down in Chicago who will raise Cain with me if I deliver those goods without surrender of the bill of lading. Put the blame on me or Mr. Lawson if you don't feel like taking it yourself. You are not to blame for the rules the company makes. But don't deliver it. When in doubt take the safe course. If you do that you will be all right and so will the company.

We had a claim of $100 a few days ago on a shipment of potatoes for Mounds, Ill. Now there were two Mounds in Illinois, one on the Illinois Central and one on the Wabash. We were instructed to send it via the Illinois Central. The agent in billing the shipment billed it via the Wabash. We delivered it to the Wabash. It cost us something like $100 to get the shipment back to the right place. They were as far apart as two places could be in Illinois; all of which might have been saved if when that way-bill was made it had been compared with the shipping directions. It would not have taken one-tenth as long to do that as to write letters and explain why the mistake was made.

We have any number of claims presented for damage to machinery and to threshing machines, especially threshers. It seems to me some switchmen take a special delight in making a fly with a car of threshing machinery to see how hard they can let it bump up against the other cars or bumping post. Before you receipt for machinery on open cars look it over and see if it is all right. We are getting claims all the time for tools and tool boxes missing. They pass through the country and every man that has a threshing machine wants the tools and helps himself. When they ship tools and boxes on an open car, look and see if they are there and receipt for the freight as you find it. It isn't at all unusual to get a consignment of a dynamo costing all the way from $2,500 to $10,000. If any of you gentlemen were in business and you were getting a $10,000 dynamo, you bet your life before you took it from the North-Western's platform you would know whether it was in good or bad order. If it was in bad order you would call the attention of the agent to it and receipt for it in that way, and that is the way we want you to handle the business of the company. Do it as you would do your own business.

Some of the eggs unloaded at Chicago look as if they had been shot out of a cannon. The cases look as if you men loaded this stuff and bumped it up against every other case in the car, and then some switchman had taken the car up to the roundhouse and tried to knock a hole through the wall. All eggs are broken right in the end of the case. A good many cases are not fit to carry eggs. Now, you ought not to accept them in packages unfit to carry them. Every three months or so I have reprinted rules 16 and 17 telling you not to receive shipments unless properly crated. I had them reissued a week or so ago and had part of it printed in red ink, thought if you saw the red ink you would think it was a danger signal, but don't know if any of you have seen it. I think we had 199 claims for eggs damaged in transit for the month of June. That is too many. If they are packed in proper cases and we load them right and cars are handled with ordinary care they will reach destination all right. If they are not packed in proper cases refuse to receive them. If they were properly loaded and carefully broken down so that they will not slide all over in the car we wouldn't have all those claims.

A little while ago we had a claim for $1,195 on a type setting machine. Now those things are about as delicate machinery as can be made, and they are expensive. They don't weigh much. I guess we got about $4 for taking it from Marinette to Manitowoc. When it got there it looked as if it had gone through a threshing machine, and, of course, we had to pay for it. In the first place it wasn't properly crated for transportation and then it wasn't properly loaded—it wasn't secured in the car. We could better have afforded to have paid something to have it properly crated than to have taken chances of paying $1,195, and if any of you gentlemen incur any expense of this nature put it on the way-bill as advances, that is where it belongs, and if the consignee refuses to pay and your Superintendent won't refund it to you, call on me. I will pay it every time and be much obliged to you in the bargain. We can't afford to take any chances with that kind of stuff. Nobody could stand the loss but a railroad company. And the more money that is saved in cutting down this expense the more there will be left in the treasury of the company for improving facilities, dividends and higher wages, and the next time your committee goes down to Chicago and wants your hours shortened and your pay raised, tell the General Manager you have reduced the damage account $100,000 by exercising more care and following instructions. That will be a point to use with him. And it will be a good point and he will give it consideration. If any other item of the operating expense had increased 700 per cent. or 400 per cent. in seven years as the freight losses and damages have there would be a receiver in Chicago instead of a president and our wages instead of being increased as they have been would have been cut down.

I had a claim presented last week on a shipment going to Chicago, I think it was $241 damage to butter loaded into a dirty refrigerator. The conductor swore up and down that it was clean, but the agent says it was dirty. He forgot to clean it. He told the truth. At least the presumption is that he told the truth. If the agent or the conductor had taken the trouble to clean the car before they loaded the property into it, it would take them actually less time to do it than to write letters explaining why it was not done. If it had been their stuff they would have cleaned the car before they loaded it. Why shouldn't they do it for the company that pays them?

Don't load flour, sugar and stuff like that which will be damaged by water into a refrigerator car. We had a claim a short time ago on a shipment of silk which was carried in a refrigerator car with the ice-boxes leaking, waste pipes blocked up with dirt. The silks, of course, weren't damaged, oh no. They were simply drowned. There was about two inches of water on the car floor and when the doors opened out came the water, and in came the claim. This time it cost the company over $100. If the car had been examined before it was loaded the damage would not have occurred.

(*To be Continued.*)

## The Theory of Accident Statistics.*

The hackneyed subject of railroad accidents has received increased attention of late, but the various discussions do not throw much light on the questions dealt with. Everybody seems to feel as helpless as ever in the presence of the Juggernaut which kills over a thousand passengers and railroad employees every year, to say nothing of the other thousands killed at highway crossings and by falling off cars, and in those other classes of accidents which are not always chargeable to train movements. What is the matter? The first point in the study of statistics is to find out exactly what the figures mean. Numerous writers confuse the totals in the train-accident class with the total of all accidents, thus leading to absurd conclusions.

Not long since comment was made on the remarkably small percentage of deaths and injuries occurring among passengers riding in sleeping cars, in the State of New York, during a given period; but the most important element in the explanation of this high immunity—the fact that sleeping cars are always, when possible, run at the rear end of the train—was not mentioned. A collision which caused the death recently of six passengers on an electric railroad in Ohio illustrates the other aspect of this feature of the safety of passengers; the six victims in this case were in the forward end of the only car in the "train," and of course bore the brunt of the collision. These hapless victims were, in fact, in a more dangerous position than that of the average engineer on a steam railroad train, for the engineer is on the alert and he knows the road and all its peculiarities.

Accident records for brief periods are of but little value. Those accidents which cause numerous deaths of passengers, swelling the records and drawing attention, occur with comparative infrequency, thus making it necessary to examine the statistics for a long period of time if it be desired to draw lessons therefrom. Comparisons of the records of one part of a country with another, or of this country with European countries, must be used with great caution, because of the differing circumstances.

A trans-continental railroad 2,000 miles long may carry no more passengers than a road in the thickly settled Eastern States less than 100 miles long. The average per mile of railroad has no meaning in a comparison between two such lines and is of no value unless the number of passengers and the number of trains is taken into account. Even then the figures must be used with caution, because the number of freight trains, the presence of which adds to the risk of accident to passenger trains, needs to be known. The number of passengers carried by any particular road, as shown in its annual report, is a very inaccurate basis for any comparison until it is known whether these passengers traveled ten miles or 1,000 miles each. Comparing one country with another is even less satisfactory than comparing different parts of the same country, or one railroad with another; for complete statistics, tabulated on the same basis, are not available for any two countries. Men working in shops are in some cases classed as railroad employees and in others are left

*Extracts from an article in the *Commercial and Financial Chronicle*.

out of the account. If all these difficulties were removed, we still have the greatest weakness of all—the fact that our statistics throw no useful light on the real causes of the deaths and injuries. The true theory of accident records makes of them a guide for marking progress forward or backward, in the same territory or on the same road, and very little more.

But if the theory of statistics is to be thus narrowed down to a point where it affords no aid in making life and limb safer, what is to be done? The most rational reply to this query is to be found in the way that the theory of accident statistics is extended by the Government statistician to include *detail causes*. He does not confine the quarterly bulletins to dry comparisons of one quarter with another, but gives also a list of causes of the worst collisions and derailments. In bulletin No. 8, which contains the statistics for the year ending June 30, 1903, the last quarter of that year is dealt with in considerable detail, and there is a table giving notes of the causes of 43 of the most disastrous collisions and derailments. Let us glance at these notes. . . .

These are statistics which have a vital meaning. Failing to extract lessons from averages or totals or comparisons of years or of countries, the next thing is to study the causes of individual accidents; and here we find the facts which enable us to do so. Where men make a mistake in calculating time by their watches and time-tables, killing a dozen of their fellow-employees, the public very naturally inquires why the block system, as used on many ro· 's and which makes such time-piece calculations unnecessary, is not more generally employed than it is. If a locomotive engineer or a flagman who commits a costly and fatal blunder has been on duty 20 hours, the question arises, what kind of a superintendent was it that permitted this excessive work? If a collision is due to the fact that only one man on a train was familiar with the stations, signals, time-table, etc., some grave defect in system would seem to need investigation. And so on through the list.

Railroad accident statistics which really show causes are a public benefit, for they keep the salient facts before the people, and they afford a basis for whatever action may become necessary to regulate unenterprising railroads so as to bring them into line with the larger companies in the matter of safety regulations and appliances; but it is worse than useless to try to deceive ourselves by reading into the statistics what is not there.

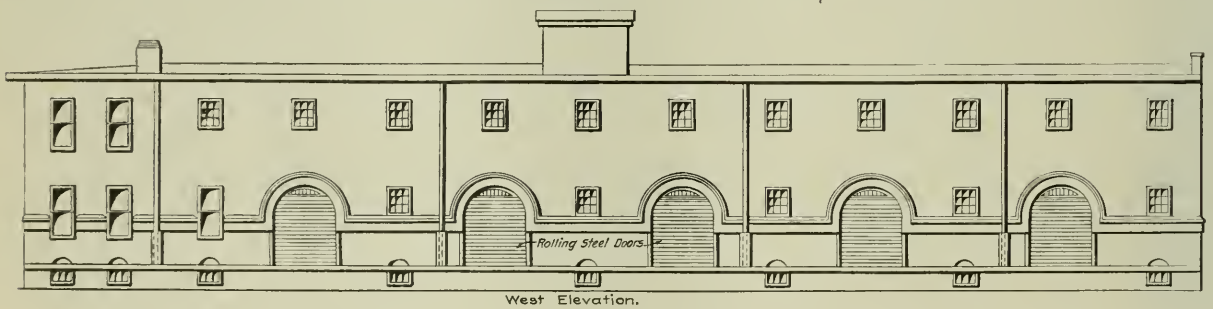
## Concrete Block Freight House for the Chicago Great Western.

A freight house built of concrete blocks has lately been completed by the Chicago Great Western at East Waterloo, Iowa. The building is 32 ft. x 155 ft. and has two stories and a basement. East Waterloo is a city of about 17,000 inhabitants and the average monthly freight business is $25,000. The former facilities consisted of a one-story frame building, 30 ft. x 130 ft., which was moved to a site adjoining the new house and is used in conjunction with it.

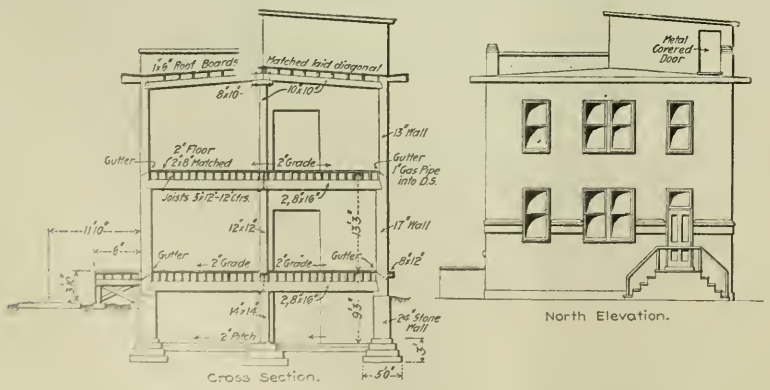
The foundations of the new building are stone, the walls being 24 in. thick and resting on footings 3 ft. deep and 5 ft. wide at the bottom course. Walls and footings are rubble stone laid in concrete mortar. The walls of the first story are 16 in. thick and for the second story are 12 in. thick, the size of the blocks for the two stories being 9 in. x 16 in. x 30 in. and 9 in. x 12 in. x 30 in. respectively. Mixtures of four and five parts of coarse sand to one part of cement were used for the blocks for the walls, while for the trimmings such as the water-table, window sills, arch blocks, etc., a two-to-one mixture, with a finer grade of sand was used. The blocks were laid in a two-to-one Portland cement mortar with ¼-in. horizontal and vertical joints. They were all laid in the winter, during freezing weather, the sand and water being heated.

The roof is three-ply asphalt, over 1-in. boards. The floors are carried by timber girders composed of two 8-in. x 16-in. pieces resting on posts at the center of the building, which are 14 in. x 14 in. for the first floor, and 12 in. x 12 in. for the second. The joists are 3-in. x 12-in. and the maple flooring is 2 in. thick. The floors are given a 2-in. grade from the middle toward each side and are made tight, with gutters along the walls to permit flooding without wetting the floor below. The head-room in the basement is 9 ft. 3 in. and the floor is 1 in. of cement on 5 in. of concrete above a 6-in. sand filling. There are three chutes for unloading freight into the basement, and there is also a cooling room at one end which is large enough for three carloads of fruit.

On the track side of the building there is an uncovered platform 6 ft. wide. There are six 8-ft. doors on this side and four on the team side, rolling steel doors being used for all ten openings. The offices are at one end of the first floor, and space has also been provided near the center of the building for an elevator to run from the basement to the second floor. The house is lighted by electricity, and there is also provision for lighting cars during loading and unloading.




Elevation of Concrete-Block Freight House for the Chicago Great Western at East Waterloo, Iowa.




End Elevation and Cross-Section of Freight House.

The concrete blocks for the building were supplied by the Concrete Stone Company, of Waterloo, and were made in Palmer machines. The cost for a building of this kind ranges from 28 to 32 cents a square foot laid in the wall. We are indebted to Mr. A. Munster, Acting Chief Engineer of the Chicago Great Western, for data.

## Foreign Railroad Notes.

The members of the Strike Committee which conducted the strike of Hungarian State Railroad employees were tried by a criminal court and all acquitted. The judges introduced their finding with a speech, in which they substantially condemned the strike, but they found that the abandonment of their work by the men was not in law a crime; and, further, they found that these employees are not State officers, having no other privileges than those of employees of private railroads.

A German commenting on the frequency of railroad accidents in Russia, where the low rate of speed and the relative infrequency of junctions, etc., would seem to favor safety, says: "Without doubt the untrustworthiness of the lower grades of employees has much to do with it. This is the worst feature of Russian railroad management, because the untrustworthiness is due in part to the very character of the people; in part to defective instruction. The people have not been accustomed to observe and fulfil exactly relatively trifling tasks; perhaps they cannot be trained to do so, because it is not in their nature."

RAILROAD GAZETTE

## UNIONS VS. INDIVIDUAL PROGRESS.

Not long ago, the general superintendent of one of the most important roads in the Southwest, a man who had himself risen from the rank of brakeman, made the remark that, in his opinion, the men who were to-day filling subordinate positions on the railroads were not of the same caliber as the men who entered railroad service twenty years ago. He was prompted in speaking by a number of cases of carelessness and stupidity on the part of his men which had come under his observation while on a trip of inspection. He had seen shiftless work in switching cars in the yard, lax observance of rules by trainmen, useless delays to trains, and helplessness and lack of initiative in times of emergency; but his statement expressed a spirit of resignation rather than of indignation. The cases were not flagrant ones that called for dismissal from service, but they evidenced a far more troublesome symptom—an almost total lack of *esprit de corps*, which could not be artificially created by discipline. They were evidences of a disorder too deep seated to be cured by local treatment.

It has long been recognized that the personal relations of the employed to the employer decrease about in proportion to the growth of an industry. The apprentice of olden times had every incentive to perform his work not only in a manner which would satisfy the letter of the requirements placed upon him, but in a manner which would gradually increase his own education, skill, and capacity to become master. But with the growth of enterprises so great that the position of master seems wholly unattainable to the worker in the ranks, while specialization and division of responsibilities first places lieutenants under the captain; then sergeants under each lieutenant, and then corporals under each sergeant, the personal incentive, springing from contact with the head and brains of the business itself, is entirely gone.

When the specialization of modern industries had progressed beyond the point where the apprentice could follow his master as leader, there was great need for some other leadership to fill the vacant place, and here it was that the labor union came in. An organized body of men with high ideals could do much in any craft. As has been pointed out in the *Railroad Gazette*, and by economic writers everywhere, a chance was afforded to provide for the careful training of apprentices, the promotion of proficient workmanship, and the elevation of the intellectual and moral plane of the working men. But, unfortunately, it is only in the most exceptional cases that the labor union movement has worked out in that way. The grave charge which lies against nearly every labor leader of the present day is that he is using his organization as a tool with which to drive bargains, and that to secure the unity necessary to accomplish this, he is sternly repressing, instead of developing, individualism. The trade union bargain is always measured in terms of quantity, not of quality, and it will not do for the skilled workman to so develop his craft that it cannot be measured by the unit with which the union is bargaining. Further, in order that time and output may be made synonymous union terms for purposes of barter, the individual workman must be prevented from mixing his units of service. Twenty years ago an engineer was his own hostler and mechanic; all of his spare time was spent at the roundhouse cleaning and polishing, tinkering with the valve gear, tightening the bearings and oiling up his engine as a trainer would groom a race horse. To-day he takes an engine out and brings it back, leaving to some other man or men, the cleaning and the repairing. He is not paid to do that.

It may indeed be questioned whether the specialists at the head of departments have not strengthened the trade union teaching to perform only the letter of the requirement, in their effort to work economies through subdivision of labor. It is quite obvious that labor must be subdivided in a complex organization, but it is possible to make some economies very expensive, if they are effected at the price of the intelligence of the men employed. The present trade union tendency to jealously limit activity and restrict output works in only too well with the evil features of specialization which are the penalty corporations must pay for being big. A writer quoted in another column complains that the railroad private no longer carries a Marshal's baton in his knapsack, for the unions have substituted seniority for merit as a basis of promotion, and throw all their influence and power against individual progress.

The remarks of the anonymous railroad official referred to above, were shown to a passenger conductor, an intelligent and thoughtful man, who made the comment that in these days neither conductors nor enginemen have a chance for promotion in railroad service; that trainmasters are usually made out of train despatchers, and master mechanics, roadmasters and superintendents, are now usually made out of the graduates of technical schools. He himself had spoken to the superintendent but twice in fifteen years' service, and he thought that the changed order of promotion and the lack of contact between officers and men were the causes responsible for the deterioration in energy and effort.

But there is no use wasting tears over this inevitable effect of the specialization of work and the subdivision of authority made necessary by the great and complex railroad and industrial organizations of the present day. The matter which needs adjustment, and the evil for which there is a remedy, is the wrong and shortsighted viewpoint of unions which emphasize and exaggerate this situation, and do all in their power to hinder the working out of the principle that the fittest may not merely survive, but may win rewards proportionate to the field of the industry in which they are engaged. When the efforts of the labor leader are confined to restriction of output, and when each minutely subdivided craft jealously guards its own boundaries against encroachment, the individual worker in the big corporation suffers all the disadvantages of its bigness, without being permitted to aspire to its correspondingly large rewards. How can it be otherwise than that the "tone of the men" should deteriorate, when their own leaders make them keep their eyes on the ground?

## ESTIMATING THE VALUE OF RAILROAD PROPERTY.

In the annual report which it submitted to Congress last December the Interstate Commerce Commission recommended an appropriation of several hundred thousand dollars to be expended in securing reliable data concerning the value of the railroad property of the United States. The objects of such an inquiry, as stated by the Commission, are two-fold. The results, in its opinion, would contribute to the solution of rate problems by throwing light upon the question as to what aggregate revenue a particular line might properly derive from its traffic, and (second) it would afford a basis for taxation. To an outsider it might seem somewhat strange that the Commission, which has no functions in connection with the taxation of railroad property, saw fit to devote the larger portion of the space which it accorded to this subject to the argument which it derived from the alleged value of such an inquiry in connection with problems of State and local taxation. Great industry was shown in the compilation of facts in support of this contention, and elaborate tables were introduced, with the evident purpose of exhibiting in the sharpest possible contrast the differences in the practices of the states in regard to railroad taxation. Besides the pages of matter supporting this branch of the argument, the two brief paragraphs urging the utility of "an authoritative determination of railroad values" for the purpose of regulating rates seem insignificant, indeed. The discrepancy even suggests that the Commission, having had some experience in the field of rate regulation, is doubtful of the strength of its argument upon this score; while, having no practical familiarity with taxation methods or problems, it was readily beguiled by the superficial plausibility of the latter branch of the argument. Whatever may be the true conclusion in this particular, it should be borne in mind that there is a radical dissimilarity between the conditions of the two problems. However defective such a conclusion may be from the point of view of sound economics, the right of state and local governments to tax railroads and similar enterprises as "going concerns" has the sanction of the highest judicial authority. In other words, it has become an established principle of law that the taxing authority may add to the real value of the property owned an assumed special value which it regards as accruing to a particular aggregation of property through its combined utilization in a particular business. (For the attitude of Massachusetts on this question, see "The Franchise in Capitalization," printed in the *Railroad Gazette* last week.) Thus the horses and wagons of an express company may be assumed, for taxing purposes, to have value beyond other horses and wagons because they are utilized as a part of an extensive and systematized express business. Now, it is obvious that no rate making authority has any business with this intangible and illusive kind of value. The Interstate Commerce Commission would not for a moment

recognize it in fixing the rate for any service, should that body ever be endowed with rate-making authority, and if it made such a mistake its action would never receive the approval of the courts. These considerations have become important because, although Congress did not see fit to give effective approval to the Commission's recommendation by providing an appropriation for the purpose urged, the latter body has, through an extraordinary chance, obtained an opportunity to prosecute the desired inquiry and to have its cost met out of the appropriation for another branch of the Federal Government. An estimate of the material wealth of the country has been a recognized feature of the work of the Federal Census Bureau for several decades. Naturally railroad property constitutes an important item in this aggregate, and its value must carefully be estimated. The present Census Bureau is now working on its estimates of the wealth of the nation, and having found no more satisfactory method of obtaining railroad values, has appealed to the Commission for aid. The latter will prosecute the inquiry, under the direction of Professor H. C. Adams, of the University of Michigan, who is its chief statistician, and the Census Bureau will foot the bills. Just how this arrangement will affect the result is not yet evident, but it is hardly likely that Professor Adams will subordinate his well-known desire to find a means of generally augmenting railroad taxation to the remote possibility of utilizing a low valuation so as to support the desire of some members of the Commission to obtain legislation under which great reductions in railroad rates can be compelled. The method to be used is to be based, it is understood, upon that devised by Professor Adams under instructions from the late Governor Pingree, of Michigan, when the latter devoted his attention to shifting the taxes of the state so that they should fall principally upon the corporations. This method provides, by an elaborate and complicated process, for giving an assumed value to railroad franchises, and thus adding to real and tangible values an intangible element. In the present instance the process will apparently be further complicated by occasional resort to "stock and bond" and "capitalization of earnings" methods of valuation, both of which have been officially condemned by the Commission, but which may be utilized as a means of saving expense and time. In any event, by giving recognition to intangible values in connection with railroads, the Census Bureau will have introduced an element which it has not recognized in any other portion of its work, and will have gone far out of its way to swell the reported value of railroad property in such a way as to make it incomparable with that of any other part of the material wealth of the nation. A statistical aggregate made up of incongruous elements is worse than useless; it is positively and dangerously misleading.

The papers discussing electric railway competition with the railroads, which have been given much space in the *Railroad Gazette* during the last two years, have all been written from the standpoint of the steam roads. The contribution by Ernest Gonzenbach, printed elsewhere in this issue, reviews the same topic from the viewpoint of the interurban road. Mr. Gonzenbach, Engineer of the Youngstown & Southern electric line in Ohio, and author of *Engineering Pretiminaries for an Interurban Electric Railway*, although believing wholly in the future of electric railways, does not hesitate to point out with great clearness some of their present limitations. We are disposed to take issue with his statement that when the demands of through service and quick time have been fully met by the electric roads, a most vigorous warfare between them and the steam roads may be looked for. It has always been held in these columns that the prime, paying function of the interurban road was short-haul traffic. In perfecting a through service an interurban line must needs sacrifice its advantage of a continuous terminal from one end to the other of every town through which it passes, since the very convenience which this affords to passengers precludes fast time. Moreover, a through service in the proper sense of the word requires private right of way, and there seems no reason to suppose that an electric line would be any better qualified thus to compete for traffic between distant points than a steam line. If developments in the art throw the advantage to electricity, the steam roads are in a position where they can electrify their present lines much more readily than can the interurban companies build new ones to compete with them. Somewhat the same criticism seems to lie on Mr. Gonzenbach's comment that the road (interurban) which stands the best chance of making money from freight traffic is naturally the one which opens new territory or new routes not touched by existing steam lines, and does not come into competition with them. The history of the interurban roads thus far shows that the most money has been made by handling a very light class of freight traffic that did not interfere with the passenger service, and this traffic, corresponding almost to an express service, has been most profitable where the territory was the most built up, and hence where competition with the steam roads was most dense. Throughout Mr. Gonzenbach's interesting paper, the point which most forcibly strikes the reader is that the author considers not how electric roads may compete with steam roads, but how steam roads may compete with electric roads, thus giving graphic testimony to the phenomenal progress in interurban railroad building and management within the last few years, and conveying again to steam roads with important short-haul traffic the warning that they must not be caught with their hands in their sleeves.

The extent to which suburban territory is dependent for its development upon a thoroughly harmonized transportation service is nowhere better shown than in the country which the New Haven road now proposes to open up by the improvement of its Harlem branch between the Harlem river at Port Morris and New Rochelle. The suburban territory along the Harlem road, which is used by the main line trains of the New Haven road below Mount Vernon, has been highly developed for a great many years, like the suburban territory across the Hudson river and that along the main line of the New York Central as far as Yonkers and beyond, but the towns reached by the inadequate service of the old Harlem branch of the New Haven road have scarcely developed at all, although situated within a radius of ten miles from New York. The service was inconvenient, involving a change of cars at the Harlem river and the use of the elevated lines from that point into the city, and hence resulted the curious anomaly of an undeveloped district in the midst of a thickly populated suburban territory. The present plans contemplate not only a frequent service over a first class roadbed, but also a through connection with the subway, and it may readily be imagined that the towns along the shore between New Rochelle and Port Morris will develop a very profitable traffic. The building of the subway really furnished the key to the situation, so far as the passenger traffic is concerned; for, during all these years while the overflow population from New York has been seeking homes within a short distance of the city, the electric lines as well as the steam road have been effectually prevented by their lack of through connections from giving this particular district a service that would make it an important suburban community.

The new six-track line, with its potentiality for lessening the serious congestion which now exists on the main line north of New York, is also of the highest importance to freight traffic, and fits in as an important part of the long discussed plan for a freight route from the new Pennsylvania Greenville terminal across New York Bay to a connection with the Long Island road at 39th street, South Brooklyn, thence through Brooklyn and Long Island City over an elevated structure and over the projected Randall's Island bridge across the East River to Port Morris.

The statement that the cars will be of standard construction similar to those used by the Interborough, means that direct current will be used. Even if local conditions did not make necessary the use of direct current motors, it is doubtful if a great deal would be saved by the use of alternating current motors inasmuch as one power house at a point such as New Rochelle could supply the entire line, with the aid of two or possibly three sub-stations, containing step down transformers and rotary converters. In fact, the step-down transformers may not be necessary, as the distances are so short that the voltage of the main distributing line need not exceed 3,000 volts, which can be converted by a motor-generator set. The length of the transmission line might be decreased by building the power house at West Farms in which case the greatest distance fed by any one line would not exceed 3½ miles. The detail plans of the electrical equipment have not yet been given out, but the arrangement and location of the power house and sub-stations will probably be made with the ultimate end in view of making the present scheme fit in with future extensions of the electric service.

Another article in this issue tells of the action of the Chicago & Alton in correcting bad practice in loading, checking and handling freight. After that article was written, the address of Mr. R. C. Richards, of the Chicago & North Western, came to hand, and though actions speak louder than words,

we put Mr. Richards' article in type first, and printed a part of it last week. It is nothing but words, but in this case we are glad to commend the North Western's words as heartily as the Alton's action. For railroad men's reading, a more spicy article than Mr. Richards' is seldom seen. As the reader will naturally infer, words are not the only corrective measures that are in use on the North Western; but the idea of giving such an address is particularly commendable because words, of the right kind, are so comparatively scarce in the operating department. Railroad officers glory in being men of action, and all who know them join in that feeling; but practice without theory is always in danger of being illogical and wasteful. Every agent on the North Western should henceforth find it easier to train his men to carefulness and intelligence in their work. Not the least valuable part of Mr. Richards' address is that which hits the superintendents; that wherein he speaks of the need of more supervision and inspection. That paragraph should be read three times in every superintendent's office, and then pasted in the superintendent's prayer book under the words "Read, mark, learn and inwardly digest." This warm praise of Mr. Richards is not called out by his originality of thought, but by his refreshing plainness of speech. The *idea* of having more and better supervision is not original; and it is one that, probably, needs no introduction in superintendents' offices; but discussion of it —which should lead to putting the idea in practice—is conspicuously lacking. Mr. Richards' field of action might be widened, with much profit.

## Freight Damage Bills and Their Settlement.

Two recent news items which have not received much notice but which may prove to have marked significance are those announcing, on the Chicago & Alton, the establishment of a freight tracing office, and on the Louisville & Nashville the appointment of two traveling claim agents. The constant stream of complaints from consignees about delays in settling bills for lost and damaged freight is one of the oldest reproaches to the railroad service. The stream is not always a flood nor are the complaints always reasonable; but the condition is often a real discredit to the railroads interested and the annoyance to conscientious managers is one that cannot reasonably be thrust aside as too trifling or too remote to deserve attention.

And the thing that has led to action at the present time is that the volume of damage bills has greatly increased. The duty of fighting unreasonably importunate claimants or of preventing delays in the investigating offices is one which, like that of feeding the poor, is always with us; but just now there is the further problem of reducing the number of just claims; of carrying freight more safely. The use of large cars and large engines, with the resulting great economies has had its incidental unfavorable conditions, and this is not the least of them. In loading 36-ft. cars full to the roof care is required to stow packages so that they will not damage each other, and this is a kind of care that freight-house men have not been sufficiently trained in. In unloading a part of such a load, the part remaining needs attention to make it ride safely during the rest of its journey, and this attention must be given by men who naturally shirk the duty if they are not looked after. The use of automatic couplers has relieved enginemen and brakemen so completely from the care formerly required to avoid crushing men between buffers that cars are allowed to bump together with any degree of violence that may seem desirable for the purpose of saving time; any degree short of that which it is seen will surely cause the culprit to be called into the superintendent's office. This rough handling has always been practiced in cases where it was known that no man was or would be between the cars, but now we have this evil condition with all cars at all times; and damage claims have piled up in heaps like mountains.

The question naturally arises whether the two roads mentioned have taken the best means of meeting this difficulty. In other words, what need is there for new or different offices or officers? Is not the usual organization fully adequate? The Louisville & Nashville traveling men are to visit every competitive point every month. This is good as far as it goes, but how about non-competitive points? Apparently these men have some power to settle small claims, although no specific statement has been made to that effect. Their influence in reducing the causes of damage must be only indirect. The Chicago & Alton official, on the other hand, goes directly to the freight houses and freight conductors. He finds the men who have caused the trouble. His usefulness, like that of a traveling passenger or freight agent, must depend on his personality. If he has the right combination of the qualities of lawyer, detective and executive officer he can accomplish great good—unless the Alton is in better condition than most roads. Correcting the faults of yard switchmen is not so easy a task as that of straightening out freight-house loaders, for each yard man is to a considerable degree his own boss and a single inspector cannot deal with 20 or 50 men at once; but, surely, if a yard man can be trained to switch dining cars without breaking their fragile contents we can train him to do the same with freight cars—if we deem it worth while.

The significant and commendable thing on both roads is the putting of the work in the hands of men who make claims and damages their chief business. Existing faults are due largely to the fact that their treatment is so generally in the hands of men with whom some other duty comes first. So far as can be judged from the situation on railroads generally, every company ought to imitate both of those which we have here named; ought to stop breakages by direct attention to freight house and freight yard work, and at the same time put in operation a reflex influence in the same direction by more promptly and energetically investigating breakages which have already occurred. It may not be very logical to look to the freight claim agent to prevent collisions and loss of lives on freight trains; and yet there can be no question that sufficient energy applied to his department could be made, in many cases, to do just that thing. Prompt and thorough inquiry into every instance of damaged freight would fix the responsibility, in a good percentage of cases, on men who had banged the cars together at furious speeds in switching; and this abuse of buffers and draw gear is the concealed cause of many a subsequent break-in-two, costing much money, and, occasionally, one or more lives. And if this worst and most dangerous evil—particularly dangerous because a break-in-two not only makes a great wreck but also endangers fast passenger trains—could thus be cured, the cure of the lesser evils of money loss to the company and annoyance to the owners of freight, would be accomplished at the same time.

## The German Railroad Union in 1902.

The railroads forming the German Railroad Union had in 1902 an average of 57,926 miles of road and, with second track, sidings, etc., 96,797 miles of track. During the year the rails were renewed on 2,745 miles of this track, less than 30 miles of the renewals being made with iron rails. These renewals amounted to 2⅝ per cent. of the whole track. That proportion in the United States would amount to about 5,820 miles of track, which with 84 lbs. rails would require 768,240 tons of rails for renewals alone. Probably the weight of rails used for renewals, taking the country as a whole, is still somewhat less than 84 lbs. per yard, however. In this, no account is taken of street railroads. For repairs and renewals of these 96,797 miles of track, 10,293,220 wooden and 1,925,991 iron cross ties were used, which is an average of 126 per mile. In this country this would mean a little less than 5 per cent. of the ties in track, indicating an average life of 20 years per tie. In Germany there are fewer ties per mile; but the practice varies, the number of late years being greater than formerly. But with only 2,000 ties per mile, the renewals were but 6.3 per cent. in 1902, indicating an average life of 16 years, which is more than double the average life here. This alone indicates that nearly all ties on the roads of the German Union have been treated. The number of wooden ties used in 1902 was nearly the same as the year before; the number of steel ties nearly one-fifth greater. The consumption of the latter depends partly on the price of iron, which was cheaper in 1902 than for some years previously. Even then, however, for every 1,000 wood only 187 metal ties were used. In 15.84 per cent. of the track the rails weigh 60 lbs. or less per yard; in 54.73 per cent., 60 to 70 lbs.; in 24.52 per cent., 70 to 80 lbs.; in 8.12 per cent., 80 to 90 lbs.; in 0.55 per cent. (that is on 392 miles of track), more than 90 lbs. There is a decided increase in the use of heavy sections from year to year.

Freight traffic for the year amounted to 56,738 millions of ton-miles, equivalent to 627,247 ton-miles per mile of road, or 859 tons each way daily (against 1,087 in the United States for the year ending six months later). On the other hand the German Union passenger traffic was at the rate of 465 each way daily, against 136 in the United States. Per inhabitant (approximately) the distance traveled by rail was 182 miles in the countries of the German Union, and 250 in the United States; and the freight traffic was 2,004 ton-miles per inhabitant here against 490 there. The average receipt per passenger-mile was a trifle less than 1 cent on the German Union (0.9984 cent), against 1.986 cents here; the average per ton-mile, 1.388 cents there and 0.757 cent. The average distance run by the 638,200 freight cars was 20,196 miles, or 55 miles per day. Their average actual load was 13,202 lbs., which was about 42 per cent. of their capacity. At the end of 1902, there were 419,631 open freight cars and 218,571 box, or other covered freight cars. The proportion of covered cars is much greater in all continental countries than in England.

The 61,971 passenger cars in the German Railroad Union at the end of 1902 had seats for 2,699,919 passengers, an average of 43½ per car. The seats in first-class cars were only 4.2 per cent. of the whole number, against 17.5 second-class, 62.5 third-class.

and 15.8 fourth-class. In most of the countries there is no fourth class, though those which have it perhaps have the larger population. Per mile of railroad there were seats for 47 in passenger cars of all classes. On the average 24 per cent. of the seats were occupied while running—equivalent to an average of about 14 per car in this country, which is rather above than below our actual average, our average passenger-train load being not more than 47, here. At German Union rates our railroads would have earned $193,000,000 *less* from passengers and $1,014,000,000 *more* from freight, or on the whole $821,000,000 more, which is nearly 4½ times the amount paid in dividends that year. On the other hand the German Union railroads at the American rates would have earned $184,000,000 *more* from passengers and $389,000,000 *less* from freight, or $205,000,000 less in all. Of course the American fares would have destroyed the larger part of the German passenger traffic, and the German freight rates would have been totally inapplicable here.

The aggregate number of employees was 897,293, which is at the rate of 15.5 per mile of line. During the same year the aggregate number of employees on railroads in the United States was 1,189,315, which is at the rate of only 5.94 per mile. The work done by the two systems per employee was 21,616 passenger-miles and 33,090 ton-miles on the German, and 16,556 passenger-miles and 132,253 ton-miles on the American; one-quarter less passenger business per employee here than there, but four times as much freight business. The gross earnings per employee were $1,451 here and $795 there. Retired employees and their widows and children received $20,000,000 in pensions, besides which the railroads in the German Union paid out about $12,500,000 to pension, relief and invalid funds; and the capital of these funds at the end of the year was about $80,000,000, which is nearly $90 per employee. The payments for the year under these heads amounted to an average of $36 per employee, which must be taken into account when the low European wages are considered.

### Railroad Gross Earnings for July.

Gross earnings for July are somewhat disappointing after the showing made by most of the railroads in June, when it appeared as though traffic conditions were gradually improving. For the month, 82 railroads report a decrease of $4,306,589 over July of last year. As each month appears, some new factor seems to arise to reduce revenues and tonnage. In April the trouble was caused by the strike of the pilots on the Great Lakes, in May it was the strikes in Colorado, while in June, adverse weather conditions in the west played a prominent part in the falling off of earnings. Shortly after the first week in July, when the traffic situation appeared to be regaining its natural condition, the beef-packing strike began in Chicago and the middle west. This has served to seriously interfere with the tonnage and revenues of the railroads, not only in the immediate vicinity of the strike, but also in the West, South and Northwest. In the first place, this strike has reduced the shipments of live stock by nearly 50 per cent. Live stock receipts at the Chicago market for three weeks subsequent to the strike numbered 9,710 cars, and shipments amounted to 3,815 cars. For the corresponding period last year, the figures were 17,696 cars and 4,585 cars, the decrease amounting, in the first case, to 43 per cent., and in the second case to 17 per cent. The strike also reduced the shipments of dressed beef 44 per cent.; canned meats, 16 per cent.; other meats, 11 per cent.; barreled pork, 43 per cent., and beef packages, 56 per cent. This falling off in shipments has affected chiefly the East and West trunk lines from Chicago, and it is in this group that the largest decrease in earnings are recorded. For the month of July, seven railroads in the trunk-line group show a decrease of $1,591,041. The traffic situation in the Southwest is also unsatisfactory, owing to bad weather and damage to crops, which has caused a heavy falling off in grain shipments. In this vicinity, nine railroads show a decrease for the month of $1,177,373. Reports from the various other sections of the country are as follows: Anthracite group (four railroads), decrease $1,207,029; Northern & North Pacific group (12 railroads), decrease $58,660; Middle and Middle Western group (13 railroads), decrease $40,383, and Southern group (nine railroads), increase $2,275.

In analyzing the gross earnings of the separate railroads for the month, it should be remembered that, in many cases, the decrease is not as large as was the increase during the same month last year, when traffic was unusually heavy. This shows that, although earnings appear small when compared with those of last year, they are, in many cases, quite normal. It should also be taken into consideration that a more conservative policy has been adopted by many railroads, so that operating expenses have been accordingly reduced, making net earnings, as a whole, satisfactory. The largest decrease for the month is made by the Reading Company, where a loss of $1,157,642 is recorded. Other heavy decreases are as follows: Atchison, Topeka & Santa Fe, $643,457; Baltimore & Ohio, $589,925; Erie, $497,807, and New York Central & Hudson River, $405,846. In the latter case, however, the loss is only about half of the increase made last July, which amounted to $812,627. Encouraging reports are shown by the Canadian Pacific, with a gain for the month of $318,656; Chesapeake & Ohio, with an increase of $100,128; Southern, with $98,493; St. Louis Southwestern, $89,444; Great Northern, $86,691; Wabash, $81,996; Missouri, Kansas & Texas, $61,295; Pere Marquette, $60,824, and Illinois Central, with $58,276.

## TRADE CATALOGUES.

*The Railway Appliance Company*, Chicago, has issued catalogue No. 112, illustrating and describing the Oldsmobile railroad inspection car and its use on steam and electric roads, with details of parts, weight, capacity, speed, etc.

*The Hancock Inspirator Company*, New York, issues a small pamphlet which describes its type "E" inspirator for locomotives, and contains much information concerning their use for feeding locomotive boilers. Tables, charts, and a diagram of parts with price list of each part are also given.

*Gould & Eberhardt*, Newark, N. J., send a catalogue descriptive of their shapers and shaper attachments. A detailed description and illustrations of these machines are given. There are also a number of interesting illustrations which show different methods of clamping work to the table while being machined.

*The Consolidated Car-Heating Company*, Albany, N. Y., issues a catalogue descriptive of the different styles of electric heaters which it makes. Diagrams of wiring show the proper method of connecting up the heaters. Up to date the company has equipped over 18,400 cars, involving the use of more than 175,000 electric heaters.

*The American Balanced Valve Company*, Jersey Shore, Pa., issues booklet Nos. 21 and 22 with illustrations. The first-named describes the use and advantages of piston valves for locomotives, and the other describes double-acting slide valves, including their use under high pressure and their efficiency in preventing leakages.

*The Laidlaw-Dunn-Gordon Co.*, New York, issues Bulletin L-601, 6 x 9 in., with illustrations facing each reading page, describing the Meyer-gear pumping engines for small water works and elevators. These engines are built on the cross-compound and three-cylinder compound types, with fork frames. It is claimed that their steam consumption is about one-half that of the best types of direct-acting compound pumps.

*The Haberkorn Engine Company*, Fort Wayne, Ind., has issued a catalogue describing the Haberkorn engine. Special attention is called to the valve mechanism which is designed so as to avoid all compression in the cylinder except as desired for cushion. Two piston valves are used. It is claimed that the engines give Corliss fuel economy at two or more times Corliss speed, and occupy one-half the floor space.

# CONTRIBUTIONS

### Draft of Baltic.

Aguascalientes, Mexico, Aug. 20, 1904.

To the Editor of the Railroad Gazette:

Will you kindly inform your readers what is the draft of the new steamer Baltic when fully loaded, and also what the depth over the bar at entrance of New York Bay is?

BEN JOHNSON.

The maximum draft of the Baltic is 36 ft. 6 in. At present, vessels drawing 32 ft. may leave or enter New York harbor at high water, but otherwise the limit of draft is 30 ft. The Government is now engaged on an extensive plan of channel dredging, but it will probably be several years before the Baltic can load to her full capacity.—Editor.

### The Schenectady Locomotive Superheater.

The American Locomotive Company has brought out a new locomotive superheater, designed by Mr. F. J. Cole, Mechanical Engineer of the company. It is to be known as the "Schenectady" superheater and has been applied to the New York Central Atlantic type (4-4-2) passenger engine No. 2,915, now in regular service on the Mohawk Division between Albany and Syracuse, N. Y. The objectionable features of previous locomotive superheaters, both abroad and in this country, have been, first, the use of bent tubes, and, second, the necessity of dismantling the whole superheater in order to get access to a single leaky boiler tube. As shown by the accompanying illustrations it has been the aim to eliminate these difficulties.

The first new feature of construction is in the T pipe, the regular conventional T pipe being replaced by one of special design. This T pipe is subdivided into two compartments by a horizontal partition, and it extends nearly across the smoke-box. Steam which enters the T pipe from the dry pipe is admitted to the upper compartment only. To the front side of the T pipe are attached 11 header castings, the joint being made with copper wire gasket, as in steam chest practice. Each header casting is also subdivided

into two compartments, but in this case by a vertical partition. Five pipes or flues of $1^1/_{16}$ in. outside diameter are inserted through holes (subsequently closed by plugs) in the front wall of each header casting. These $1^1/_{16}$ in. tubes are first expanded into special plugs, and then firmly screwed into the vertical partition wall. Each $1^1/_{16}$ in. tube is enclosed by a 1¾ in. tube which is expanded into the rear wall of the header casting in the usual way; each nest of two tubes (one $1^1/_{16}$ in. and one 1¾ in.) is encased by a regular 3 in. boiler tube, which is expanded into the front and back tube sheets. The back end of each $1^1/_{16}$ in. tube is left open, and the back end of each 1¾ in. tube is closed, the back ends of the two tubes being at a point about 36 in. forward from the back flue sheet. The detail arrangement and grouping of the three flues is shown by figure 3. The back end of the 1¾ in. tube is closed by welding, and the tail is formed so as to support this tube in the upper part of the 3 in. tube, thus leaving a clear space below. Fig. 1 shows that the $1^1/_{16}$ in. tubes

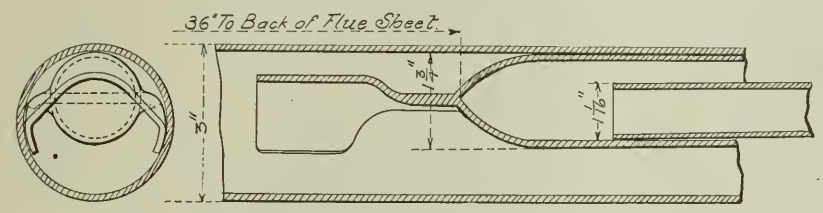



Fig. 3.

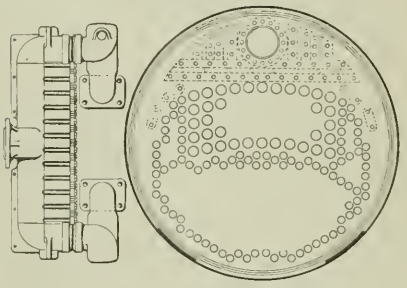


Fig. 4. Fig. 5.

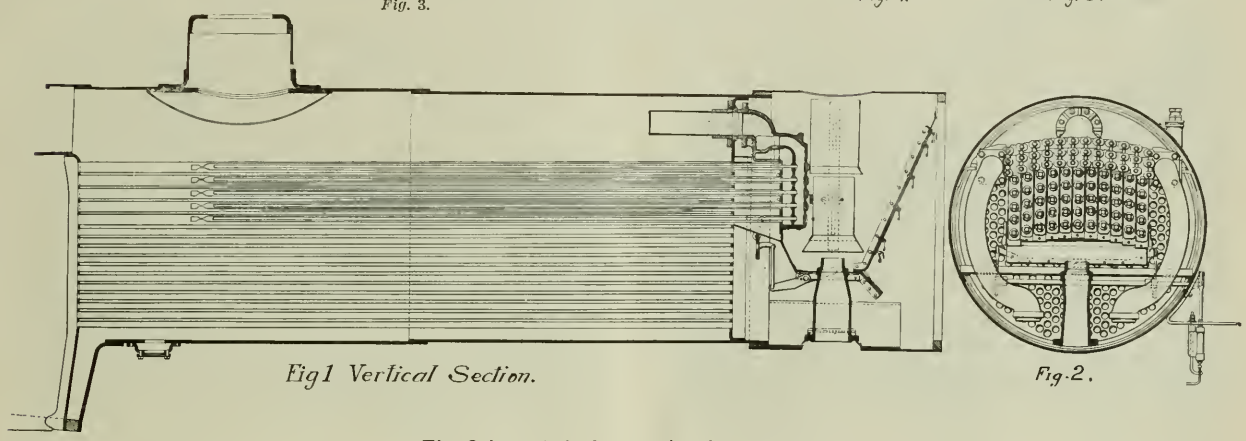


Fig 1 Vertical Section. Fig. 2.

The Schenectady Locomotive Superheater.

are concentric with the 1¾ in. tubes at their back ends, but the fact is the $1^1/_{16}$ in. tube is allowed to drop and rest on the bottom of the 1¾ in. tube, as shown by Fig. 3.

Steam from the dry pipe enters the upper compartment of the T pipe and then enters the forward compartments of each of the 11 header castings, after which it passes back through each of the 55—$1^1/_{16}$ in. tubes and then forward through the annular spaces between the $1^1/_{16}$ in. tubes and the 1¾ in. tubes to the rear compartments of each of the 11 header castings. The steam then passes into the lower compartment of the T pipe, and then, by the right and left steam pipes, to the cylinders. In passing forward through the 1¾ in. tubes the steam is superheated by the smoke-box gases and products of combustion passing through the 3 in. tubes. In this particular design 55—3 in. tubes are inserted in the upper part of the flue sheets, thus displacing as many of the regular smaller tubes as would occupy the same space. The arrangement of flues is shown by Fig. 5.

In applying the superheater to a locomotive it is necessary to provide some means of protecting the superheater tubes from excessive heat when steam is not being passed through them. This is accomplished by an automatic damper, shown in Figs. 1 and 2. That portion of the smoke-box below the T pipe and back of the header casting, is completely enclosed by metal plates, and the lower part of this enclosed box is provided with a damper which is automatic in action. Whenever the throttle is opened and steam is admitted to the steam chests the piston of the automatic damper cylinder (shown in Fig. 2) is forced upwards and the damper is held open, but when the throttle is closed the vertical spring immediately back of the automatic damper cylinder (and concealed by it in Fig. 2) brings the damper to its closed position, so that heat is not drawn through the 3 in. tubes when the engine is not using steam. In this way the superheater tubes are effectively prevented from being burned. In introducing the group of 3 in. tubes and applying the superheater, there is a slight loss of heating surface, but it is more than offset, as regards economical results by the superheating process. The heating surfaces of the regular New York Central Atlantic engine and the sister engine which is fitted with the superheater, are shown by the following table:

*Heating Surface (sq. ft.).*

| | Engine | | |
|---|---|---|---|
| | Regular. | Superheater. | Per cent. |
| Fire box | 175.0 | 175.0 | 0.0 |
| Fire tubes | 3248.1 | 2837.0 | 12.6 |
| Arch pipes | 23.0 | 23.0 | 0.0 |
| Totals | 3446.1 | 3035.0 | 11.9 |

The application of the superheater reduces the heating surface of the fire tubes by 12.6 per cent., and reduces the total heating surface by 11.9 per cent. The actual superheating surface is 301 sq. ft., which is 10.6 per cent. of the fire tube heating surface, and 9.9 per cent. of the total heating surface of the superheater engine. A pyrometer is inserted in the left steam pipe, as shown in Fig. 2. Readings from this pyrometer since the engine has been in service, show that the average temperature is about 517 deg. Fahrenheit, the boiler pressure being 200 lbs. per sq. in., which corresponds to a temperature of 387 deg. Fahrenheit. A superheating of 130 deg, is thus obtained.

Service tests on the Canadian Pacific with a superheater locomotive showed savings (on the ton mile basis) of 33 per cent. in fuel consumption, as compared with a similar simple engine, and 16 per cent. as compared with a similar compound engine, when the performance was reduced to the same unit of comparison.

The piston rod metallic packings are made of a special mixture (which, in this particular case is a mixture melting at about 1,200 deg. Fah) to guarantee that they will not be unfavorably affected by the excess heat in the cylinder.

When superheated steam is used no chances can be taken as regards lubrication of the cylinders, and, therefore, forced feed is used instead of the usual gravity feed. It is probable that the constant temperature of the cylinder walls, when steam is being used, is about 385 deg., which, however, is considerably higher than the corresponding temperature in the case of an engine not equipped with a superheater.

The forced feed lubricator used is of German make, and consists of four reservoirs which are filled with oil before the beginning of the run, the oil being forced out of these reservoirs through connecting pipes to the cylinders, by plungers which receive a gradual but constant downward impulse by a screw motion, which is actuated by a system of levers connected with a return crank on one of the rear driving wheels. In this case two oil pipes are led forward from the lubricator to each side of the engine. One of each pair of oil pipes enters the live steam passage through the cylinder saddle, and the other is led directly into the cylinder at the middle of the stroke.

Casual consideration of this design might lead to the prediction that the upper of 3 in. tubes would be likely to choke up in service; but the annular space in the lower part of these 3 in. tubes is quite free and unobstructed and can easily be reached and scoured by a steam jet from the fire-box end. The upper flues, however, are not as likely to choke up as the lower flues.

## A Practical Method of Adjusting Suspension Bridge Cables.*

It is always a difficult problem in the erection of a short span cable suspension bridge in which the cables are made up of groups of separate ropes to adjust the length of each rope so that it will carry its calculated proportion of the total load on the cable and to provide for the necessary camber to the bridge under full working load. It can be shown that the error in dip is greater than the error in cable length producing it, and as it is the dip which is required to be accurate, it is the dip that ought to be measured, not the cable length. It can also be shown that the curve of a rope is not sufficiently defined to admit of accurate measurement of the dip by tangential observation, unless the rope is uniformly loaded so as to produce a fair curve free from wave, and to eliminate sag beyond the towers. While it is manifestly out of the question to apply such a uniform load during erection as would give the desired result, a central load can be used which will not only give a similar result, but will admit of the necessary measurements being made with great accuracy and with all possible sources of error eliminated.

This method was adopted in erecting a 250 ft. span over the Kangaroo river, New South Wales, in the following manner: The saddles on the towers having been wedged in a central position and greased, a rope was drawn into position, permanently fastened to its anchorage-bolt at one end, and temporarily to that at the other, care being taken that the temporary fastening was made in a similar manner to the permanent one. The rope was allowed to hang between the towers in a curve having a dip of a foot or two less than that required, but no care was taken to obtain a particular dip. A weight of 4.36 tons was placed in the bed of the river (which was dry at the time) under the center of the rope, and, a snatch-block having been placed upon the rope, the weight was connected to it and lifted slightly off the ground. The effect of the weight of 4.36 tons was to draw the rope into a series of practically straight lines, under a stress of 12.22 tons (equal to that produced by the dead load), and to take up the slack in the fastenings and anchorages, as well as the sag beyond the towers, the waves in the rope, and the extension due to dead load. In order that the rope should be of the correct length, it was only necessary that the portion of it forming two straight lines from the tops of the towers to the snatch-block in the center should be equal to the calculated length of the curve in a vertical plane under the dead load, viz., 256.89 ft., or, in other words, that the center of the rope should be 22.93 ft. below its level at the top of the towers, Fig. 2. This, of course, would not be the case on the first trial. It will therefore be supposed that the dip to the snatch-block was found on observation to be 1 ft. too much, or 23.93 ft.; the length of rope between the towers, as determined by calculation, would then be 257.24 ft. as against 256.89 ft. required, the rope being thus 0.35 ft. too long. It would, therefore, only be necessary to release the weight, take up 0.35 ft. on the rope, make the fastening permanent, and apply the central weight again as a check to complete the operation.

That this system of adjustment is capable of producing very accurate results is well shown by the foregoing example, the small error of 0.35 ft. in the length of the rope producing a whole foot of dip, the error being multiplied by three at the point of observation. Indeed, the only reason for not getting the rope exact after the first trial is that some allowance has to be made for yield, or want of accuracy in making permanent the connection of the rope at the end which is temporarily fastened during the test. In erecting Kangaroo river bridge any small error found on second application of the weight was taken up by the tension-screws, but after experience had been gained in fixing the first two ropes it was not found necessary to move the screws more than about one thread, so little indeed that they might well have been dispensed with. There is a certain inaccuracy in assuming the several lines of rope under the action of the central weight to be straight lines; they are, of course, very flat curves; further the point of application of the weight is not a point, but a curve dependent upon the size of the sheave of the snatch-block used to suspend the weight. These inaccuracies are inappreciable, and, being common to all the ropes, are of no account, especially as any sag in the ropes beyond the towers when under the adjusting-weight remains equally under the dead load in the completed bridge.

With regard to temperature, correction may be made by calculation, but it is best to assume a temperature readily obtainable at some portion of the 24 hours, to fix the

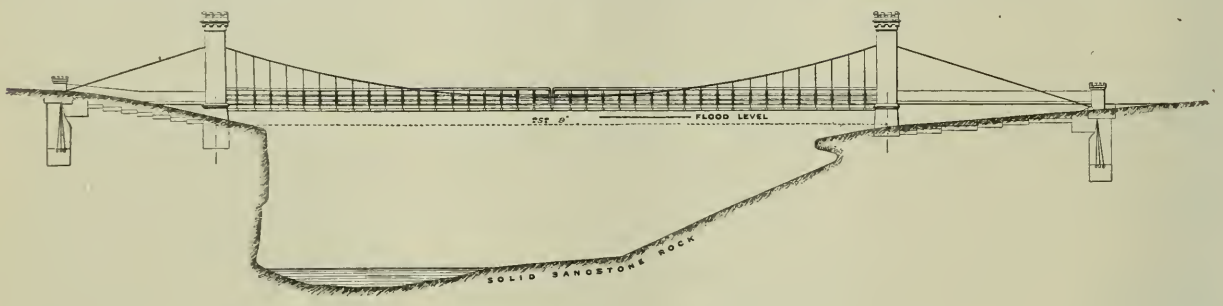



Fig. 1—Kangaroo River Bridge.

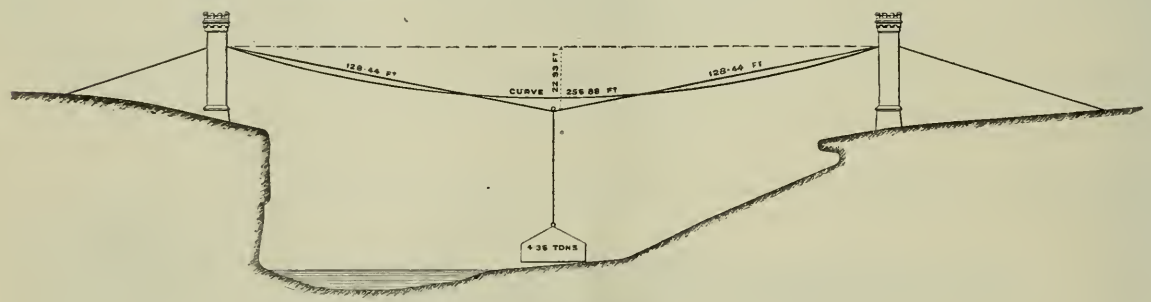



Fig. 2—Method of Loading Test Cable to Determine the Proper Dip.

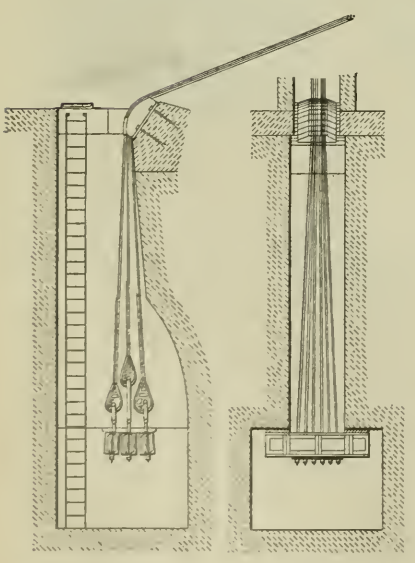


Fig. 3—Kangaroo River Bridge Anchorage.

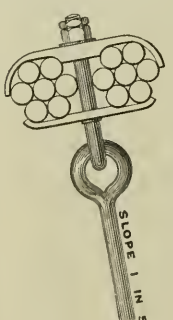



Fig. 4—Section of Cable.

*Extract from a paper by E. M. de Burgh, M. Inst. C. E., published in the Proceedings of the Institution of Civil Engineers, Vol. CLVI., 1904.

expansion-rollers, and to work to that temperature with each rope. A certain temperature may generally be relied upon to recur twice in each 24 hours, and it is better to wait for it than to test one rope in a very hot sun (when the temperature of the steel is really not known) and another in the cool of morning or evening, and attempt to bring them into line by calculation; indeed, it will be found better not to test ropes at all with the mid-day sun shining on them.

In dealing with cases in which the portions of the cables behind the towers support portions of the bridge the same method of adjustment is applicable, but the difference in length (calculated) between a straight line from the top of the tower to the anchorage-saddle and the length of the required curve must be added to the calculated length of rope to be drawn into the center span by the test-weight; and lengths equal to this should be measured from the centers of the towers towards the central weight and accurately marked upon the rope while under test. If on the removal of the test-weight the ropes are then clipped with these marks over the centers of the tower-saddles the lengths will be correct for each span.

### Bridge Wrecked by Cyclone at St. Paul.

The cyclone which struck St. Paul and Minneapolis on the evening of Saturday, August 20, destroyed property valued at more than a million dollars and caused the death of 12 persons. The storm cut a pathway about a half mile wide and eight miles long through the business and residence district of St. Paul and did considerable damage in Minneapolis across the river. A theatre on the edge of the river was completely demolished and several members of the audience were killed and injured. As the storm swept up the river valley it struck the High Bridge across the Mississippi at Smith avenue and carried away two 60-ft. plate girder approach spans on the right-hand bank, one 170-ft. span, a trestle tower carrying a 50-ft. span and one 250-ft. span. This bridge, which was built in 1889, is one of the most noteworthy structures in the Northwest. It has a total length of 2,770 ft., with a 24-ft. roadway and two side-walks 8 ft. wide. The bridge starts from the bluff on the left bank of the river at an elevation of 90 ft. above low water, and is built on an ascending 4 per cent. grade to the bluff on the opposite side, where it reaches an elevation of 200 ft. above low water. It consists of four spans of 40-ft. plate girders, three spans of 50-ft. plate girders, two spans of 60-ft. plate girders, nine spans of 80-ft. riveted open web girders, five spans of 90-ft. riveted open web girders, one 170-ft. pin connected truss span, and four spans of 250-ft. pin connected trusses. The piers of the bridge are built of heavy masonry and are carried up from 5 to 10 ft. above high water. The trusses are carried on iron trestle towers and rocking bents of heights varying from 27 ft. to 118 ft. The floor system was designed with special regard to stiffness, so as to allow trotting on the bridge. The total cost of the bridge was $479,878, and the total weight of the iron in the bridge was 2,980 tons. The river channel is spanned by the four 250-ft. spans

The 250-ft. span which was carried away fell into the river. The total weight of the iron that fell was about 500 tons, of which 267 tons lodged in the river. The cyclone came down the river, and the width of the cyclonic action at this point was not more than 100 to 150 ft. The storm evidently struck the tower and the end of the 250-ft. span, lifting the tower bodily from the masonry, breaking the 2-in. bolts with which it was anchored to the masonry, and threw it down stream. Falling from such a height, the iron work was, of course, twisted and bent in every direction, and it is impossible to make an estimate at the present time of how much of the material can be saved. The balance of the bridge was not injured in the least. Work has already been begun toward clearing away the wreckage and as soon as an estimate can be made of the salvage on the material in the wrecked spans, the contract will be let for replacing them.

High Bridge at St. Paul after the Storm.

Wrecked Spans on the Right Bank of the River.

We are indebted to Capt. L. W. Rundlett, Commissioner of Public Works, St. Paul, for the photographs and particulars of the above statement.

### The Effect of Unions on Railroads.

The *New York Sun* prints the following, as an interview with a "prominent railroad official," whose name is not mentioned. Further comment on the subject is printed this week in the editorial column.

Undoubtedly fatalities have increased unduly in the last decade. And why? It is a puzzling question at first. Traffic has grown enormously, it is true; yet never before has so much thought, care and money been expended on safety appliances and devices. The factors which make for safety seem to have gone ahead of the factors which make for danger. The air-brake is now made compulsory by law. The use of vertical plane couplers and improved systems of signals is universal. Steel bridges have replaced the old, dangerous wooden trestles. Roadbeds are improved all along the line. We have devised better and smarter methods of railroading. And yet the accidents increase out of proportion to the increase of traffic.

Most railroad men will tell you, and rightly, that the fault lies with the employees. In spite of everything, discipline is lax. The tone of the men is deteriorating. There was a time, 20 or 25 years ago, when every railroad employee was right up on his toes trying to do the best he could, because promotion was on merit. As in Napoleon's army, every private carried a Marshal's baton in his knapsack. The railroad presidents and general managers of to-day came from the energetic and faithful trainmen of those days. But now promotion is not made on the basis of merit, but according to seniority.

The labor unions have done this. They have made seniority alone the basis of promotion. There is no chance now—at least on roads where the men are thoroughly organized—for a spectacular career. There is no chance to rise through alertness and faithfulness. And so the men have no interest except in getting the biggest day's pay for the smallest day's work.

Not only that; union men arrange among themselves to conceal from the company any small slip or lapse of duty. These things should be reported. Human life depends on weeding out stupid and unfaithful employees. But the men now shield one another and balk the officials in their efforts to hunt out incompetents or to place the blame for accidents. The men don't look upon the company as a friend and refuge, but as an oppressor. It is a reproach to be a "company man."

Unfortunately, the communities, especially the small ones, stand by the men in this attitude. It isn't the road that suffers from big wrecks; it is the public. It isn't the railroad official who gets killed in accidents; it is the ordinary citizen. They sow the wind when they stand by the unions, and they reap the whirlwind.

On the 6th of July a locomotive boiler exploded while standing on a station track in Paris with a violence rarely if ever equaled. It was reduced to so many fragments that it was difficult to recognize where any of them belonged, when investigating the cause of the explosion. It had come in with a train four hours before and was to go out three hours later. No one was on it at the time, but its engineer and fireman were on their way to it and near enough to be hurt, with 12 other persons, some of them in the streets at considerable distances. This was the first locomotive explosion on this railroad for 33 years.

## The Ganz Rail Auto-Car.*

European railroads have been experimenting extensively with rail auto-cars for the purpose of improving the service and decreasing the cost of operation of branch lines, where, owing to the limited traffic, train service had been operated at a loss. In many cases it has been found that the cost of conducting transportation by the rail auto-car is one-fourth of the cost of train service. Experience has also shown that by establishing four runs each way with auto-cars as against one train each way and with reduced rates the net earnings can be doubled and in some cases even trebled. It has also been found that the use of auto-cars is responsible for a considerable saving in the cost of road maintenance owing to the absence of the unbalanced reciprocating parts of the locomotive.

The car shown in the accompanying illustrations is the design of Ganz & Company, of Budapest, and has met with much favor in Europe. There are cars now in use or under construction for the Hungarian State Railways, the Southern & Kassa-Oderberg Railways, the Russian railroads, the Servian State Railways, and others. The Bavarian State Railways were the first to decide on the general adoption of this car. The half-tone illustration (Fig. 1) shows a car built for the Servian State Railways. A typical floor plan is shown by Fig. 2.

Fig. 1—Ganz Auto-Car for the Servian State Railways.

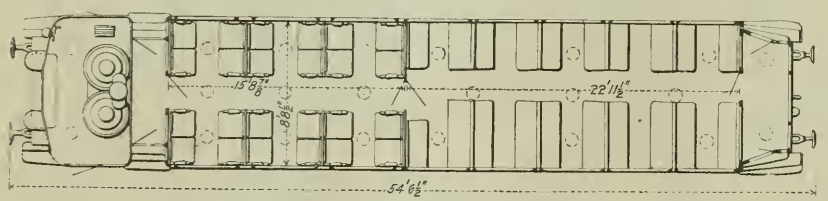



Fig. 2 —Floor Plan—Ganz Auto-Car.

The steam generator of the Ganz car is shown in Fig. 3. These boilers are built in sizes from 35 to 80 h.p. each. They are applied singly up to 80 h.p., and when more power is needed, two boilers are used on the car. The boiler consists essentially of an outer and an inner annular water space connected by short water tubes. The coal is fed down through the hopper formed by the inner ring of the boiler and is burned on the grate below. The smoke-box and stack are built up over the annular space crossed by the water tubes. A live steam jet is provided for increasing the draft if necessary, but the exhaust from the cylinders is usually sufficient. The steam is slightly superheated on leaving the boiler.

The motors are built in sizes from 35 to 80 h.p. Up to 80 h.p. one motor is used and for greater power two motors are used. Each motor has compound cylinders. The motor is shown in Figs. 4 and 5. The motor drives the car axle through a differential gear having two speeds. Going up grade, half speed can be obtained without changing the speed of the motor. The frame of the motor is flexibly suspended at the cylinder end from the car frame. The gear box is air tight and is filled with oil. The motorman can control the motor without leaving his post. The control apparatus is shown in Fig. 6. In starting, both cylinders of the motor can be worked simple. The coal bunker is near the boiler and against the end partition of the car. The hopper can be filled from outside the car. The water tanks are suspended to the car frame. A feed pump of special design is used. A 100 h.p. car having two boilers and two 50 h.p. motors weighs, in working order, about 35 tons, and carries enough coal and water for a 50 mile run. The maximum speed on a level track is 46 miles an hour, and on a 1 per cent. grade the speed is 25 miles an hour. With a 26-ton trailer, the speed on a level track is 28 miles an hour, and on a 1 per cent. grade, the speed is 15 miles an hour. The coal consumption is from 8 to 14 lbs. per mile. The car has a seating capacity of 46 passengers and has a toilet, and a baggage, mail and express room.

The cost for conducting transportation and maintenance of equipment with auto-car service has been estimated as follows. On a basis of 200 miles service per day.

| | Per mile. |
|---|---|
| For writing off capital outlay (Cost of car, including royalty) | 5 cts. |
| Cost of repairs and renewals of mechanical parts | 1.5 " |
| Cost of repairs of car body, couplers, brakes and trucks | 2 " |
| Cost of fuel, lubricating and water | 3 " |
| Cost of crew (1 motorman, 1 conductor, 1 trainman) making about 200 miles per day | 5 " |
| Total, per mile | 16.5 cts. |

Considering the present cost of train service which, if the item of writing off the capital outlay is to be included, would amount to 60 cents per train mile, gives the

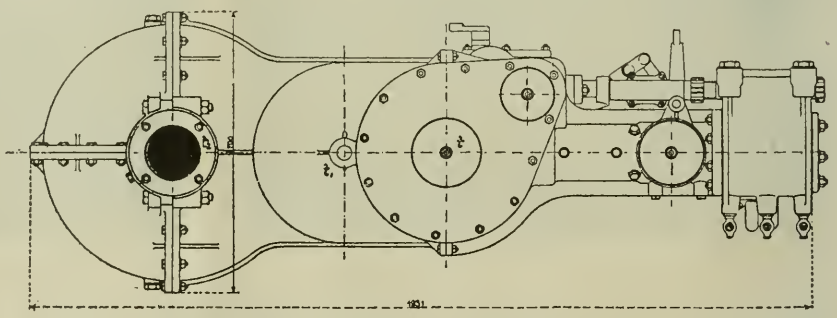


Fig. 4 —Side Elevation of Steam Motor—Ganz Auto-Car.

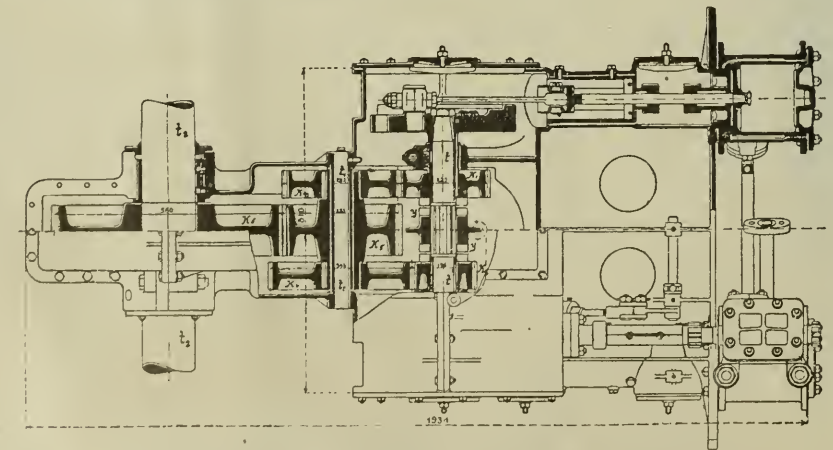


Fig. 5.—Horizontal Plan and Sectional Elevation of Ganz Steam Motor.

*The American rights of Ganz & Company are represented by Mr. G. Leve, 114 Liberty St., New York.

auto-car a great advantage for branch line and suburban service. There is no reason why small types could not be used on surface and interurban lines where the frequency is not sufficient to warrant the capital outlay for electric traction. Such small units could be operated at much reduced cost, not exceeding 10 cents per car mile.

The following statistics of a Hungarian branch line using the Ganz car may be interesting. Similar results have been obtained on a number of other lines. Auto-cars were used in 1903.

| Year. | 1899. | 1900. | 1901. | 1902. | 1903. |
|---|---|---|---|---|---|
| Number of trains | 14 | 18 | 18 | 20 | 32 |
| Number of passengers | 371 | 791 | 889 | 1,190 | 1,904 |
| Gross earnings, in kronen* | 164.22 | 340.06 | 373.38 | 460.25 | 649.70 |
| Earnings per train-kilometer, in kronen | .25 | .44 | .51 | .43 | .46 |
| Earnings per passenger, in kronen | .67 | .43 | .42 | .38 | .35 |
| Cost of transportation per train-kilometer, in kronen | .302 | .302 | .302 | .302 | .12 |

*1 krone is about 20 cents.

By the above it will be seen that for the year of 1899 the cost per train kilometer was .302, and the gross earnings per train kilometer was .25, leaving a deficit of .052. In 1903 the cost per auto-car kilometer was .12, and the gross earnings per auto-car kilometer was .46, showing a net profit of .34 per auto-car kilometer notwithstanding the fact that in the first case the rates in force allowed .67, while in 1903, using auto-cars, the rates had been lowered to .35 per passenger.

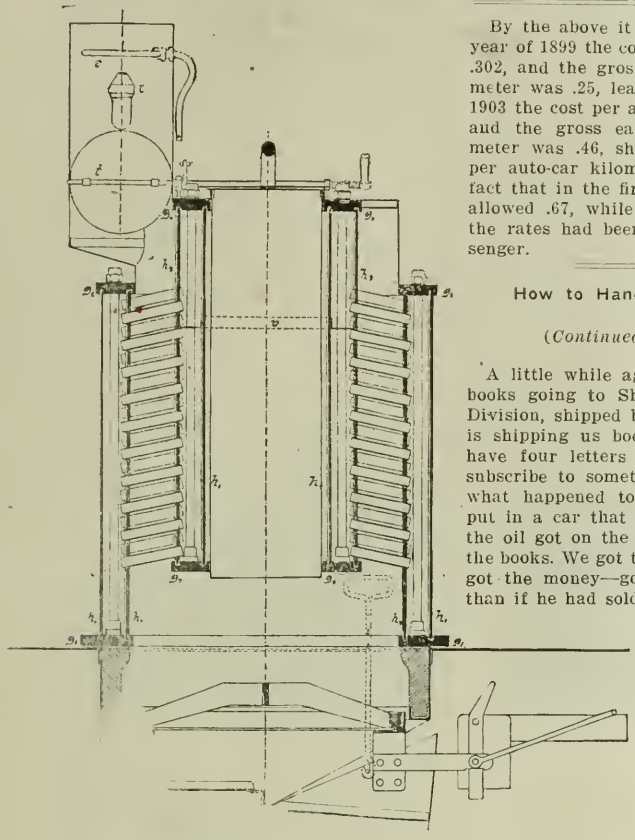


Fig. 3 —Steam Generator—Ganz Auto-Car.

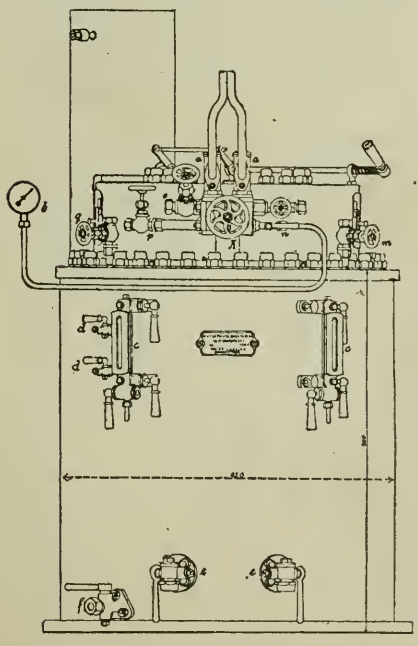


Fig. 6 —Controller of Ganz Auto-Car.

## How to Handle Freight Safely.*

(*Continued from page 287.*)

A little while ago we had a shipment of books going to Sheboygan on the Ashland Division, shipped by John Wanamaker. He is shipping us books all the time. I now have four letters from him asking me to subscribe to something I can't read. Well, what happened to the books? They were put in a car that had oil in it. Of course, the oil got on the books and it got all over the books. We got the books and Wanamaker got the money—got it a good deal quicker than if he had sold the books to me. . . .

We always work better when watched occasionally, when somebody comes around to see whether we are doing our work right. Now, you gentlemen here who have men loading freight for you, if you will go into the cars in the morning and see that they are clean and go into them after they are loaded and see if they are properly loaded—you don't have to do it all the time, but just often enough to catch some one and you will catch them every time they do something wrong, then we will have this thing going right. Just give it the supervision that you would give your own business, just give it the supervision that you are paid for giving it. That is one of the things lacking on a railroad to-day. There isn't enough supervision. We don't have enough superintendents and a great many times where we have them—I say that without disrespect to any of the gentlemen here—where we do have them, they are not the right kind, but we do not have enough supervision. What we need is more inspectors, more superintendents. The pay roll would be a little higher but the loss and damage account would be a great deal less—if the supervision was the right kind.

On the Northern Wisconsin Division, you have some places where the cows have calves three or four times a year, and I think often they must be twins. Now, don't load those calves [veals] on top of butter. That is not the place for them. The butter tubs are all covered with blood, and the agent at destination has got to scrape those tubs and wash them off with water to clean them. Don't put the heavy boxes and packages on top all the time. Don't make a special effort to put machinery on flour or sacks of sugar and don't put it on automobiles. We had a shipment of an automobile the other day where a lot of agricultural implements had been loaded on top of it. The fellow that did it was sure the car would be sealed up and pulled out and put into some train. If he thought somebody was going to look into the car before it went out and find that the freight had been improperly loaded he would not have done that. And that was a $2,500 automobile. Automobiles are about as delicate a piece of property as we have to handle. See that they are properly braced in the car so they won't run from one end to the other and up the sides and knock the end out.

We receive a great deal of perishable freight, and we want to load it in a refrigerator. If you don't have any ice at your station and the stuff will spoil before it reaches the next icing station or destination, go and get some ice. Don't let the property spoil because you don't want to spend $2 or $3. If the Superintendent won't refund that amount I will. I will agree to pay for it every time. And in loading a refrigerator see that the waste pipes are open so that the water will run out of the car instead of into it.

Refrigerators in the winter time have vents; they have covers on the top where the ice is put in the bunkers. If you leave the pipes open the cold will get in there and if the car is going far enough it will freeze the contents. If you have a refrigerator car and there is a heater in it, see that it is burning and that it has enough oil in it to keep it going and carry it through to the next division terminal and don't turn the wick up too high. We lately had two cases of damage to butter. The stuff was so covered with soot and dirt that nobody would take it and we had to pay for it. We paid up to the first day of July $13,833 for damage to stuff by frost; and we have a lot more to pay for on claims that have not been settled, all because this refrigerator business is not properly handled.

We are having flour claims to beat the band. Claims for flour damaged by wet on account of being loaded into cars with leaky roofs. When an inspection of a car is made it should be made carefully and with a view of locating defects. There is no need of making an inspection if we do so to find everything all right. Only a short time ago a man was running a train on a certain road on double track. He was on the wrong track and didn't discover it until he had run ten miles. He was the best engineer they had, but that night he worked automatically and didn't think where he was going and a collision resulted. Frequently we make an inspection or do things in that way.

Sacked flour, when wet should be resacked. There is only a very little of it damaged around the edges that sticks to the sack. The damage don't get inside. If anyone tries to tell you a sack of flour is damaged to the extent of 50 cents or $1, don't you believe it. When you have any claims of that kind and the consignee won't take the flour and resack it, do it yourself. If you

*Extracts from an address by R. C. Richards, General Claim Agent of the Chicago & North Western, recently delivered at meetings of the agents of the company.

can't do it yourself hire somebody to do it, and if you can't get anyone to do it send the flour to me and I will have it resacked; but don't wait two or three weeks before you do it, because if you do the flour will become mouldy. It wants to be attended to right away—do it right off. Whenever we have a sack damaged in that way it amounts to about 10 cents, and we usually get a claim all the way from 50 cents to $1.50. Handle this flour just the same as we would handle it for ourselves, then you will be all right.

In the grain States the business of carrying the wheat, corn and oats will soon commence. Insist upon the elevator people patching up any leaky car before it is loaded, and if one man won't do it give the car to his competitor who will; then we won't have a continual stream of claims for grain leaking out of cars this winter.

But for goodness sake, examine cars to know whether they are loaded with grain before issuing receipts for them, and mark the receipts, "Shippers load and count." Don't do as Missouri Valley did with his car of corn.

Rule 65 says that when a shipment is delivered to us for transportation it becomes the property of the consignee. It don't belong to the shipper any more. If you get a request from the shipper or anyone else not to deliver it to the consignee or to deliver it to some other consignee, don't you do it, but notify me about it, and notify me right away because under certain circumstances the shipper has a right of *Stoppage in transitu* where he finds after the shipment has gone forward that the party has no money to pay for it or the goods were obtained in a fraudulent manner and that is why he wants the shipment stopped. Don't you do it, but notify me by wire. If there is any possibility of its getting to destination and being delivered before you can notify me and proper action can be taken, wire the agent at destination to hold it subject to my order. If you can't get a message off by railroad wire—sometimes it takes longer to get a telegram through than it would to walk—use the telephone, or if Sunday or a holiday is going to intervene and you can't reach me, or the agent at destination by railroad wire send a Western Union telegram, and charge it to the shipper. He will be glad to pay the charges to have his goods taken care of. If he won't pay for it, charge it to Richards, he will pay for it every time. If you can't reach me by telegraph use the telephone. And when the shipment is stopped we must not deliver it until the dispute is settled, because if we do it may turn out that the shipper did not have the right to stop it, and if we make a mistake in delivering those goods we have got to pay for it. We have pending now a claim of this kind for $700, the value of a carload of corn from River Sioux to Nashville. . . . We had a whole lot of claims last year on the A. Division for shipments delivered to somebody other than the consignee. . . . Always check packages when you make delivery, and know whether they are in good order or bad order; and you want to know that you are delivering it to the right consignee. If the consignee don't come himself and sends a drayman the drayman must have an order. Don't deliver it to the drayman without an order. A shipment of cigars going to Tracy was delivered to drayman and he receipted for them. The consignee says: I didn't get them or give an order. We show him his forgotten standing order, and we don't have to pay the claim. Now, it is just as necessary to preserve those standing orders as it is to take them. Because if we can't produce the order and the consignee comes to us and says he didn't get the stuff—he is going to lie about it—we will have to pay.

If you get bad orders, shorts or anything like that of large value, $50 or over, in addition to making your report, telegraph me about it. Make me get busy. A letter will always receive more prompt attention than a form. We handle about 4,000 pieces of mail a day. Just think of it. Just think of what it amounts to in a year.

If a shortage occurs and there is another railroad running into your town, inquire of the agent of the other railroad if he is over the property, as losses are frequently located in this way.

Rule 94 states that over freight when marked with the name of consignee and destination should be sent forward. That don't mean to put it in the freight house behind a lot of rubbish for a year or two and after the claim has been paid find it. It means that you should bill it out on a separate way-bill that day. I have no doubt in my mind, from looking around some of the freight houses, that some of you never saw that rule. . . . We try to keep the shorts and overs by commodities, not by names of the consignee.

Rule No. 118½ says if you get any piece of unmarked over freight you want to tag it. There is a wire on the tag, you need not get a string, and all you have got to do is to put it on. Show the car number from which received and the date received, and put it where it will be seen and not get torn off. If you don't get disposition for it in 30 days send it to division headquarters.

When you get a shipment that is refused, the first thing you want to do is to notify the billing agent. If it happens to be merchandise that can be sold only in a certain season, and the time for selling goes by, the first thing we know we get a claim for $400 or $500, the full value of the consignment. The shipper says: "You didn't tell me the stuff was refused and I didn't know it until I sent the consignee a bill." . . .

At the end of every month you are supposed to send in a list of stuff that is unclaimed and refused. Many that we receive are made up with great care and are of great assistance to us, but there is a whole lot that are of no account. They are taken from the expense bills in the cashier's desk and filled out.

We have a great many claims for damage to perishable freight because we do not notify the shippers. I recently had printed on the perishable way-bills: "Notify the billing agent by wire if shipment is not accepted in side of 24 hours." If you will do that we will do the rest. If you have any carload freight in penalty cars which is refused or which consignees do not unload promptly notify me.

You men who handle this freight in trains, when you get one-half of the car unloaded don't leave the rest of it four or five tiers high so that the first time the car is switched the freight will be sent to the other end of the car; we aren't paid for that additional ride. Break it down and fix it so it won't get spoiled or damaged. Handle it the same as you would your own, as if you were driving a dray. And when you have merchandise going to small stations and you don't have enough help and it is raining to beat the band, don't unload the stuff in the rain, but take it on to the next place and bring it back next day, because the chances are if the freight is unloaded in the rain it will all be damaged. Don't put pianos under the eaves of the freight house.

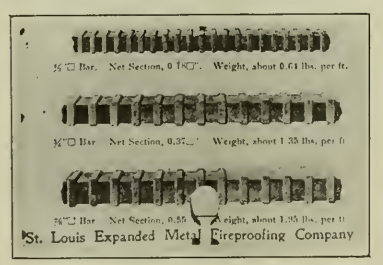
*(To be continued.)*

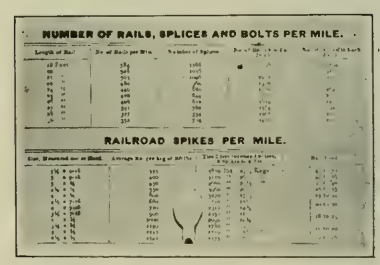
## The Card System for Engineering Information.

BY G. R. WADSWORTH.

The advantage of the card over the book system for various forms of records has so often been elucidated that it is unnecessary here to dwell on the pros and cons of the case. The writer has for a number of years used with great satisfaction the card system for preserving engineering notes, clippings, etc., which are usually kept in note book or scrap book form.

A 3 x 5-in. card was adopted as being a convenient size, and wide enough to take a column of ordinary printed matter. Although this size seems small at first thought




Specimen Cards, Engineering Card Index System.

with some ingenuity in the use of scissors, and in arrangement on the card, it will be found that considerable information can be crowded in the 3 x 5-in. space. The reverse of the card is of course available when cuts are large, and in some instances the accordeon fold may be used to reduce the size of a large cut. At all events it is the essence of the system to preserve the salient details in a logical arrangement within a small compass.

Engineering periodicals, trade publications, catalogues, etc., contain matter with accompanying cuts which are of more or less interest, and after the special features are taken out for the cards, the publication can be discarded, as a file of them soon assumes unwieldy proportions. Observations resulting from practice may be placed on the cards roughly at first, and afterward given to a stenographer and typewritten in neat shape. Prevailing prices for material and labor, also for work in place may be kept in tabulated form under the proper heading, and added to from time to time as further information is available.

In some engineering offices detail plans, working drawings, etc., are reduced by photography to a uniform smaller size sheet, and when blue prints of these reductions are accessible, it is often possible to obtain a copy of an assembled drawing not larger than the card size, and on the reverse of the card may be tabulated in detail the items, with contract prices which give the cost per unit of the part in question, which is convenient for future estimates.

Results may often be reduced to advantage

to a graphical representation, and for this purpose millimeter cross-section paper of the thin tracing paper type, pasted on to the card, or of the thick type pasted back to back may be used. Paragraphs or clauses for specifications, to apply in general or in particular instances may be written on cards and placed under appropriate headings, whence they are quickly available as guides in drafting specifications for new work, or they may be given to a stenographer to copy in toto. Standard practice in the way of detail design, when shown on cards in the way of a sketch or clipping from an illustration, may be turned over to the draftsman with instructions to follow the general idea. In short, information preserved in this form, although of a widely varying nature, is always perfectly classified and sub-classified, and is quickly available.

The accompanying illustrations of cards taken at random give an idea of the scope of photographic reductions which can be made of diverse kinds of material, without regard to typewritten cards and those filled out with pen and ink, as well as blue prints, which constitute a considerable part of the record.

## Specifications.*

For convenience of reference and for clearness, specifications are usually divided into clauses, which may be classed as general and specific. General clauses refer to the business relations that shall exist between the parties to the contract. In them is found the general description of the work as a whole without any particular reference to details. Times and methods of making payments, adherence to specifications, inspection, and other analogous headings make up their subject matter. They should be comprehensive in their scope, and should not contradict one another. Contradictory clauses are sure to be a stumbling block that will create friction and delay. At first glance one would say that such clauses are easily eliminated, but care is necessary to accomplish this. For instance, a certain result may be desired in the substructure of a bridge that will not fit in with the kind of substructure wanted.

Specific clauses have to do with the details of construction and the description of particular features of design. They embody the special ideas that the engineer wishes to incorporate in the work, and they should be just as minute in detail as is requisite to set forth the exact plan desired. Detailed drawings may be necessary to indicate clearly just what is to be done, and these drawings either should be prepared before the specifications are written, or at least should be sufficiently matured in the mind of the engineer to enable him to write his specifications in accordance with them. It must be remembered that the specifications and plans constitute a guide book for the contractor and the resident engineer. They should tell what must be done, but should not necessarily state just how it should be done. Specifications should look to the accomplishment of an end rather than to the means of its attainment. Of course there are exceptions to this, as when the engineer believes that for the best results a thing must be performed in some particular way, in which case it is necessary to incorporate the method in the specifications. It must be remembered that under these circumstances the contractor cannot be held responsible for the mistakes of the engineer. When an engineer specifies that a thing shall be done in a certain way, he must assume the responsibility of the outcome, because the contractor is not free to adopt the method he thinks best suited to the case in hand. For this reason specifications should leave the method, as far as can be done consistently, to the contractor, and instead should dwell upon the end to be attained. A good contractor who is active and progressive may frequently wish to introduce methods of construction better than those conceived by the engineer, and it were a poor set of specifications which would prevent his doing so. A specification can readily be very strict concerning the finished work and at the same time very liberal as to the methods to be employed in its accomplishment.

It frequently happens that specifications are written without any accompanying plans at all. In such cases it is usual to require bidders to submit with their tender plans more or less detailed of what they propose to do. In this way the engineer may make a choice from various plans presented and thus obtain what he considers the best of a number of ideas. Specifications of this kind will have, of course, very little or nothing at all to do with the details involved, but will be concerned almost entirely with the final desired outcome. In other words, such a specification will consist very largely of general clauses, those of a specific nature being either entirely eliminated or reduced to a minimum. This method of letting contracts without any accompanying plans is by no means to be commended. A good engineer does not want other people to tell him what to use or what to do. If he is thorough and well posted in his profession, he is not going to let his own ideas be superseded by those of a contractor who furnishes plans with his bid. In such a case the engineer becomes only an inspector who simply passes upon the work and determines whether or not it fulfils requirements, when perhaps much of the work is entirely at variance with his own ideas. It is reasonable to suppose that an engineer who devotes his entire time to designing structures of a particular kind (and no one man will attempt to cover the entire field), is more capable of arriving at the best design for a given case than a contractor who is engaged in work of a varied nature, and who perhaps has given little or no thought to the designing of the particular kind of structure upon which he desires to tender. It is undoubtedly a fact that the best results are accomplished when the plans and specifications are prepared by a competent engineer, and when the bidder is governed by their requirements.

Let us consider some of the salient features of good specifications. Primarily, they should give a clear and concise description of the work, first when considered as a whole, and then in detail, no part being slighted in this description. It will not answer for the engineer to suppose that the contractor will do things as a matter of course, but he must produce a specification that will insure their being done. A contractor, if he be thoughtful and careful, will pay close attention to every detail set forth in the specifications; and he should make his bid expecting to fulfil just the requirements enumerated in them, no more and no less. If he be wise, he will not bid with the expectation of having them changed to conform to his convenience or his notions of what is best. The engineer is supposed to have stated in his specifications just what he wants; and no prudent contractor will tender, expecting his own ideas to prevail. If then upon the engineer devolves the responsibility of determining the work to be done, it will be readily seen that it behooves him to cover in his specifications the entire ground. He should give special attention to the point he intends to require absolutely without alteration, and should leave no possibility for doubt in the mind of the contractor as to what will be expected concerning them. He should be careful to set forth clearly the units of measure to be employed and what is to be considered a part of the finished work, as distinguished from what is merely accessory. If extra work is to be performed, the amount of which it is impossible to determine in advance, the greatest care should be exercised in defining clearly just what shall constitute such extra work and in fixing the compensation for it. Failure to do this is frequently a source of trouble and annoyance that might be avoided by careful wording.

Specifications should be designed to secure the best results consistent with what is considered good practice. It is possible to make requirements of such a nature that to fulfil them would mean an enormous outlay of money not at all proportionate to the result. Such clauses in a specification make a bidder uneasy and will cause him to add to his bid a sufficient amount in addition to his profit to insure him against loss. A bidder should make his tender expecting to comply with the conditions of the specifications, and expecting that his fellow bidders will do the same; and a clause that involves an unduly strict condition is liable to cause him either to tender high or to bid hoping that its fulfilment to the letter will not be demanded. In nine cases out of ten such a clause will be dearly paid for.

Absolute perfection is not to be expected, but the very best that the most approved practice will afford should govern the requirements. An engineer must lose prestige if he specify things which cannot consistently be done; and by inserting such requirements he works injury to all parties concerned. In the matter of materials to be used he must be governed by the locality and by what the market has to offer. He may be unable to get just what he would like, so he must use the best that can be obtained. These remarks do not imply that the engineer should be satisfied with any makeshift that is offered. He can rest assured that he will not receive anything better than he demands, and he is fortunate if he succeed in getting everything as good as he specifies.

Again, specifications should be written in simple, plain language without any attempt at rhetoric. All verbs should be complete, and no words should be omitted on the assumption that they are understood. Of course, the law will interpret a contract or a specification in accordance with what the court decides is its spirit, but an engineer should not rely upon this to guard against omission. Short sentences and simple words are preferred. Punctuation and grammar, while usually and erroneously considered of minor importance in an engineer's practice, certainly play an important part in this particular kind of literature. The meaning of a sentence can be easily distorted, or even entirely changed, by the placing of a comma. Do not fear to repeat the same words or phrases over and over again in your specifications, if you find they best convey the idea you have in mind. This may involve occasionally some lack of euphony, but that can very readily be dispensed with in writings of such a prosaic nature.

Should more than one contractor be employed upon a piece of work, great care must be exercised to define clearly the duties of each. Just where one is to finish and the other is to begin should be set forth so as to leave no possibility of doubt. When prac-

*Extract from a lecture delivered to the senior class of the Rensselaer Polytechnic Institute by J. A. L. Waddell, D. Sc., LL.D.

ticable in such cases, separate and distinct specifications for the different parts of the work should be prepared. Care should be taken that the same thing is not required of both contractors, and that one contractor is to leave his part of the work in such shape as to involve no hardship or inconvenience for the one who is to follow. As an illustration of cases of this kind, in bridge work it frequently happens that one contractor will do the substructure work while another will build the superstructure. It is then necessary to specify who is to set the anchor bolts and anchorages.

Another point about which the engineer must be careful is the putting of anything into his specifications that has even the appearance of favoritism. He must be constantly on his guard to avoid this; for his position is such that his reputation is liable to suffer if he deviate in the least from strict fairness to all. It is bad policy, generally speaking, to require a particular brand of material or the product of a given firm without stating that other material will be accepted, if, upon testing, it be found of equal quality. When a given brand is well known and has an established reputation, it is sometimes proper to specify that it shall be used to the exclusion of other makes; but usually it is best to set a standard which is commensurate with the best product to be had, and then accept any brand which meets the requirements. An exception to this rule is permissible when specifying paint for metal work, because, unless the particular brand be stated, the contractor is liable to give endless trouble by offering for test inferior brands; and the result is very likely to be the adoption of a paint that is not really satisfactory. Unscrupulous parties are ever ready to give the engineer a bonus in case he use their product, and that engineer is fortunate who has an extensive practice and is yet entirely free from all charges of peccability. Where one man's product is rejected and another's used, there is a great temptation on the part of the disappointed person to question the fairness of the proceeding.

To insure all the conditions that have been enumerated, it is evident that the engineer must familiarize himself with every detail of the work in hand. If he does not understand it himself, it is certain that he will not succeed in getting a clear idea of what he wants into the mind of another. Even when the scheme is perfected in the engineer's mind, it is difficult sometimes to make it plain to the contractor.

It will not do to jump at hasty conclusions, for very often one finds that an idea, which at first seemed to be just what was wanted, proves utterly untenable when considered in connection with other ideas that must be incorporated in order to produce a finished construction. No idea for a specification has any value until it has been fitted into the proposed structure, and is found to harmonize with all the other requirements.

It is usual and proper in specifications to insert a clause allowing the engineer the privilege of changing them or the plans as the work progresses; but it is desirable for all concerned that the number of these changes be reduced to a minimum. A perfect set of specifications would render such a clause useless; but since we have not yet attained to perfection, we must have some means of recourse, bearing in mind, however, that the more such a clause as the one referred to it brought into use, the farther we are from the ideal.

The question of precision is one which should never be lost from sight. If the engineer is to maintain his prestige, he must be precise. It will not do for him to say "about this" or "about that"; for the "about" is very liable to assume proportions which were never dreamed of when the term was used. Of course there are times when it is neither necessary nor desirable to be absolutely exact in requirements; but generally speaking the word "about" has very little place in a set of specifications. What is put into them is placed there with the idea that it is to be operative and binding in the construction of the work; and it is the duty of the engineer first of all to impose no impossible or unwise conditions, and next to see that what he has required is fulfilled to the letter.

The specifications form a part of the contract, and when the latter is signed, the contractor agrees to all the conditions they set forth. It is proper to assume that he has read the specifications and is familiar with their requirements, and that he signs the contract and makes his bond with the full knowledge of what is before him. A specification should never hide from the contractor difficulties that are likely to be encountered. On the contrary, when such difficulties are known to the engineer, they should be specially called to the contractor's notice, so that he may bid more intelligently. His attention, however, should not be drawn to them in such a way as to frighten him and to cause him to make a bid abnormally high; but the facts as they exist and are known to the engineer should be stated. As in all relations in life, straightforward, fair-and-square dealing is by far the best policy. No railroad company or other corporation is benefited by letting a contract for a sum below the actual cost with a reasonable percentage for profit, since the delays incident to the contractor's failure, and the litigation that is likely to arise, will more than counterbalance the supposed saving. No contractor who is losing money is going to make the same exertion to accomplish his task properly as one who realizes that he is earning a fair profit.

In spite of every precaution that may be taken, it is almost impossible to avoid mistakes entirely. To reduce them to a minimum, the engineer must be thoroughly conversant with all contingencies likely to arise in the execution of the work. He should familiarize himself with the appliances ordinarily employed, and should so design his work that their use be not prohibited. In writing his specifications and in making the plans, he should have a clear and complete mental picture of just what he is striving to attain. It must be remembered that if the specifications are lived up to, they will determine entirely the result, and that it is the plans and specifications wherein the creative power of the engineer asserts itself. Finally, when all is said and done, common sense must govern the interpretation and execution of any set of specifications. All should have but one object in view, the production of a structure that will be a credit to everyone concerned.

## Jubilee of the North-Eastern Railway.

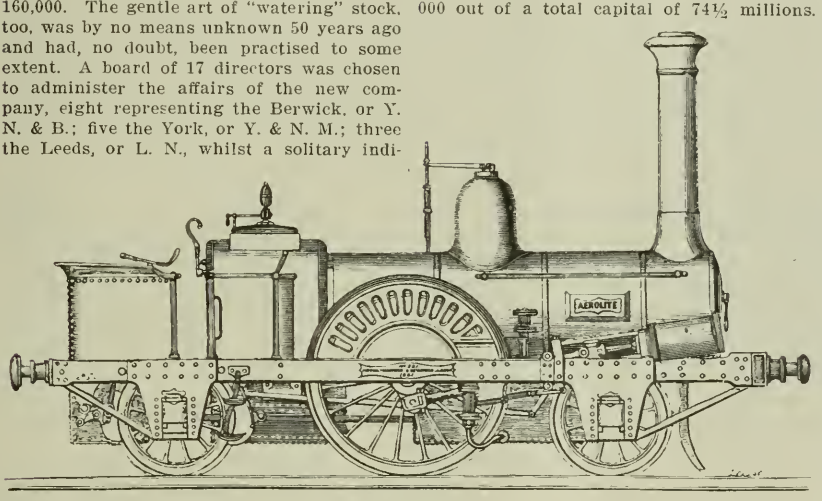
BY W. B. PALEY.

On the 31st of July the North-Eastern Railway, now and for many years past the third longest line in Great Britain, completed the first half century of its existence under that title. A curiously local system at all times, unaggressive, monopolistic, yet popular in its district, the North-Eastern is seldom heard of except between the Humber and the Tweed. To most Londoners its name is quite unfamiliar. Half of them go down to Scotland by it but they begin the journey on the Great Northern and end it on some Scotch line, so that the "middle passage" over the longest link of the chain leaves no impression on their minds.

The line, as it stands to-day, represents the fifth of those great amalgamations of English railroads of which the Midland, under the able leadership of George Hudson, was the first. We gave a sketch of the history of that undertaking on June 3 last. The present London & North-Western, London, Brighton & South Coast, and Lancashire and Yorkshire companies followed, as the result of combinations effected, the two former in 1846, the latter in 1847. In each case the result was satisfactory, and at last it became evident that a similar policy must be carried out in the great district between Leeds, Hull, and the Scotch frontier. Here a number of separate companies were at work, forming by no means a very happy family, each being perpetually afraid that its neighbor would combine with some other line to ruin it. For a long time no means of effecting a proper balance of power could be found, but at last the York & North Midland, and the Leeds Northern agreed to combine with the York, Newcastle & Berwick, and to dissolve and cease to exist as separate companies. The last named then changed its title to that of The North-Eastern Railway Company. The example of the Midland was followed and preliminary joint working had been tried since April 1, 1853, to see how the various interests were affected and obtain a clear idea of what arrangements as to traffic would be needed. As in that case this proved most useful and had a material effect in popularizing the new scheme with the traveling public. Each of the three lines named was in itself more or less of an amalgamation. Into the history of each it is unnecessary to enter. Suffice it to say that the name of the former well describes its geographical position. The York & North Midland, originally only a line 23 miles long from York to the North Midland at Normanton, had developed largely in the Whitby, Scarborough and Hull districts into a system 263 miles long. The Leeds Northern, formerly the Leeds & Thirsk, had been exactly what its name implied, but latterly, forming a scissors crossing of the York, Newcastle & Berwick at Northallerton, had got into the Stockton district. It was therefore a competitor with the larger company, but was itself only 70 miles long. The Y. N. & B. having 330 miles open for traffic the joint concern formed a remarkably compact system of 663 miles. About 100 miles of the Y. N. & B. section consisted of colliery branches, mostly in Durham, and of these some 70 miles were worked by wire ropes as self-acting inclines or by stationary engines. Such ropes were then very expensive, the wear and tear costing £7,000 or £8,000 a year. Some of these inclines dated from 40 or 50 years before and were very interesting specimens of engineering. They are still in use here and there, many of the older pits being on the tops of hills. The loaded trucks going down pulled up a fresh supply of empty ones, but on the Whitby & Pickering section of the Y. & N. M. a water-balance system was used in one place for nearly a mile in the working of general traffic of all kinds. This line was opened in 1836 and was about the last public railroad built for horse-traction. In 1847, Mr. Hudson, then chairman of the York & North Midland, altered it for locomotive working and employed a stationary engine and wire rope instead of the water-balance. A heavy incline-van with "sledge" brakes acting on the rails was used behind the trains, in case the rope broke. It did break one frosty day in 1864, when the "sledge" brake proved inefficient and allowed a train to rush to the bottom, where it upset and killed two pas-

sengers. A deviation with easier grades was then made and the branch is now wholly worked by locomotive power.

A small company called The Malton & Driffield Junction, whose line united two important sections of the Y. & N. M., joined the new confederation on Oct. 28, 1854, but was evidently not of much account, for it was settled that from 1855 the receipts of the North-Eastern should be apportioned as follows, namely, to the "Berwick" shareholders 57.1 per cent.; to the "York" shareholders 32.9 per cent., whilst the "Leeds" got the remaining 10 per cent. This arrangement endured till 1870. The three companies had spent, at the date of the amalgamation, roughly 7½, 5½ and 2½ millions sterling respectively, the actual total being £15,611,000, but a number of loans and other obligations made the actual amount upon which interest had to be paid about £20,160,000. The gentle art of "watering" stock, too, was by no means unknown 50 years ago and had, no doubt, been practised to some extent. A board of 17 directors was chosen to administer the affairs of the new company, eight representing the Berwick, or Y. N. & B.; five the York, or Y. & N. M.; three the Leeds, or L. N., whilst a solitary individual looked after the small interests of the Malton & Driffield. Mr. James Pulleine, who had been chairman of the Berwick Company, was appointed to the same office on the North-Eastern, headquarters being fixed, where they still are, at York. The present board comprises 20 members, practically all, as they should be, local men. At the date of the union all three companies were in an unsatisfactory financial condition. The two larger ones, of which George Hudson, the founder of the Midland, had at one time been chairman, had been splendidly successful under him. Extraordinary economy in working was one of the secrets of his railroad successes, but it was secured by starving the properties (and the men too) and placing as much as possible to capital account. Sooner or later his system must have broken down. For the year 1848, the last in which he controlled either line, the Berwick paid 7 per cent., and the York 10, and had done so ever since 1842. When Hudson came to the ground in 1849, both companies fell with him, for in that year they paid 1⅜ and 1 per cent., respectively. It must have been a glorious time for the "bears". By 1853, however, affairs had so far improved that they paid the one 3½, the other 2¼ per cent. The Leeds Northern had always been more or less of a failure.




The Aerolite.*

*The engine Aerolite was built for the Leeds Northern Railway in 1851, and was shown at the Great Exhibition in London, of that year. It had cylinders 11x22, 6-ft. drivers, 3½-ft. carrying wheels. The boiler contained 105 tubes, 1¾-in. in diameter, giving 536 sq. ft. of heating surface. The firebox gave 62 ft. more, or a total of 598 sq. ft. The 2 tanks carried 495 gallons of water in all, and the bunker 10 cwt. of coke; the total weight, full, being 19 tons, 42,560 lbs. The engine was built for running light fast trains, but was broken up a long while ago. The hook-shaped regulator handle will be noticed, and the absence of sand pipes.

Dividends continued to be paid by the North-Eastern on the capitals of the three companies in the proportions named till the end of 1869, when they were receiving 6½, 6¼, 4$^{9}/_{16}$ respectively as dividend. Meanwhile some other important lines had been absorbed and a fresh arrangement became necessary. The principal new partners were the old Newcastle & Carlisle, and Stockton & Darlington Companies. The latter's name is too well-known from its association with George Stephenson to need description now; of the former, more anon. A new stock termed North-Eastern Consolidated Ordinary (briefly known as N. E. Consols) was created in 1870, in return for £100 of Berwick stock the shareholders got £100 of Consols, York £100 holders obtained £98, Leeds £65, Carlisle £133, Darlington £136, and Malton & Driffield £10. At Dec. 31, 1903, the amount of N. E. Consols in existence was £30,700,000 out of a total capital of 74½ millions.

The Newcastle & Carlisle Railway obtained its Act on May 22, 1829, or some months before the celebrated trials of locomotives at Rainhill. It was really that event, or rather the opening of the Liverpool & Manchester Railway in 1830, which showed what steam traction could do, consequently we find that by Clause V. of the N. & C. R. Act it is further enacted, "That no locomotive or movable steam engine shall be used on the said railways or tramroads for drawing wagons or other carriages, or for any purpose whatsoever," while even stationary engines were prohibited within view of eight specified country residences, some of which commanded a very long view indeed. However, before the line was well commenced, the L. & M. was opened, and a new Act allowed the use of locomotive engines. The N. & C. was 60 miles long, 40 of which were double line from the first, while the rest was widened before long. Nearly the whole was originally laid with stone blocks, wrought-iron 15 ft. rails, rolled with five fish-bellies, and weighing only 42 lbs. per yard, resting in small chairs. Part of the line was opened so early as March, 1835, the whole being completed from the Gateshead side of the Tyne at Newcastle in 1838, and from Newcastle itself in 1839. The line is an interesting specimen of early construction, and running through much beautiful country is well worth inspection, more especially towards the Carlisle end. The trains used to run on the right-hand road till the N. E. R. took over the working, after the company was amalgamated with its big neighbor in 1862. The Clarence Railway in Durham, the Taff Vale in South Wales, and the London & Greenwich were the only other lines in Great Britain, it is believed, where this practice obtained. In the latter case it was continued till only three years ago.

The directors congratulated themselves at their first meeting, Aug. 30, 1854, that the amalgamation had been carried through without the insertion of any stipulations injurious to the company, and without any sacrifices being made for disarming opposition in Parliament. The working to the end of that year was not very encouraging, the large increase in receipts of £86,000 being swallowed up in additional expense, due to 8 per cent. extra mileage run, to a great rise in prices caused by the war in the Crimea, and to very heavy expenditure in renewing and standardizing the permanent way. However, things soon settled down to a course of steady prosperity and the average dividend since 1870 has been 6.85 per cent. The early seventies were the hey-day of the North-Eastern's fortunes, from 8½ to 9¼ per cent. being paid time after time, whilst N. E. Consols stood for years at higher prices than the ordinary stocks of any other great line.

The North-Eastern has never been specially distinguished for high speed. Except the through Scotch traffic, none of its business requires exceptional rapidity. In 1854, however, its down night mail was said to be the fastest train of its kind in the country, doing the 84 miles between York & Newcastle (by the route then followed) in 135 minutes, with four stops. At that time the rolling stock consisted of 371 engines, 705 passenger coaches, 3,564 goods wagons, and about 14,000 coal trucks. Of these 10,000 were the small hopper wagons locally called, from holding only 53 cwts. "chaldron wagons." Coal was commonly measured in the district then by the "Newcastle chaldron" of 53 cwts., but the "London chaldron" was only half that quantity. Such wagons had 3 ft. wheels with inside bearings, wooden frames, and sides and ends curving outwards. They were only used for local traffic, weighing but 44 cwts. and being unsuitable for traction by locomotives of more than very limited power. Main-line rolling stock was provided with extra buffers of wood to suit the chaldron wagons, a few of which may still be found on the colliery lines.

It might be supposed that the North-Eastern's rich traffic ground would be a constant temptation to other companies to try for a share of it, but the only serious attempt of the kind, the opening of the Hull & Barnsley Railway in 1885, has not been successful enough to encourage further attempts. Only the broad and shallow Humber protects the company in this quarter, elsewhere their great monopoly, the Durham & Newcastle country, is too far off to be profitably attacked, while its coal is mostly used locally or sent short distances for shipment. The N. E. R. owns docks at Hull, Middlesborough, Hartlepool and Jarrow, which help to swell the capital to the great total of £74½ millions, at which it stood at the end of 1903. At the same period the rolling stock had increased from the figures given before to 2,142 engines, 3,218 coaches, and about 100,000 goods and coal wagons. The system comprised then 1,669½ miles of railroad, all but 41½ of which was absolutely owned. Of the total, 1,100 miles were double line, and 500 single. Foreign lines to the extent of 233½ miles, in addition to the above, were worked over. North-Eastern engines making during 1903 some 28,350,000 miles, a little more than half of which was with passenger trains. As the gross receipts of the joint working for the first half of 1854 were £742,000, and for the six months last ended £4,415,000, it follows that while the mileage open is 2½ times greater than it then was, the railroad earns six times as much. It is remarkable that, both then and now, the receipts are nearly equally divided between the passenger, goods and mineral traffic.

## Chicago Freight Houses of the Baltimore & Ohio.

The new inbound freight house of the Baltimore & Ohio at Chicago, although not the largest in the city, is in many respects one of the most convenient. It is located on Polk street, quite close to the Chicago river, and extends back, parallel to the latter, 570 ft. A platform at the south end makes the total length 670 ft. For 400 ft. of its length the building is 51 ft. wide. The last 170 ft. of the west wall is curved to the east in conformity with the river bank, the width at the south end being 24 ft. 2 in. The north end for 200 ft. is two stories high, the second story being for the offices of the freight department.

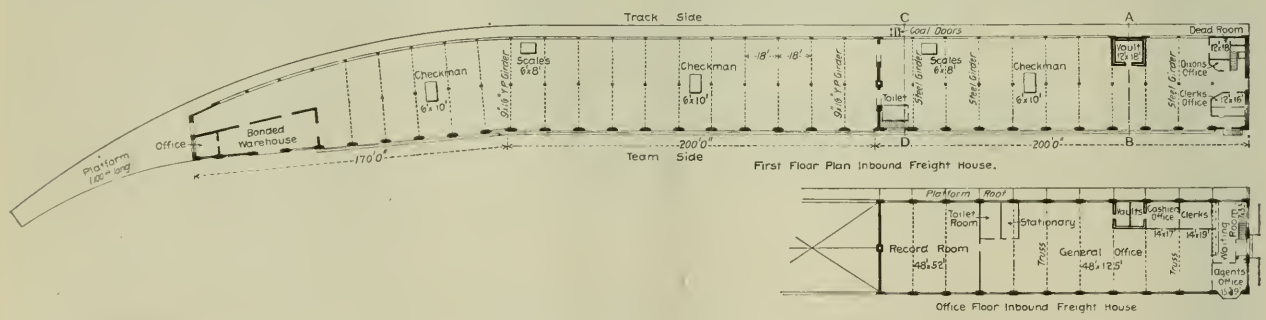
The building is brick on concrete foundations. The roof of the office section is slate, that of the remainder being gravel. Between foundation walls there is a solid filling of sand to within 6 in. of their tops, the remaining space being filled with cinders in which are bedded 4-in. x 6-in. sleepers, 3 ft. on centers. To these are nailed 2¾-in. x 8-in. hemlock boards, over which are laid tarred wool felt and on this 1¼-in. dressed and matched maple flooring. The roof of the one-story section rests on 5-in. x 16-in. yellow pine girders supported on the east side of the building by the brick walls and at the middle and on the west side on I-beam columns. This latter side, which is the track side of the building, has a continuous door system, the opening between columns, which are 18 ft. on centers, being closed by 17-ft. Variety horizontal folding doors. There is a 6-ft. platform on this side, protected by a roof supported by rods from the building wall. On the east, or team, side the Variety doors are 12 ft. wide. There is room for two teams at each door, or 56 teams in all can load at one time. A wheel guard, made of 8-in. x 12-in. white oak faced with an 8-in. channel and supported by cast-iron brackets bolted to the concrete foundation, protects the latter from injury from the wheels.

Baltimore & Ohio Inbound Freight House, Chicago.

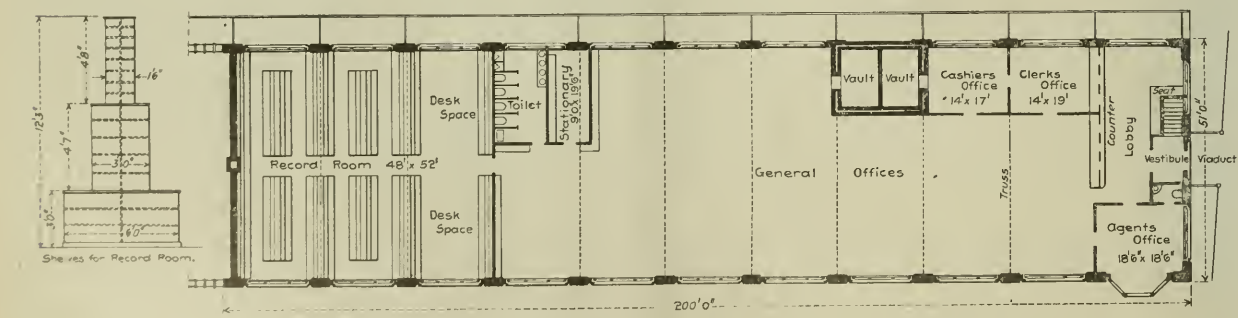
The general freight room is divided into two parts by the south wall of the two-story part. One of the conveniences of the house is the location of the offices at the north end of the general freight room, making it unnecessary to go to the general office upstairs to transact detail business. At one of these offices teamsters may pay their freight charges and receive their delivery tickets, while at another bills for transfer freight are handled. The dead room at the northwest corner has slat walls so that its contents may readily be seen at any time. The vault is convenient to the offices. It is 11 ft. 6 in. x 15 ft. 6 in., with cement floor, and it extends into the second story. At the south end of the house is the bonded warehouse with office for the government officer. This office is elevated so as to allow the use of all of the floor space. The room is enclosed with brick walls and is practically fireproof. The distribution of the freight on the floor of the general freight room is such as to leave an aisle on each side, instead of through the center. This avoids any chance of the freight piling up against the walls and hiding pieces, causing loss of time in looking for them.

The general offices occupy all of the second floor except 52 ft. at the south end, which is used for a record room. These offices are light and pleasant and contain room for double the force that will occupy them at the outset. They are entered directly from the Polk street viaduct crossing the railroad yards, and also by stairways from the first floor. The agent's office at the northeast corner has a bay window from which he can see at any time the condition of business along the team side of the building. A complete desk telephone system is installed so that every clerk needing one in the transaction of business has it close at hand. Roomy ventilated lockers are provided for the office force. They are ranged along the walls of the toilet and stationary rooms in the southwest corner of the office.

The record room has storage room for five year's records. Additional space is available above the offices, under the roof. Shelving built in conformity with the record system used on the B. & O. is placed in the room as shown in the plan. The two sets along the north wall are for current records, there being room for eight months' daily records. The compartments are each made just the size for a daily record book and are numbered for the days of the month. Any clerk wanting the records for a particular day can put his hand on the book at once. By this system as many clerks as there are books for the month can be looking up back records for that month without delaying one another. As the "current" shelves fill up, their contents will be moved over, a month at a time,




General Plan of Inbound Freight House at Chicago —Baltimore & Ohio.




Plan of Office Floor, Baltimore & Ohio Freight House at Chicago.

to the storage shelves. A sketch of one of the latter is shown.

The foundations and walls of the building are designed for a three-story structure. When the need for this additional room arises, a viaduct will be built on one side of the building connecting with the Polk street viaduct, so that freight can be delivered direct from the second floor to teams, saving rehandling to the first floor and also increasing the delivery capacity of the house.

Plans are also completed for an outbound freight house to replace the present old and inadequate building. It will occupy the same site as the latter, with additional ground, the location being on the eastern side of the same square on which the inbound house stands. The distance between the two houses is about 300 ft. The outbound house will be 780 ft. long and 30 ft. wide. Its construction will, in general, be similar to the one-story part of the outbound house. However, its team side, which fronts Fifth avenue, is of considerably more ornate design than the corresponding side of the inbound house. This elevation is shown in the engraving. The walls will be of hard-burned paving brick with terra cotta cornice and window sills. Both ends of the building will also north wall. The roof will be supported on 18-in., 55-lb. I-beams, the slope being toward the track side. The west wall of the present building supports the east side of a viaduct connecting the Polk and Taylor street viadncts. The new building will be narrower and the work will therefore include placing steel column supports under the east side of this viaduct.

These stations are built for the Baltimore & Ohio by the Chicago Terminal Transfer Railroad, lessors of the B. & O. terminals. We are indebted to Mr. F. E. Paradis, Chief Engineer of the Chicago Terminal Transfer, and to Mr. T. E. Wayman, Freight Agent of the Baltimore & Ohio, for data.

## Foreign Railroad Notes.

The organization of hospital trains at the seat of war in Manchuria has been established by order of the Czar. As a rule, they will consist of 16 cars, fitted to carry 250 sick or wounded; but only 10 of the cars are for patients; the others are occupied by the medical staff, the kitchen, refrigerator, stores, baggage, dispensary, operating room, baths and wash room. The medical staff consists of three surgeons, five sisters of mercy, five other nurses or assistants, and a variable number of servants. A number of mechanics accompany these trains, to make repairs where shops are not accessible. The Red Cross Society, other benevolent or patriotic societies, and private persons may provide and equip such trains in whole or in part; but in service the military authorities have sole control of them.

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The Gotthard Railroad had its largest earnings last year, when they were 8¾ per cent. more than in 1902. The stockholders get a 6.8 per cent. dividend on their stock. The three countries which advanced a large part of the cost of the road get nothing, however. They are entitled to a share of the profits only after the stockholders have received 7 per cent. The Swiss government has the right to take over the road in 1909; and it gave notice last February that it will exercise that right, if an earlier transfer is not made by mutual agreement.

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The war and the hasty building of the Circum-Baikal Railroad together have been giving the vessels on the lake and the several rivers which flow into it a rich harvest. Immense quantities of cement are required for the railroad, for carrying a given quantity of which the steamboats charged $12.50 a year ago; now they get $40 for it; and it is said that the contractor pays 29 cents apiece for carrying ties across the lake; very likely it is for carrying them down some of the rivers *and* across the lake.

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It is reported that the various Russian railroad managements have authorized station masters when a passenger has lost his ticket or hand-baggage in consequence of a railroad accident to issue him a new ticket to destination and give money to live on till he arrives, at the rate of 1, 2 or 3 rubles a day, according to the class of his ticket. (The ruble is about half-a-dollar.) This will perhaps make railroad accidents popular; and they are not precisely rare now: the official statistics show 5,301 accidents in connection with the operation of the railroads in 1902 (when the Russian mileage was about one-seventh ours), by which 1,528 persons were killed and 3,773 injured. Of the killed, 121, and of the wounded, 600, were passengers.

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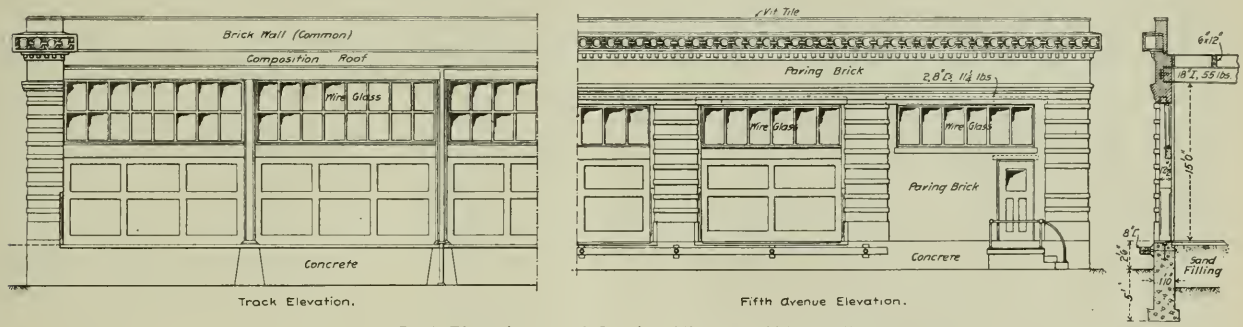
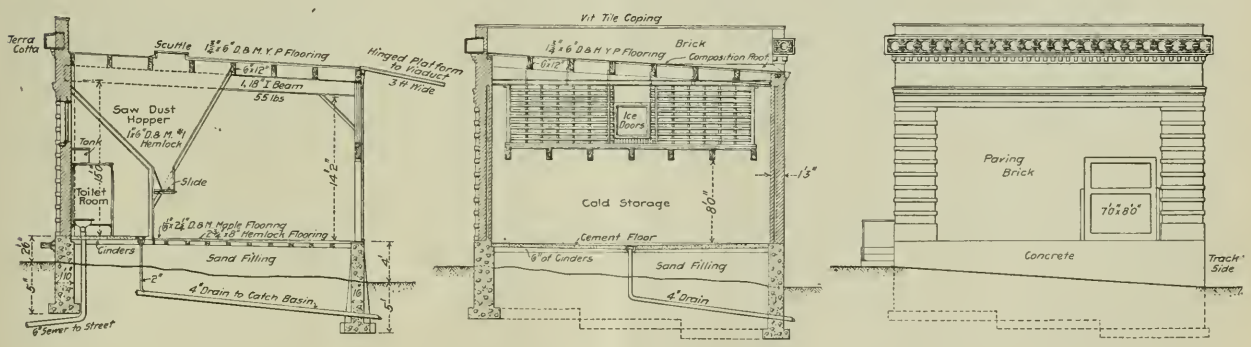
Work has been suspended, and probably permanently, on the northern end of the Simplon Tunnel. More hot springs have been struck, and the drainage up-hill over the summit, which this end of the tunnel passed some months ago, is so difficult and costly that probably it will be left till reached from the south.




Part Elevations and Section Through Side Walls.




End Elevation and Cross Sections of Freight House.

be finished to correspond to the Fifth avenue frontage.

A cooling room, 18 ft. 6 in. x 27 ft. 6 in., will occupy the extreme south end of the building. Ice will be delivered to it most conveniently from the adjacent Taylor street viaduct. A section through this room is shown, also through the sawdust hopper for storing sawdust for the floors of refrigerator cars, etc. The sawdust is delivered to the hopper through a scuttle in the roof, a viaduct along the western side of the building enabling wagons to be brought to within a few feet of the scuttle.

The floor of the house slopes from the east, or team, side toward the west for 17 ft. of the width of the building, the total fall being 6 in. It is level the remaining distance; also for the same width along the

## The Future of Interurban Electric Railways.

BY ERNEST GONZENBACH.

It should be unnecessary to point out that the above title has nothing to do with the future of electric traction. That future seems to be taking care of itself quite well. Again, electric traction, *per se*, is not likely to affect radically the future of interurban roads, as the latter seem to be working out their destinies with small regard for their origin.

For a proper estimate of the future we may look back to the beginning; say we find two populous towns connected by street cars, single track 20-footers with perhaps two 15 h.p. motors and the power down to lowest ebb half way between the two centers. The arrangement produces a new and steady stream of nickels. There is another center a longer distance away which looks promising and a line is built there, with not as good results as expected. Why? Because the trip consumes too much time. Re-enforcements in the shape of double truck cars and boosters remedy this condition, and the stream of receipts is again swelled—dimes this time, not nickels. All this is ancient history and has been recounted time and again. Now, does the prosperous and well satisfied street and suburban railway management branch out and build interurban lines through farming districts to other towns 20 or 30 miles away? Not in the least. It is rather a curious fact that in the majority of cases interurban roads have been promoted and built by men not connected in any way with the local and existing street railways and in many cases, even to-day such roads are owned and operated by comparatively new-comers in the railroad business.

Just who is entitled to the distinction of building the first strictly interurban road, it is difficult to decide. The ubiquitous Ohio man seems to lead in the race and modestly claims that not only was the first interurban road built in his State, but that it has more interurban mileage than any other State, Christian or heathen, in the whole wide world, all of which we will concede to him. The roads are here and here to stay, no matter who built them, and a glance at an interurban map is in itself a sermon on their future.

It is well understood that the largest percentage of interurban roads parallel existing steam lines, for the natural reason that the greatest density of population exists adjacent to steam roads and, *vice versa*, that steam roads exist adjacent to the greatest density of population. The steam road is there, and the people are there—there are luxurious trains and quick time and all the facilities for travel. And the people travel —when they have to. Did you ever hear a person say: "I have a little time to kill, come let's enjoy a ride on the Pennsylvania Limited?" Very likely not, and what is said about the pleasures of riding on "accommodation" trains would hardly make good advertising for the service, even if it passed the U. S. mails. It is quite apparent that the steam railroad does not cater to our natural born desires for transportation, it merely satisfies our necessities in that line, and that is where lies the secret of the success of the numerous electric roads. It is generally stated that the electric road "creates its own traffic," meaning, more exactly, that it rouses everywhere the latent traffic, by offering transportation which is at once pleasant and inexpensive.

On this basis then, the electric road should get about all the traffic there is, but it does not—for good and sufficient reasons. One cannot go everywhere on electrics—through service is nearly unknown, and most of all, a lost distance trip may require twice the time which the steam road demands. Granted that the electric road has a great advantage over the steam road in convenience and cost, we have still to improve our facilities by giving through service and quick time. When these conditions have been fully met, and our service can compete in every way with the steam service, then we may look for a most vigorous warfare and the invariable law of the survival of the fittest will begin to operate.

It is of course obvious that the electric road does not owe all its traffic to pleasure riding, but it is equally true that all of the short trip pleasure riding is done on the electric road and not on the steam roads. The lesson taught by the success of many of the interurban roads is, that the part of the public obliged to travel wants comfort, and when that is provided, the balance of the public will find an excuse to travel, if rates are reasonable.

To provide this comfort is not quite as easy as the word. It means more than handsome, well-appointed, easy-riding cars. Suppose these are provided and one must wade through muddy depths to get at them, or must undergo the annoyance of waiting for cars behind time, or endure a rough track and poor trucks; no amount of beauty in the car will make up for this. Comfort to the passenger should begin when he makes up his mind to take a ride on the road. He should have only a short walk to the car. Perhaps board it in front of his place of business, and it should be on time. Once seated, the car should get out of the way of impediments to quick time as promptly as possible. Getting to his destination, the passenger will want to be let off to his best advantage, and his comfort must be considered even after he is out of sight of the car. If it is not possible to pick him up and deposit him to suit his convenience, then the next best thing the road can do is to provide him with a comfortable and attractive place in which to wait. During his ride he does not want to stop oftener than can be helped; the speed of the car in miles per hour does not interest him, but he is vitally interested in the total elapsed time from the beginning to the end of his journey. Even if it is a pleasure ride and time does not count, he would rather ride 20 miles in one hour making no stops than the same distance in the same time making from 15 to 20 stops, but reaching a maximum speed between stops of 50 m.p.h. To be convinced of this try it yourself. Neither are hold-ups at grade crossings any additional comfort to the passenger—nor to the operating company.

This naturally brings forth the argument that, after all, one of the most vital parts of any railroad property lies in its terminal facilities, and the rule holds good whether the road have steam, electric, cable or mule motive power. This is especially true in the large cities, and no better illustrations can be cited than the two cities of New York and Chicago. The first is older than the railroads, which have up to the present time had insufficient terminals. Two roads alone are now spending something like a hundred million dollars to improve their facilities. There are some roads in this country and more abroad whose terminal facilities represent 20 per cent. and over of the value of the property. Chicago, on the other hand, grew up with the railroads, and we find terminals all around the periphery of a small circle not more than a mile in diameter and enclosing the heart of the business district. No such expenditures as those now being made in New York are there required to improve terminals. The electrification of the New York suburban service is quite liable to be followed by similar improvement in the magnificent suburban service offered in Chicago by the North Western and Illinois Central roads, and it is interesting to consider its effect on existing electric interurban properties, especially on the Aurora, Elgin & Chicago. The Aurora, Elgin & Chicago is a third-rail line about 35 miles long, competing with the Chicago & North Western, but tremendously handicapped in its terminal facilities. Besides interchanging with the West Side Elevated over a long and slow piece of elevated track, it has seven grade crossings with heavy-traffic electric and steam railroads, and something like 200 grade crossings with highways, many of them within Chicago city limits. Should the C. & N. W. at any time decide to follow the New York example and electrify its suburban service as far west as the Fox River Valley, there can be little doubt as to what would happen to the Aurora, Elgin & Chicago. In the smaller cities satisfactory terminal facilities are quite generally obtained with comparatively small trouble and at low cost, but it is safe to say that they are quite as important there as in the larger cities.

These arguments indicate that three things are essential for the success of any interurban property, good terminal facilities, permanent roadway and quick time. It is safe to say that this triple alliance will guarantee success wherever there is sufficient population to support a road. "Success" should here be defined as referring to an ample return on the actual, intrinsic value of the property. In these days of "high finance" a property may be bankrupt and in receiver's hands and still remain profitable, or its statements may indicate success and wealth, while beneath is demoralization and decay.

Within the past year Wall Street has grown exceedingly skeptical on the subject of interurban railways, and it has come to be the fashion to examine their promoters for evidence of milk on their boots and hayseed in their hair. Making all due allowances for the provincialism of New York in general and Wall Street in particular it cannot be denied that this attitude of the financial world is due to gross abuse of confidence by some railroad promoters. So long as there are people who build electric railways for the sake of a construction profit so long will this lack of confidence continue. There are some roads, more or less abandoned after completion, which went so far as to convert the underwriter's and promotors rake-offs into funded debt. One such electric road, capitalized for millions, after having an enormous bonded debt saddled on it, was put under the management of an ex-clerk with a few months experience in a railroad office, who was paid a salary about equal to the pay of a good mechanic. And to-day the "syndicate" which built that road is calling on Jehovah to witness the stringency of the money market which prevents them from raising the funds required to meet their necessities, a fact regretted by few who are familiar with the circumstances. Unfortunately a case like this can do more harm to the standing of interurban railways in the eyes of the investing public than 20 honestly financed and well managed properties can do good, and the weeding out process of this class of projects cannot commence too soon.

We are considering, however, the bona-fide, built-for-business kind of an interurban railway, and what is to become of it. Only a small percentage of them radiate from the

larger cities, the majority center in cities with a population under 500,000, where they have made serious inroads on the passenger traffic of the steam roads, and have developed transportation as a refined form of amusement for the masses. The millions of dollars paid annually into their coffers by the public is being regarded with envious eyes by the steam roads, who are bound, sooner or later, to make an effort to get some of the laboriously developed traffic of the electric, and it is still doubtful what form their onslaught on the business will take. Present indications are that some steam roads will add an electric passenger service in the vicinity of and connecting towns along their lines while maintaining their freight and through train service just as is done at present. There are many cases where this could be done without interfering with existing traffic, and in other cases an extra track or two can readily be built on the existing right of way. Such an electric service would steal a long march on interurbans, as on the well maintained roadway of the steam road running time could be made very far superior to the interurban schedule. And still the interurban will get the business, solely on the strength of its terminal facilities.

The next move of the steam road would be to so improve its terminal arrangements as to be able to run its electric passenger cars to the heart of the cities. To do this traffic arrangements may be entered into with street railways; they may be purchased outright, as at New Haven and at Syracuse; or the railroad may build its own track either on the surface of a street or on an elevated structure. While city governments, as a rule, are in no mood to grant privileges to steam railroads, the plan is workable. With this accomplished, the steam road becomes a very formidable competitor of the interurban for short haul traffic, and will no doubt get a share of its passengers. If an existing interurban does not parallel any steam road it is quite unlikely that it will ever be subjected to steam competition, and its returns would have to be something out of the ordinary to tempt investment in a parallel electric line. Both forms of competition will be quite out of the question if, as above outlined, terminal facilities are adequate, the roadway permanent, and the service as it should be in point of comfort and time.

So far, we have considered only the passenger traffic of the electric road. The future will no doubt see a greater development of freight service, but much is being done along these lines. The Toledo & Western, Buffalo & Lockport and Albany & Hudson are good examples of combined service, particularly the latter, because it has shown what a road can do in the line of heavy freight transportation, even if handicapped by 3 per cent. grades. Satisfactory freight returns depend to some extent on interchange of traffic with steam roads, but even without that, much can be accomplished if the business is handled right. The business should, however, receive consideration in planning the construction of the road and should not be an after-thought, grafted on a street railway construction. If the freight carrying and handling facilities are provided, the road which stands the best chance of success is naturally the one which opens new territory or new routes not touched by existing steam lines and does not come into competition with them. Such a road will always do a much heavier freight business than an electric road, which must win its share of traffic away from an existing steam road.

It is not the simplest thing in the world to handle a combined electric passenger and steam freight service over a single track road, but it can be done very satisfactorily by bringing to bear on the operating plans the highly developed and specialized modern system of railroad organization, and it is the best of business to keep the rails busy with revenue bearing loads of whatever nature every hour of the twenty-four.

Transportation securities will no doubt always hold their place in the favor of the public. Industrial corporations may come and go obedient to the shifting law of supply and demand and their securities will shift with this law, commanding fabulous prices to-day, down in the inky blackness to-morrow. But transportation must exist during good times and bad, war or peace, so long as there are people who demand communication with each other and transportation for their persons and goods. The extent to which electric railway securities can share in this general confidence will depend entirely on the skill displayed in financing, constructing and managing them. A high degree of strategy is just as valuable in railroad work as in warfare, but it will not win battles without the support of thorough organization, experience and loyalty to the work to be accomplished.

Applying to all that has been argued above, we may conclude that interurban electric railroads will work out their own destinies strictly in accordance with the amount of judgment which has been put into them. The road whose prosperous future seems most assured is the one which is located along a favorable route, constructed in a most permanent manner, equipped to handle freight on a modern scale and having the best terminal facilities for both freight and electric passenger service. For such a property competition, absorption and all the bugbears of modern finance can have no terrors, and if supplemented by skilful and experienced management it will survive as the fittest of them all.

## Signal Batteries in Summer.*

BY H. S. BALLIET.

Previous articles have dealt with the maintenance of batteries during the winter; the principal thing being to prevent chilling or freezing. In summer the expansion of porcelain and glass and the evaporation of solutions are our chief trouble.

There is no uniformity of practice as to the use of either porcelain or glass jars in gravity batteries. Roads using porcelain claim that the breakage of jars in service is reduced to a minimum, very few interruptions being caused thereby. On the other hand, they agree that it is difficult to observe the action of the cell. This leads the maintainer, in an effort to save work, to take chances of having exhausted cells, dirty zincs or a dense solution. Many jars are broken and frequently small cracks started, afterward causing rupture when handled.

Experience indicates that it is economy to use porcelain for track batteries. Generally speaking, these cells are kept in chutes. In order that the highest standard may be maintained, they must have frequent inspection, usually once every two weeks, but this increases the liability to breakage, owing to the need of raising and lowering the jars.

When glass is used there is more breakage not only from lifting and lowering, but in handling them when renewing solution; but the action of the cell can be better watched and frequently a longer life maintained without danger of interruption by short circuits, dirty zincs or exhausted supply of sulphate of copper.

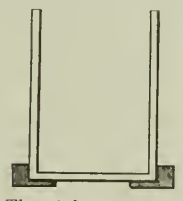
The question of broken jars is, however, not so serious where two cells in multiple are employed, with reasonably short track sections, as with three cells in series-multiple and long track sections. In the former the track relay will work when one cell is removed or broken, as only part of the source of supply is lost; while in the latter, the potential is reduced and after the passage of a train, the relays will not become energized.

In cases where track batteries are not renewed every six weeks, it is common to find that the solution is evaporated sufficiently to cause the zinc to be exposed. This is liable to increase the internal resistance of the cell and cause interruption; fluctuations of voltage will take place during a spell of wet track and the track relay will fail to operate. Sometimes such interruptions are erroneously classed as "leak in track section" or "escapes." To guard against this evaporation, a number of remedies have been suggested; principal among which are the application of crude or kerosene oil on top of the solution or the use of air-tight enclosures.

Track batteries should, of course, be kept dry; yet they have been known to work while completely flooded, being submerged for six days, delivering current uninterruptedly during that time and failing only when the supply of sulphate of copper became exhausted.

Batteries used for other than track purposes are usually kept in wells and houses. When placed in wells, a great difference is noticed as compared with those kept in chutes. In the latter the changes in temperature shorten their life. In the warmer months of summer there will be breaks, apparently due to expansion and contraction of the material of the jar. Sometimes the passage of trains will set up a vibration within a well which will disturb the cells and their contents and cause cracks.

To establish air circulation, thereby anticipating about 90 per cent. of the breaks in jars, a strip, shown in the illustration, has been designed, by which the cells are held above the shelf level, thus not only allowing the free circulation of air but preventing the accumulation of dirt under and around the bottom of the cell. This plan has been in use for several years and has accomplished its object beyond anticipation. The strips are straight, a pair supporting a row of jars. Strips are usually made in 4 ft. lengths. These strips also prevent cells from being thrown off the shelves by vibration, an accident which has been known to cause interruptions.



Glass jars are frequently shattered by repeated blows on the top edges by zincs which are caused to move up and down by the passage of trains. In a number of cells which were fitted with hard rubber cushions, placed between the zinc carrying wire and the top edge of the jar, this cause of damage was overcome. Extra heavy rubber tubing and tape were also partially successful.

Battery jars which have a lid or cover, such as the Edison Primary and the Nungesser, etc., often break, owing to the weight which is suspended from the lid. This is readily demonstrated by putting porcelain lids on glass jars; for glass jars tin lids seem to be the most successful.

In a certain territory comprising many thousand cells of battery of several prominent designs, half of the jars are glass and the other half porcelain, practically all being in wells. Records for a period of three years

*Articles by Mr. Balliet on the performance of automatic signals under unfavorable conditions were published in *The Railroad Gazette*, of Feb. 26, March 25, April 15, May 20, July 1 and July 8.

indicate that the breaks in glass, while in service, are about two to one of porcelain. The total number of breaks from all causes, in all types, is less than two hundred a year. The number of trains stopped at signals on account of these broken cells is very small when a rigid inspection is maintained. Few interruptions need occur with acid batteries, because it takes from one to six days for the solution to leak through an ordinary crack.

Records have been kept to show the comparative length of life of batteries using glass and porcelain; they indicate an increase of about 20 per cent. with glass over porcelain. This is apparently due to the ability of maintainers to run all cells nearer to complete exhaustion, owing to the fact that they can make a closer inspection.

There are very few cases where either glass or porcelain cells crack when kept in battery enclosures fixed on concrete foundations, or attached to posts which are set on concrete.

When porcelain jars are used, inspection is limited to taking readings with a low reading volt-meter. If the cell is of the acid type, the zinc and the other element may be raised through the oil film, but this is objectionable, for it is liable to break the wires, adding another cause of interruption.

## Railroad Shop Tools.

(*Continued.*)

BORING MACHINES.

The accompanying illustration, Fig. 1, shows the 72 in. horizontal boring, drilling and milling machine made by the Detrick & Harvey Machine Company, Baltimore, Md. The machine consists of a horizontally revolving spindle, having a horizontal traverse parallel to the bed-plate and at right angles to the column runway. The spindle is mounted in a saddle having a vertical movement of 72 in. on the face of the column, and the column has a horizontal movement of 72 in. on the runway. Fast and slow power movements for the saddle and column, and power feeds and quick return for the spindle in either direction, are provided. Hand feeds are also provided for all motions. The runway is a box casting, ribbed and flanged. The top surface consists of a front and rear slideway, 14 in. and 8½ in. wide respectively. The width of the slideway over all is 56 in. and the depth under the slideway is 18 in. The column is a tapering box-shaped casting, with a base 71 in. wide x 81 in. long. At the rear and side of the column are the driving gearing and the motor for rotating the spindle and for feeding the column and the saddle. The spindle saddle is box section with a bearing on the vertical face of the column 56 in. long. The saddle is counterbalanced and has a 37-in. bearing for the spindle rotating sleeve. The bearings for the driving shafts and gears are cast on the saddle. The spindle is hammered steel, 5½ in., 6 in. or 6½ in. in diameter, with a No. 6 Morse taper hole in the end. The spindle is ground to a sliding fit in a sleeve 46 in. long. The sleeve is slightly tapered on the outside and revolves in the saddle on a bronze bushed bearing 37 in. long. Bronze and steel thrust washers are provided on the front and rear, and take-up collars are provided for wear. When motor driven, the rotating mechanism for the spindle consists of a 7½ h.p. reversible motor of the constant speed type, direct connected to the driving gearing and mounted on the base of the column. The work bed or bed plate is a flat box-shaped casting 12 in. deep, with T slots on its top surface. It is tongued and bolted to the runway. The dimensions of the bed plate are made to conform to the requirements of the customer. The outer support for the boring-bar consists of an upright post, carrying on its vertical face a vertically adjustable bearing for the end of the boring bar. This bearing is fitted with a stationary bushing, with a vertical bearing of 24 in. on the face of the post. The post slides horizontally, parallel to the main column on a supplementary bed resting on the bed plate. The adjustments in the outer support are made by screws hand operated. The boring and drilling feeds are eight in number. They are reversible and range from .007 to .4 per revolution of the spindle. The milling feeds to the saddle and column are also eight in number, ranging from .01 in. to .5 in. per revolution of the spindle. The speeds to the spindle are 20 in number, 10 through the sleeve gear and 10 through the face plate gear. The changes of speed are made by means of a cone of geers and by levers operating clutches. Four changes of speed are obtained by shifting of the levers and without changing the step of the cone. All power and hand movements, fast and slow, for the spindle, saddle and column are controlled by the operator from his platform attached to the saddle. Levers are conveniently placed within reach of the operator. The rapid movement of saddle and column is obtained by an independent reversible motor of 7½ h.p., mounted on a supplemental base at the rear end of the runway. The saddle has a 72-in. vertical movement and the spindle has a 72-in. adjustment. The column has 72-in. (or more if desired) horizontal traverse. The distance from the center of the spindle to the bed plate in its lowest position is 48 in., and in its highest position, 120 in.

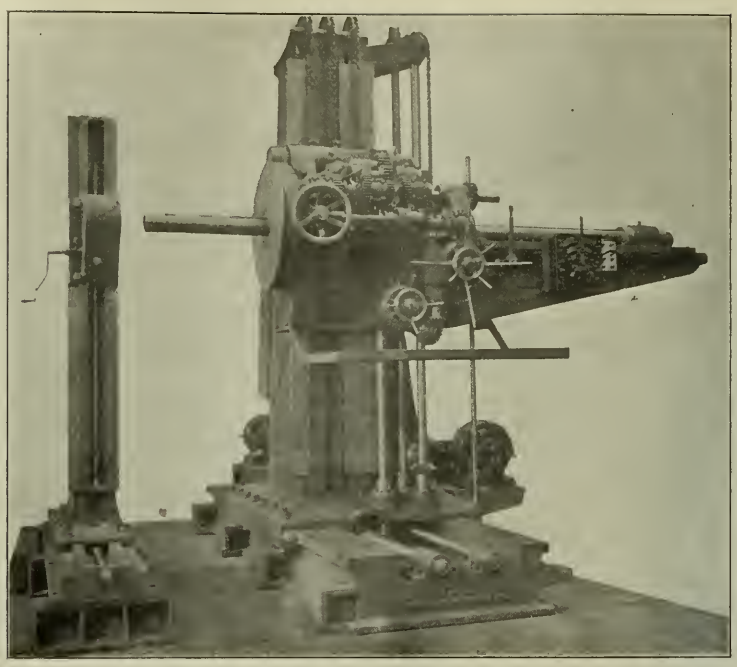


Fig. 1.—The Detrick & Harvey Horizontal Boring Machine.

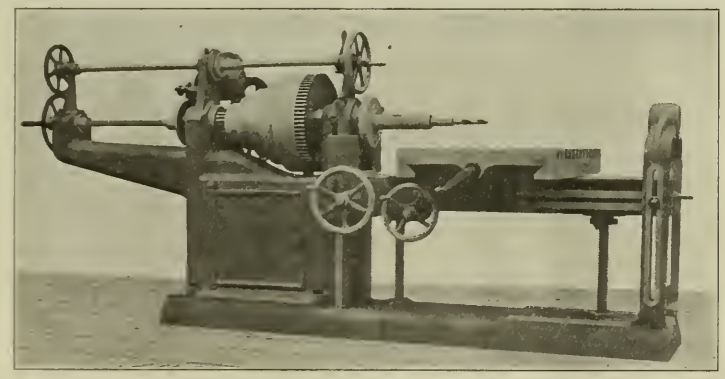


Fig. 2.—The Sellers Horizontal Boring Machine.

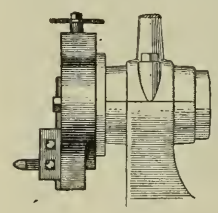


Fig. 3.—Sellers Facing Attachment.

The horizontal drilling and boring machine shown in Fig. 2 is made by Wm. Sellers & Company, Philadelphia, Pa. The spindle of this machine is 2⅞ in. in diameter and has an adjustment of 30 in. The feed is variable from the finest to over ½ in. per revolution of the spindle. The power feed is operated instantly by a positive clutch. The machine also has quick hand traverse and hand feed. The ratio of the back gear is 12 to 1 and the largest step on the cone is 20 in. in diameter for a 3-in.

belt. The table is 48 in. long by 28 in. wide and is slotted to receive bolts for holding the work. The table is adjustable both lengthwise and crosswise of the bed. The distance from the center of the spindle to the top of the table in its lowest position is 21 in. The pulley on the countershaft is 16 in. in diameter and has a 4-in. face and should run at 75 r.p.m. Fig. 3 shows a "revolving slide rest." This can be bolted to the flange on the end of the sleeve in which the spindle slides and is used for facing off large surfaces.

The double car box boring machine (Fig. 4,) is made by the Niles-Bement-Pond Company, New York. This machine will take boxes up to 6 in. x 12 in. It has two spindles. These are arranged so that four boxes can be bored and faced at the same time. The spindles are 2⅞ in. in diameter and are driven by gearing. The saddle has automatic feed and hand adjustment, and is provided with specially designed chucks for holding the boxes. One pair of boring mandrels 3 in. in diameter is furnished with each machine. The countershaft pulleys are 20 in. in diameter for a 4½-in. belt and should run at 350 r.p.m.

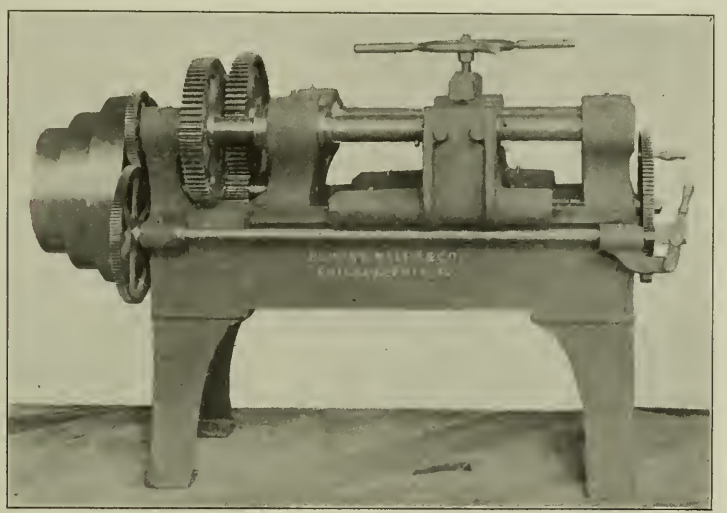


Fig. 4 —The Niles-Bement-Pond Car Box Boring Machine.

*(To be Continued.)*

## A Panacea for One Class of Butting Collisions.

BY H. W. FORMAN.

The effect that displaying the order signal at "stop" at train order meeting points would have upon the collision record seems to have been brought out convincingly in the Train Accidents Report in the United States for May, published in the *Railroad Gazette* of July 1st.

If the statement were made that a pine tie would last as long in track as one of oak, no one would be justified in contradicting it unless he was in position to prove to the contrary. And so it is in the matter of surrounding train-order meeting points with additional safeguards, by also sending the order to the operator at the meeting or time-limit waiting point. No one should contend that it cannot be done successfully if he has never tried it. The only adverse argument that I have ever heard of is that three despatchers cannot handle the same number of trains on a district of the same length; that trains not interested may be unnecessarily delayed by order signals being at stop at so many stations, and that the extra expense for additional operators would be too great a burden. It has never been contended that it is not a good thing and that it has not and will not prevent many collisions. If there were more telegraph offices and fewer "blind sidings" despatchers would be able to move trains with less delay, and less overtime would be paid to the train and enginemen. Have those who have made the experiment found these objectionable conditions actually present to such a degree that trains could not make their trips satisfactorily? Has the outlay been found to be greater than the loss by the accident account and damage to reputation where such a plan was not followed? In speaking to any one who has not given the plan a fair trial, I may be allowed momentarily to disregard the objections advanced, for I shall deal only with the facts of a quarter of a century's experience with this method of moving trains on a very busy single track railroad.

The rule that all train orders shall be shown to brakemen and firemen is quite recent, having been adopted generally only a few years ago. No doubt it has been the means of saving many collisions, but even this precaution has not stopped them entirely, and it never will. The fact to-day is that in nearly every case of butting collision all the men on the train are found to have forgotten orders, or misread them. Orders will be forgotten hereafter with the same frequency, and it is useless to hope that this factor can ever be expunged from the collision record by discharging the men who forget. The new men put in their places are quite as likely to possess the same seemingly, and it never will. The fact to-day is that operator at the meeting point may also sometimes forget to display his signal should not dishearten any who are earnestly seeking relief from collisions; the remedy is not absolute but it is a real remedy. Collisions due to forgetting train orders will continue indefinitely under the present almost universal way of holding trains, and the easiest and most direct relief is to be found by including the operator at the meeting or waiting point in the movement, and requiring him to keep his train order signal displayed at stop and deliver a copy of the meeting or waiting order to all trains concerned, until all have arrived from one direction, or until the waiting time named in the order has expired.

Accidents due to complex breakage, fire and flood may be regarded as largely irremediable; those due to misplaced switches can be reduced by interlocking; but those brought about by aberration of the mind must be dealt with by the formation of habit, systematic checking and reminders in the form of cautionary or stop signals as the exigency demands.

Standard Code Rule 221A provides that train order signals shall normally indicate "stop," except when changed by the operator to "proceed" to allow a train to pass after getting orders, or for which there are no orders. Many operating officials are convinced that this is the true logical position for all signals. Rule 94 allows trains to change their relative positions at any siding without consulting the despatcher, and it is very doubtful whether, when one train passes another under such circumstances, without exchanging schedule or right, the crews always take the precaution to stop at the next open telegraph office and advise the operator and despatcher and wait for further instructions from the despatcher before proceeding. Therefore, it will be seen that Rule 221A leaves a great deal to the operator's intelligence and judgment, and that the only absolutely safe course for him to pursue under this rule is to stop every train while there are orders in effect at his station. The rule does not contemplate this being done. Operators do change their order signals to "proceed" to allow disinterested trains to pass, and there seem to be few if any accidents under the practice. If the normal position of the order signal is "proceed," as provided by Rule 221B, and it is displayed at "stop" on account of an operator being included in a meeting order, is there any greater danger, after conferring with the despatcher, in changing such signal to "proceed" for only a few seconds to allow some fast train which is not concerned to pass, provided that, in such cases, the interested superior train is invariably given a copy of the meeting order before it reaches the waiting point? If there is a particle of risk, and the despatcher often knows whether or not there is, all trains may be stopped for a clearance. It is in this manner that trains are handled on most roads which require all meeting or waiting orders to be addressed in duplicate to the operator at the place of meeting, and it is satisfactory. It is very desirable to use the semaphore form of train order signal when operating under this arrangement.

Any delay that trains may sustain stopping to get clearances is more than compensated for as the plan allows a more liberal use of the "19" form of train order. It permits such orders to be addressed to the superior as well as the inferior train. The "19" form may also be used to fix a meeting between extra trains, by first completing the order to the operator at the place of meeting and issuing the same instructions to the extras before they reach such station. Of course the order is worded to all alike, and, ordinarily, is sent to the three offices simultaneously. When a "19" order can be safely used for the superior train a delay of from five to twenty minutes is often avoided as it does not have to be stopped to get an acknowledgment of the order. It may be contended that, should the operator fail to deliver the order to the superior train, a collision would result; but the order signal being at stop at the meeting station prevents this. If the operator who is to deliver to the superior train were to overlook the order it is likely that he would at once inform the despatcher who could then if necessary take steps to prevent a collision.

I cannot recall many instances of failure

to deliver "19" orders; they are torn off and hung up in a conspicuous place as soon as completed and are not nearly so likely to be overlooked as "31" orders, which must be left in the book on the table where something may be allowed to cover them up. A collision has never been known to occur, through train and enginemen's forgetfulness, when the meeting order was sent to both trains where they would get them before reaching the meeting point, and also in duplicate to the operator at the place of meeting, except in cases of the grossest neglect, which cannot be fully guarded against under any system of orders.

What may be promised if these suggestions are thought enough of to secure the adoption of the plan? During the past twenty years from forty to ninety daily trains have been handled in this manner on several large roads in the United States having single track districts of 60, 85 and 115 miles in length, and it has been found that it could be done by the use of from 75 to 150 orders each 24 hours. The "31" form is seldom used by these despatchers, for it is not often necessary to stop trains to sign orders, except when meeting points are made at blind sidings. During this time there have been no collisions due to forgetfulness. This remarkable immunity results from the remoteness of the chance that the train and enginemen, and the operator, will all fail in their duty. Even if an operator were to incorrectly repeat an order (and those who have made a study of the collision record will find this to be of frequent occurrence) and the despatcher not detect the "lap," the order signal being at stop at the meeting point would prevent a collision. I cannot say just how many collisions have been prevented during my period of service under this rule, nor how many men have suddenly felt a choking sensation when an operator handed them an order reminding them of a meeting point which they had forgotten; but there must have been a good many, since the record shows that there were no collisions on that particular road, while others not operating under such rules were having them now and then. We did not have operators at every station, but meeting points were fixed at telegraph offices as much as possible, and every one admits that the percentage of risk is reduced in proportion to the number of available telegraph offices. It may be claimed that the proposition is impracticable for the reason that the operator at the selected meeting point often cannot be raised promptly. In such event, the order may state that the order signal is not at "stop" at the place of meeting, which is of itself a safeguard, because unusual.

Is there another officer with some such accident fresh in mind, or who has found it necessary to almost tie up his road by requiring acknowledgment from the superior train before permitting the inferior train to act on the order, now willing to join the ranks of those who have already thought best to adopt this scheme? The fact that there has never been an accident or error of this kind on your road, is hardly sufficient to warrant you in deciding that it is unnecessary to take this precaution, for no one can tell how soon some heretofore reliable employe may forget. Few escape. The spirit of the code rules is not violated in adopting this additional protection; a railroad may not do less than the rules prescribe, but it surely has the right to adopt additional safety practices if deemed expedient.

For years the Burlington road has been operated under the following rules:

"208.—A train order to be sent to two or more offices must be transmitted simultaneously to as many of them as practicable. The several addresses must be first to the operator at whose station the trains are to meet, and next in the order of superiority of trains, each office taking its proper address. When not sent simultaneously to all, the order must be sent first to the superior train."

"221 (C). Orders addressed to operators, restricting movement of trains, will be respected by conductors and enginemen the same as if addressed to them. Operators, in such cases, will deliver copies of the order to all trains affected until all have arrived from one direction, when, if there are no other orders in effect at that station, the train order signal will be changed to "proceed."

## Master Mechanics' and Master Car Builders' Committees, 1905.

Mr. J. W. Taylor, The Rookery, Chicago, Secretary of these two associations, announces the subjects and committees for the year 1904-05.

MASTER MECHANICS' ASSOCIATION.

1. *Proper Loading for Locomotives.*—What should be the practice underlying the proper loading of locomotives on the basis of conducting transportation with the greatest efficiency and at the least cost, considering all the factors individually? C. H. Hogan, Chairman; H. T. Herr, D. F. Crawford, H. T. Bentley.

2. *Locomotive Tests of Pennsylvania Railroad Company at St. Louis Exposition.*—To report to the convention the results obtained from tests made. F. H. Clark, Chairman; H. H. Vaughan, F. M. Whyte.

3. *Locomotive Front-Ends.*—(a) To carry to completion the tests outlined in its report to the convention of 1903. (b) To investigate the question of design and material for locomotive fronts and front doors with the view of affording relief from leaky front-ends. H. H. Vaughan, Chairman; F. H. Clark, A. W. Gibbs, Robt. Quayle, Prof. W. F. M. Goss.

4. *Locomotive Driving and Truck Axles and Locomotive Forgings.*—To submit specifications after they have been considered by the International Railway Congress to be held at Washington in May, 1905. F. H. Clark, Chairman; S. M. Vauclain, L. R. Pomeroy, J. E. Sague, E. B. Thompson, F. W. Lane.

5. *Shrinkage Allowance for Tires.*—To consider whether the present shrinkage allowance—$^1/_{80}$ in. per foot—is sufficient for the large diameter wheels with cast-steel centers. F. J. Cole, Chairman; J. E. Muhlfeld, A. S. Vogt, W. A. Nettleton.

6. *Motive Power Terminals.*—What can and should be done to reduce locomotive terminals to the basis of a machine for treating and handling engines, apart from the question of housing, the object being the prompt handling of power, greater efficiency in service and less detention at terminals, while affording more time and better facilities for care and repair of engines? To investigate the best method of heating and ventilating roundhouses. D. R. MacBain, Chairman; G. W. Wildin, P. Maher, C. R. Chambers, W. R. McKeen, Jr.

7. *Flexible Staybolts.*—To consider the subject of flexible staybolts, number in use, manner of applying and service rendered. R. N. Durborow, Chairman; F. M. Whyte, C. E. Fuller, O. H. Reynolds.

8. *Water Softening for Locomotive Use.*—The practicability of water softening for locomotive use by means of chemicals or the application of heat, and the maximum cost per one thousand gallons permissible that the expenditure could be recovered in reduced motive power expenses. J. A. Carney, Chairman; L. H. Turner, J. F. Dunn, F. N. Risteen, Robt. Quayle.

9. *Service of Locomotives.*—To consider the average engine hours locomotives are in service, in shop under repairs or waiting to get in shop, per annum, and the percentage of total time locomotives are actually in and out of service per annum. Wm. Forsyth, Chairman; H. Bartlett, D. Van Alstine, J. S. Chambers.

10. *Shop Layouts.*—To consider the question of shop layouts for roads having 350, 500, 750 and 1,000 locomotives. R. H. Soule, Chairman; R. P. C. Sanderson, C. A. Seley, H. D. Taylor.

11. *Subjects.*—To suggest subjects for committee work and individual papers during the year 1905-06; also subjects for topical discussions at the convention of 1905. J. F. Deems, Chairman; Wm. McIntosh, R. D. Smith.

MASTER CAR BUILDERS' ASSOCIATION.

1. *Arch Bars.*—To prepare a design for arch bar for 100,000-lbs. capacity cars. J. E. Muhlfeld, Chairman; A. S. Vogt, C. E. Fuller, W. T. Gorrell, F. M. Gilbert.

2. *Safety Appliances.*—(a) To confer with the Interstate Commerce Commission in regard to the standards of the Association; (b) to prepare and submit to the convention of 1905 a design showing: (1) Ladder; (2) Location of ladder; (3) Location of handholds on roofs. D. F. Crawford, Chairman; H. D. Taylor, A. E. Mitchell.

3. *Tank Cars.*—To continue its investigations and report result of tests as outlined in report of proceedings for 1904. A. W. Gibbs, Chairman; C. M. Bloxham, R. Gunn.

4. *Steam Connections.*—To continue experiments and submit detailed dimensions for steam heat hose coupling. H. F. Ball, Chairman; T. W. Demarest, F. H. Clark.

5. *Passenger Car Rules.*—To consider and report whether a revision of the present passenger code of rules is advisable. J. T. Chamberlain, Chairman; G. W. Wildin, F. W. Chaffee, F. N. Hibbits, R. W. Burnett.

6. *Repairs of Steel Cars.*—To design a more effective form of fastening the center sills when cut off near the bolster, and such other questions as were referred to it by the convention. T. H. Russum, Chairman; R. F. McKenna, I. N. Kalbaugh, E. B. Gilbert, G. N. Dow.

7. *Air-Brake Hose.*—To follow up tests suggested in report at 1904 convention, under both present and proposed specifications, and report results. Le Grand Parish, Chairman; T. S. Lloyd, J. Milliken, F. H. Scheffer, G. H. Emerson.

8. *Coupling Chains.*—(a) To revise present design for permanent safety chains for wooden cars. (b) To submit design of chain for chaining cars together when hauling twin and triple shipments. R. P. C. Sanderson, Chairman; R. L. Kleine, Jas. Macbeth, R. B. Rasbridge, J. F. Walsh.

9. *Stenciling Cars.*—To submit a design for stenciling cars. H. M. Carson, Chairman; J. S. Lentz, W. F. Bentley, Geo. T. Anderson, Jos. Buker.

10. *Doors.*—(a) To revise the drawing of the outside sliding door shown on M. C. B. Sheet F, and recommend a design for a flush door. (b) To consider the question of a suitable grain door to meet requirements of the present large capacity cars. J. E. Keegan, Chairman; W. E. Sharp, T. A. Treleaven, J. W. Muncy, D. Van Alstine.

11. *Subjects.*—J. S. Chambers, Chairman; F. T. Hyndman, O. M. Stimson.

M. C. B. STANDING COMMITTEES.

*Arbitration.*—F. H. Clark, P. H. Peck, T. W. Demarest, J. J. Hennessey, E. D. Bronner.

*Supervision of Standards and Recommended Practice.*—C. A. Schroyer, Chairman; M. Dunn, T. S. Lloyd.

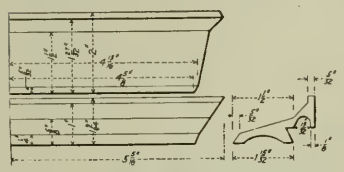
*Triple Valve Tests.*—Wm. McIntosh, Chairman; F. H. Scheffer, C. A. Schroyer, W. S. Morris, A. J. Cota.

*Brake-Shoe Tests.*—Chas. Coller, Chairman; Wm. Garstang, Prof. W. F. M. Goss.

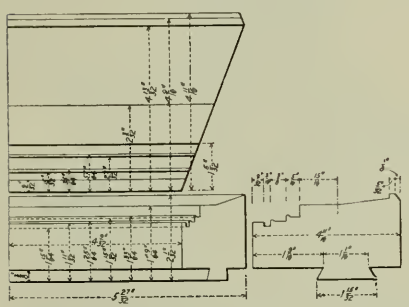
*Tests of M. C. B. Couplers.*—R. N. Durborow, Chairman; W. P. Appleyard, W. S. Morris, Jos. Buker, F. H. Clark.

*Draft Gear.*—E. D. Bronner, H. D. Taylor, W. F. Kiesel, Jr., G. W. Smith, Mord Roberts, Le Grand Parish.

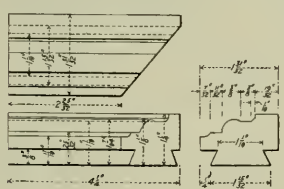
*Revision of Rules for Loading Long Material.*—A. Kearney, Chairman; W. E. Fowler, J. W. Luttrell, A. Stewart, F. H. Clark, T. H. Curtis, W. F. Kiesel, Jr.



Undercut Tool for 4¼-in. U. S. Packing.



Undercut Tool for No. 10 Simplex Injector Steam Nozzle.

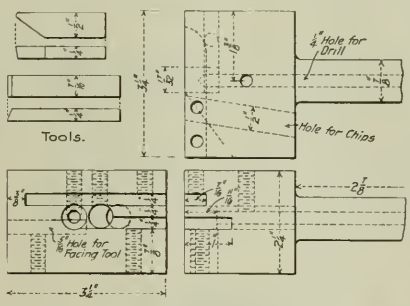


Undercut Tool for ¾-in. Globe Valve.

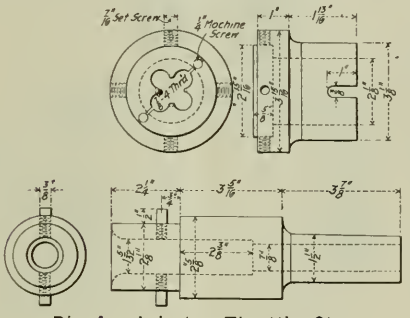
The Oriental Railroad Company, which works the railroads in European Turkey, had sufficient excitement last year. Uprisings, actual or threatened, in Macedonia and elsewhere, were accompanied by numerous explosions of dynamite at bridges and other structures, and dynamite cartridges and infernal machines interrupted the regular operation of trains, wounding not only several soldiers, but killing the cook and injuring several passengers on the Oriental express. The army of soldiers which the government sent to protect the railroad was itself a considerable hindrance to its operation. The Turkish soldiers were very suspicious of the trackmen and other employees, who are largely Bulgarians. Moreover, the transportation of the soldiers was destructive of all regularity in train service, orders being given and countermanded in a heart-breaking way. Notwithstanding all this, the railroad earned 15 per cent. more than in 1902 (which had its own troubles), and the stockholders got 5 per cent. dividends.

## Box and Undercut Tools in the Santa Fe Shops.

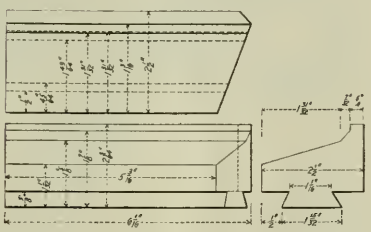
In the article "Notes from the Topeka Shops of the Santa Fe," published in our issue of June 3, reference was made to the special forms of box and undercut tools in use in the brass department, which have greatly cheapened the cost of producing different parts by largely reducing the number of operations. The full set of record drawings of these tools has been completed only lately, and a set of blue prints from these drawings has been set us by Mr. A. Lovell, Assistant Superintendent of Motive Power. A number of representative tools have been chosen from this lot for illustration herewith.




Box Tool for 8-in. Air Pump Valve (Steel).




Die for Injector Throttle Stem.

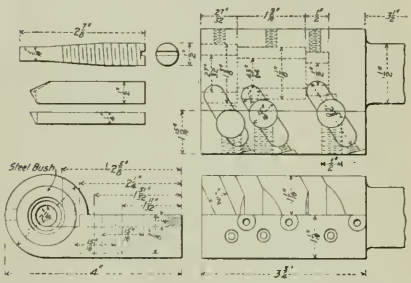


Undercut Tool for 2¾-in. U. S. Packing.

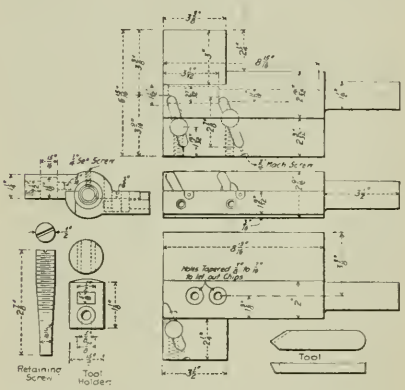
## The New Haven's Electrification Plans In the Bronx.

President C. S. Mellen, of the New York, New Haven & Hartford, has announced that that company is about to spend eight million dollars in electrifying the Harlem River & Port Chester line through the Borough of the Bronx, New York City, and Westchester County, from the Harlem river to New Rochelle. Plans and estimates have been made for a six-track road, two tracks to be used for steam trains and four tracks for electric trains. Two of these latter will be used for express service and two for local trains and the present local passenger service by steam trains will be discontinued.

The main line of the New York, New Haven & Hartford is four-tracked down to Mount Vernon, and from there to Woodlawn, where it runs into the Harlem division of the New York Central, there are at present but two tracks. The New Haven's suburban business is drawn almost entirely from the towns situated between Mount Vernon and Greenwich, Conn., and all of the suburban trains are run through Mount Vernon and Woodlawn, from which point they run express over the Harlem division of the New York Central to the Grand Central Station. The region lying between the Sound and the main line is served by the Harlem River & Port Chester line, a double-track road which branches off from the main line at New Rochelle and ends at the 129th street station of the Second and Third avenue elevated lines. The freight terminals of the New Haven road in New York City are located along the Harlem river and connect with this branch line and all freight trains as well as the through passenger trains between Boston and Washington, which are ferried around Manhattan Island, are run over it to New Rochelle on the main line. It is therefore essential, for the present at least, to maintain two tracks for steam trains.




Box Tool for No. 10 Monitor Injector Heater Cock Stem.




Box Tool for Injector Throttle Stem.

The improvements, which practically amount to entirely new construction, will begin at the east end of the Harlem river yard and will extend all the way to New Rochelle, a distance of a little more than 12 miles. The right-of-way of the present line will be followed except in a few places where a slight divergence will improvve the alinement. All grade crossings will be eliminated without any radical changes in the established street levels, the grade of the new line being adjusted to meet the contour of the surroundinng country. Many of the streets are laid out on paper only but the necessary abutments for bridges will be put in at the

time of building in the event of these streets ever being opened, so that no expense or delay will be incurred after the line is once in operation. There are in all 31 under passes and 25 overhead bridge crossings provided for. The maximum grade has been fixed at .6 per cent., and the maximum curvature at 5 deg., so that the new line will be suited for high speeds. East Chester Bay is to be crossed on a pile and timber trestle 1,600 ft. long with an 80-ft. rolling lift bridge over the channel. With the exception of a short swing bridge over Westchester creek this is the only obstruction to high speed.

The four tracks for electric trains are to be on the north side of the right-of-way, and the station buildings wherever possible will be placed on that side. At some of the stations, however, where the street approaches are from the south, the buildings will be placed on that side and the platforms will be connected with subways under the tracks. The construction will be chiefly third-class masonry retaining walls in the cuts and fills with solid-floor steel bridges over all the highways. The engineer's estimate of the cost of construction of the new line, exclusive of the electrical equipment, is $4,825,900. Mr. B. F. Simmons, Assistant Chief Engineer of the Electric Department, estimates the cost of the electrical equipment to be $2,876,000, distributed as follows:

| | |
|---|---|
| Seventy cars equipped with electricity, complete | $750,000 |
| Four third-rails with top protections and bonding surface rails with necessary marine cable at drawbridges | 415,000 |
| Feed wire, high-tension wires and pole line, complete | 336,000 |
| Two sub-stations (with electrical apparatus) | 280,000 |
| Power house, with all material | 920,000 |
| Car barn | 100,000 |
| Sundries | 75,000 |
| Total | $2,876,000 |

The cars which will be used are to be very similar to those in use by the Interborough, and most of the details of the third-rail and transmission lines will be in accordance with the company's standard practice on its other lines through Connecticut and Massachusetts, which are now operated by electricity.

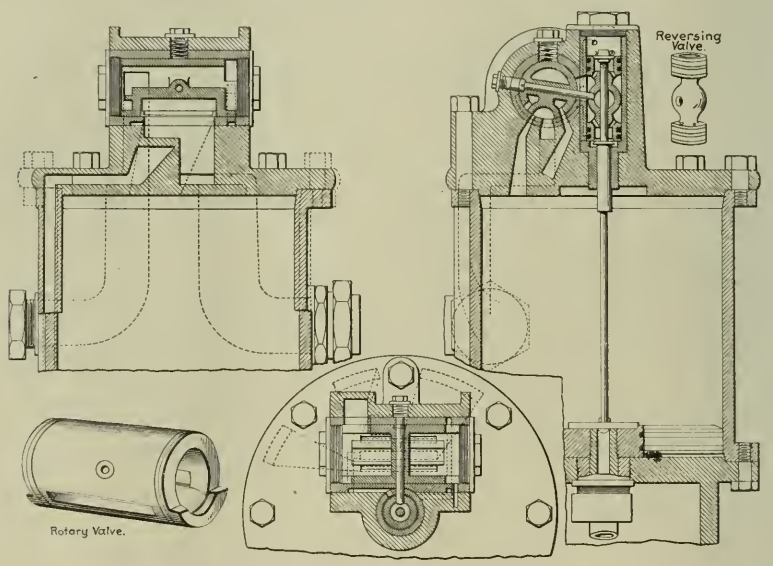
In addition to this proposed change, the New Haven road is considering building a branch line from West Farms on the Harlem River & Port Chester, north along the Bronx river to Woodlawn, the western terminus of the main line, a distance of about 3½ miles. This would serve Woodlawn, Mount Vernon and Pelham and give these towns both the main line steam service and the electric service. The Interborough subway line will probably be ultimately extended up through the Bronx to West Farms, so that there is the possibility of through electric train service from New Rochelle to City Hall and the Battery.

The funds for these improvements will be furnished by an issue of $15,000,000 in bonds which has been authorized by the directors of the railroad company. The surplus from the sale of these bonds over the cost of constructing and equipping the new line will be used to repay the money advanced from time to time by the New Haven road to the Harlem River & Port Chester, which road is held under a 99 year lease. The current press statement that the New Haven road has never had any funded debt is, of course, incorrect. The general balance sheet of June 30, 1903, shows $4,364,000 of bonds outstanding, secured by mortgage.

The work is to be begun as soon as the formal approval of the city and State authorities is obtained, and the line will probably be ready for operation in a year and a half. It is the intention to run both local and express trains between the Harlem river and New Rochelle at 15 minute intervals.

## A Rotary Steam Valve for Air-Brake Pumps.

A rotary valve for steam engines has been patented by Messrs. John C. Lyons and Daniel H. Brown, of McComb, Miss. The accompanying engravings show the valve applied to a 9½-in. air pump, the change required in the regular pump being the application of a new head. The perspective view of the valve shows it to be a cylindrical shell with two ports in the lower half, a lip on the lower side of each end and packing rings near each end. At the bottom between the steam ports the valve is recessed, as shown in the sectional views. The valve bushing has an opening on top for the steam supply similar to the Westinghouse pump except that it is near the end, outside of the valve packing ring. The bushing has a cap screwed into each end. Steam enters the interior of the valve and is admitted to, and exhausted from, the cylinder by the oscillation of the valve. This oscillation is accomplished by means of a pin passing through the center of the valve, one end of which engages a recess in the reversing valve.




A Rotary Steam Valve for Air-Brake Pumps.

The reversing valve, a perspective view of which is shown, is the piston type with a spherical central part. It is drilled lengthwise for the reversing rod and is also counterbored at each end. Mounted on the reversing rod at each end of the reversing valve is a valve which seats on the outer edge, and forms a closed chamber, of the counterbored recess. The distance between these two valves is slightly greater than the distance between their seats, so that when one chamber is closed the other is open, and in communication with the exhaust. Small holes lead from these chambers to the space around the central part of the reversing valve. This space is also in communication with the main exhaust through a port on the outside of the rotary valve bushing.

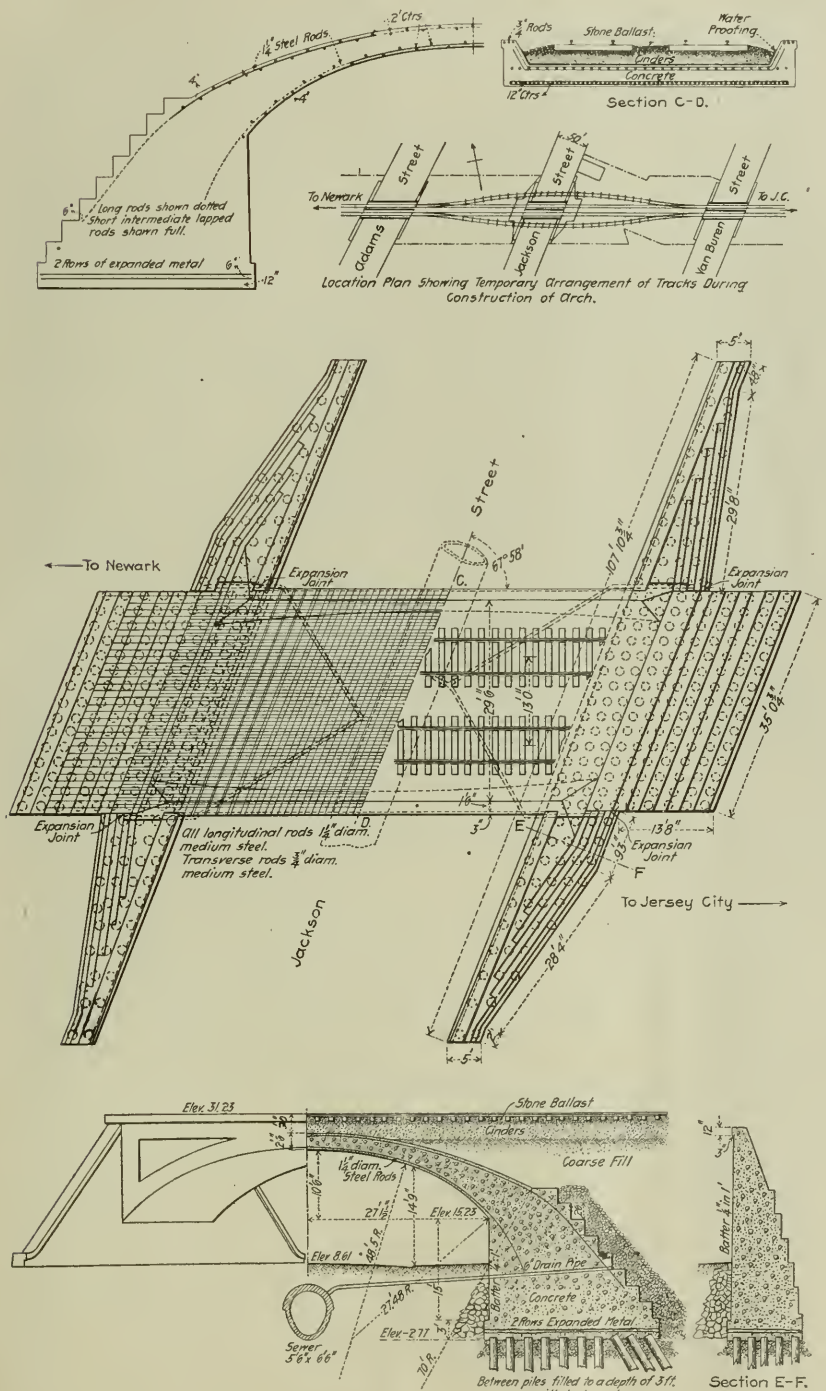
The drawings show the piston at the lower end of its stroke and the rotary valve in position to admit steam to the lower side of the piston. One lip on the rotary has closed a small port leading to the bottom of the reversing valve, while a companion port at the opposite end of the rotary is open to admit steam to the top of the reversing valve, holding it and the rod in the lower position. When the piston nears the upper end of its stroke it strikes the shoulder on the reversing rod, unseating the top valve and permitting the steam above the reversing valve to escape through the latter to the exhaust. As the piston continues its movement the reversing valve is also carried upward, moving the rotary valve by means of the pin. The lip on the opposite end has meanwhile cut off the steam from the top of the reversing valve, and steam has been admitted to the lower side of the reversing valve, holding the latter and the rod in their upper position until the piston in its downward stroke again causes reversal.

Should the rotary by chance stop on center, both steam ports would be closed, but the auxiliary ports to the ends of the reversing valve would both be open. The weight of the reversing rod would cause it to seat on top of the valve and upon steam being admitted to the main valve, its entrance above the reversing valve would force the latter downward, moving the rotary and closing the port leading to the lower side of the reversing valve. Leakage past the packing rings of the reversing valve would have no effect beyond wasting steam to the exhaust.

## A Double Track Concrete Steel Arch.

The 54-ft. concrete steel arch shown in the accompanying illustration was built to replace a 3-span plate girder composite wood and iron bridge over Jackson street, Newark, N. J., on the line of the Newark & New York branch of the Central Railroad of New Jersey. The arch is 32 ft. wide over the copings and is designed for an E-50 loading. The piers are built on a pile foundation. The piles are of yellow pine 10 in. in diameter at their smallest end, stripped of all bark and driven to a firm foundation. They are spaced 2 ft. 6¾ in. center to center. The three back rows of piles are batter piles and are driven in a line with the thrust of the arch. Portland cement was used throughout and the concrete was mixed in the following proportions for the different parts of the arch; for the arch ring from springing line to springing line, 1:2:4 concrete; for the abutments, 1:3:6 concrete; and for the wing and parapet walls a 1:3:5

mixture was used. The cement mortar was composed of one part cement and three parts of sand. The specifications required that the stone used in the arch ring must not exceed 1½ in. in any direction. The longitudinal reinforcing bars are 1¼ in. in diameter and are placed in the arch about 4 in. from the surface and are carried well down into the haunches of the arch. The transverse rods are ¾ in. in diameter and are spaced 2 ft. between centers. They are interwoven with the longitudinal rods. The concrete was laid quite wet around these rods so as to procure a good bond with them. Two rows of expanded metal reinforcement was laid in the abutments close to the top of the piles. The exterior of the arch is finished with a waterproofing consisting of three coats of Cerion paint and over this is laid a ½ in. layer of pure asphalt. A covering of clean sharp sand and fine gravel was spread over the heated asphalt before the filling was put in place. The drain from the fill over the haunches of the arch is led off through drain pipes which project through the wing walls and connect with the main street sewer as shown. While the erection of the arch was in progress, the tracks were conveyed over Jackson street on a temporary trestle placed on each side of the arch, as shown in the plan. Thus the work was carried on without interfering with traffic. The contractors for this work were Holmes & Cogan, Jersey City, N. J. Joseph O. Osgood, Chief Engineer of the railroad, designed the arch and we are indebted to him for the drawings.




A Double Track Concrete Steel Arch, Central Railroad of New Jersey.

## Analysis of Passenger Train Earnings.

The fundamental idea of all railroad statistical groupings is to place cause against effect or in the case of business, expenses against earnings and absolutely identify one against the other. Because the effects are mixed in with a great many other effects in other places, it is exceedingly difficult to do this, especially in connection with passenger service which includes many elements of advertising and in many ways tends to serve the freight department. But it is always desirable to know the amount of money we are spending for advertising, whether it be to the newspapers or whether it be a loss in running a passenger train, and carry it either in our statistics or in our thought against the revenue which it is a cause of producing.

The indirect effect of train service, perhaps, may fall under two heads:

(1) The general advertisement for carrying competitive business.

(2) The passenger service necessary to support and exploit a territory for account of the freight business which it will offer.

Remember that our business is to identify outgo against the intake which enjoys the benefit of it and that the only reason for outgo is the intake or the prospect of intake and the fundamental classification is into the groupings on the revenue side; therefore we want to break our revenue into these groups of demand which are more or less separable and independent from one another. In the case of a freight ton mile one freight ton mile is the same as another in the service of a particular point provided they are no more than 24 or 36 hours apart, let us say; but in case of a passenger train mile the service must have a schedule and we deal not only with the passenger train mile itself, but with the modified condition of the frequency of the service rendered. The other feature of demand which the passenger train serves is the movement from place to place; that is, a passenger train mile on one division is of no use for meeting the demands for a passenger train mile on another division. In a general way, we may say that a passenger train mile made one way requires an equal passenger train milé in return, although there may not be passenger miles in that direction to fill the train. A passenger train mile in addition to being a service between specific points on any one division and at a certain rate of frequency per day is modified by a further consideration that it must have relation to connections reaching to destinations off the given division.

The passenger train mile in addition to meeting the demands of passenger transportation supplies the demand for mail, express and milk transportation in various combinations. Still keeping in mind that the principle of our classification is to offset intake with its expense, we either should assemble all of the earnings against the passenger train mile expense that produced them or arrive at some basis of apportioning the passenger train mile expense under the classes of earnings which it serves. The latter proposition is most intricate and the principle upon which it could be done is so far unknown.

If the foregoing reasoning is correct in the application of these principles, the following rules would provide for a natural classification of passenger train earnings that would give the traffic man and the operating man logical totals with which to deal.

(1) Determine from the general knowledge of all traffic what are conceived to be general groupings that will fairly describe

the frequency and quality of service rendered, to cover all the varieties from the most elaborate to the crudest of the branch lines. One of these would be the minimum local service, another one would be the minimum local service with the minimum through service, possibly another one might be the special service run for a special connection or a shopping train to a particular town. So the traffic man as he knows the general field of demand would break it up into a few logical groups that were detachable one from another.

(2) Group all minimum service trains, regardless of direction or division, together and set against them their entire earnings.

Inasmuch as a train mile may be a differing thing according to speed and class of cars and number of cars in trains it would be best to substitute for the train mile an arbitrary estimate of the expense per mile, computed for each of the various runs. In doing this we would simply carry out the idea of the train mile, which if we look at it closely, is merely an index to expenses and if we find that it is inaccurate as an index we substitute the expense itself by an arbitrary estimate which is a little more accurate.

(3) Through service regardless of direction shown by divisions.

(4) Special services.

Passenger train earnings analyzed by the above groupings, would enable the traffic man to know where he was spending the money and where he was getting it back. It would further enable him to locate those places where he was spending money where he would have to look into some other department for the earnings and the amount of such money that he would expect such other departments to produce to offset this expense in the earnings. The whole field could then be kept in mind, not by indefinite impressions but by close analysis of the factors which controlled it.—*Wall Street Journal.*

## New Train Rules on the Delaware & Hudson

General Superintendent A. J. Stone, of the Delaware & Hudson Company, has issued a new Book of Rules for the operating department, and it went into effect on August 1. That portion of it which corresponds to the Standard Code of the American Railway Association appears to have been made up with exceptional discretion; and it goes without saying that the work has been done with minute care. As evidence that the world is moving it may be noted that two words which are found probably in every other rule book in America are here conspicuous by their absence—"brakeman" and "operator." In the place of brakeman and flagman the word trainman is used, and where the reader expects to find "operator" he finds "telegrapher."

The rules of the D. & H. were revised only five years ago and were then made to conform in most respects to the Standard Code, but the present issue is a marked improvement over that one, a noticeable change being the adoption of numbers for the rules which correspond to the Standard; in the former code the numbers did not correspond.

The "form of order putting rules in effect" is printed on the title page. Next comes an index, with the topics arranged alphabetically, in place of the more common "list of contents" arranged in the order of pages. The general rules A, B, C, etc., number 26, as compared with 12 in the Standard, and this chapter is greatly amplified from the former D. & H. code. The subjects of some of these rules are:

M: Employees must pay their debts; N: Assignment of wages forbidden; Q: Economy, order and cleanliness, etc.; S: Minors must not be employed in train, yard or engine service without the written consent of parents or guardians; U: No person whose sense of hearing, sight or color perception is defective will be employed in any branch of the service where signals are used; V: Caution against taking care in coupling cars; W: Similar caution as to machinery and tools, etc.; Y: Pay rolls.

Among the definitions are one of "meeting point" and one of passing point. A passing point is a place shown on the timetable where trains moving in the same direction pass, by schedule or by train orders. (The question which train passes the other is left for the reader to figure out.)

Rule 2 requires the watch certificate to be renewed and filed with the superintendent Feb. 1 and Aug. 1. Rule 3 is followed by 3a and 3b, which are rules for station clocks not standard; and 3c, which requires conductors before leaving terminals to compare time with enginemen and trainmen, and requires enginemen to compare with firemen. For Rule 4 the D. & H. takes the second form given in the Standard. Rule 5a says: Meeting or passing points at the ends of double track, at junctions, and at terminal stations will be shown in schedules when the difference in the times of trains is five minutes or less.

Rule 10b shows green for proceed, the same as the former D. & H. code; but Rule 10c prescribes yellow where the old code had red and green.

Rule 17a reads: When there are more trains at a meeting point than the siding will hold, the head-light of the leading engine must not be concealed.

Rule 26 formerly prescribed a red and blue flag, but now it conforms to the Standard, requiring blue only. Rule 33a prescribes the use of white signals for keeping people off the track at crossings. Rule 33c prescribes a yellow flag or light as a slow sign, where the track is not perfect; it indicates a speed of six miles an hour unless another rate has been announced by bulletin. Rule 88a authorizes an extra moving in the superior direction to hold the main track; 88b applies Rule 99 to cases where a train backs out or pulls out; and Rule 88c requires a train crossing to the other track to apply Rule 99 in both directions on that track.

Rule 90a reads: When trains meet by special order, or time-table regulations, conductors and enginemen must inform each other what train they are.

Rule 90b requires the conductor to give a stop signal on approaching a meeting point, the same to be given immediately after the station whistle is sounded. On passenger trains signal 16d will be used.

The time interval in Rule 91 is five minutes. Rule 93 is amplified considerably. It provides, among other things, that on double track a regular train may pass and run ahead of a train of the same class or its sections; an extra may pass and run ahead of another extra or a second-class train, etc. Rule 104a reads: "Any employee intending to open or close a switch after a train has passed over it, must stand on the opposite side of the track from the switch-stand until the train has passed."

Rule 211a forbids the use of a "19" order to move opposing trains; rule 211b requires conductors to show train orders to their trainmen, and requires enginemen to show them to their firemen.

The train order forms given are A, B, C, D, E, F, G; H for single track and H for double track; J, K, L, M, P, R and S. Thus ends the standard portion of the code.

The rules describing the duties of the principal classes of employees begin with No. 500 and fill 90 pages. They are somewhat fuller and more detailed than the similar rules of the Pennsylvania, but still are rather brief. Electric self-winding synchronizing clocks are the only kind designated as standard clocks. Enginemen must take the utmost pains to sound the whistle signals accurately, and must report to the superintendent any improper rendering of hand or lamp signals by other employees.

Among the rules for station agents are the following:

565. They are in charge of the company's interests at their respective stations, of its buildings, sidings and grounds within the station limits, of the station appliances and equipment, of its accounts and records, of the material and supplies furnished for its work, of all cars at the station except in trains, of the receipt, care, forwarding and delivery of baggage and freight, of the sale of tickets, collection of the station revenues, remittance or deposit of money received for the company, of such disbursements thereof as may be properly authorized, of all station employees, and other employees while at the station, so far as relates to their conduct or to the station work. They will also have charge of such other matters as may arise in connection with the station management or may be assigned to them by proper authority. The company's business affairs must not be divulged except to the proper officers of the company.

569. They must familiarize themselves with the boundaries of the company's property at their stations, and not permit any encroachment thereof. Unless provided for by lease, they must not allow any commodities to be placed on grounds of right of way at their stations for the purpose of storage without written permission from the Superintendent, and then only after release on prescribed form has been executed by the owner.

570. Agents must acquaint themselves with the business and interests of people among whom they are situated, use all proper means to secure traffic, and act with a view of accommodating the public and promoting the best interests of the company, notifying the proper officers of anything affecting the departments, detrimental thereto, or conducive to its good, present or future.

571. They must prescribe proper hours of duty for their subordinates, and see that the time so defined is faithfully devoted to the business of the company.

Train employees must contribute "as far as they can without being unduly officious," to the convenience and comfort of passengers, particularly women and children, the infirm, inexperienced, etc. They must see that the ventilation of cars receives "intelligent" attention. Passenger trainmen, when not performing other duties, must station themselves at the end of the car where the air-brake attachment is located, so as to be able to apply the brakes in case of emergency. A trainman must never flag a train at night with a red and a white light in the same hand. In the daytime they must spread the flag so that it can be seen, and should wave it so that the engineman may be able to distinguish it from other objects of the same color. A frequent injunction in the rules for freight conductors, as well as for other classes of employees, is to "notify the superintendent by telegraph." If these rules are faithfully carried out in each case the D. & H. wires will be kept pretty "hot" most of the time.

Following the rules for classes of employees are extracts from the postal regulations prescribing what is to be done in dealing with mail bags and explaining under what circumstances a post office inspector has authority to interfere with the handling of the mails.

Special order books and bulletin boards are maintained at all principal points, and the rules prescribe how these are to be used. Four pages are given up to lists of tools required on engines, cabooses, etc.; and there are three rules on the care of lamps.

## WAGES OF SUBWAY MOTORMEN.

Announcement is made, at the time we go to press, that the threatened strike of employees on the elevated roads in New York has been averted by a concession on the part of the Interborough Company of practically all that was asked. The company had a full force of strike breakers on hand, under the leadership of James Farley, and the police reserves were all kept on duty; as one of the daily papers expressed it, the management held all the trump cards, yet it did not play them.

The situation, in brief, is that the Brotherhood of Locomotive Engineers demanded that the motormen on the Interborough Rapid Transit Subway receive $3.50 for a day of nine hours, when the subway is opened, instead of $3 for a day of 10 hours, as offered by the management. By the terms of the concession, the day will be 10 hours, but $3.50 will be paid. It will be recollected that the payment of $3.50 a day to the motormen on the elevated road was fixed as an act of special courtesy, out of consideration for the old employees, at the time that the change in motive power from steam to electricity was made. The former engineers were kept in employment and were paid a steam engineer's pay, although the service which they performed could have been duplicated by the company at a considerably lower figure. The work of a motorman is so much simpler than the work of a locomotive engineer that the prevailing wage scale is much lower; but the elevated road desired to retain its employees, partly in recognition of their long service and partly, no doubt, because they were a thoroughly steady and reliable set of men. Running trains on the elevated road, with the throngs of passengers that are carried during the rush hours and the short headway of trains is responsible work, although the moderate speed compared with that on ordinary railroads, and the constant inspection of the short lines, together with the entire freedom from danger resulting from washouts, freight wrecks or grade crossings, greatly reduces the element of risk.

Responsibility usually commands its own wage, as well as skill, and that is the chief reason which General Manager Bryan gives for the attitude of the company. He is quoted as saying:

> If accidents had occurred to the subway trains the cry might have been raised against the company that we were employing cheap men. That is one reason that consent to the $3.50 rate was given. Then again, it was arranged that the agreement should be binding for three years. That insures the company against labor troubles in the operation of the subway trains for that time at least.

Just how much should be paid for responsibility is hard to determine, and, like most similar questions, is best answered by a trial to determine what genuine efficiency can be bought for. If subway motormen can be hired for $3.50 who are so much superior in character, in steadiness and in intelligence to the men who can be hired for $3 that the safety of the traveling public is actively increased thereby, the higher price is none too much to pay for this efficiency; but if, as seems highly probable, the Interborough management could have secured men entirely qualified for the work at $3, the citizens of New York will have nothing to gain from the payment of the higher price, and the Interborough Company will have much to lose.

The Brotherhood of Locomotive Engineers has an admirable reputation as an intelligent and conservative body, and it has been marked for many years by the absence of the hoodlum element which clamorously determines the policy of so many unions against better counsel. In view of this, the threat of a strike by the elevated motormen, who have been receiving far higher pay than that given to any other motormen in the world as a recompense for reliability and loyal service, and who surely have no grievance, was evidently a test case to determine a principle.

With the recent great developments in the use of electricity, and the certainty that in a few years' time motormen, and not locomotive engineers, will handle most of the short haul traffic around New York and elsewhere, the Brotherhood of Locomotive Engineers naturally wished to stand firm on the principle that responsibility, as much as skill, should form the basis of the motorman's pay. However true this may be in theory, we feel strongly that the question will ultimately be settled purely on economic grounds, and that the ultimate rate of wages will be neither less nor materially greater than the amount which will serve to get and keep the services of thoroughly qualified men. For the present, the rather weak-kneed action of the Interborough Company, hampered, perhaps, by political affiliations, has really settled nothing, except that the subway must be worked for the next three years on a needlessly high wage scale.

## STANDARD SPECIFICATIONS FOR TESTING MATERIALS.

The first step towards the adoption of international standard specifications is the use of standard test pieces, in order that the results may be comparable. The tension test pieces proposed by the Engineering Standard Committee of England will no doubt come into general use, as they seem to be a practical solution of this troublesome problem. It is to be hoped that a series of tests will be made here on universal plates, shapes and eye-bar flats, using test pieces of 1½ in., 2 in. and 2½ in. in width for different thicknesses of material, in order to bring out the effect of varying widths on the percentage of elongation, when tests are made under the conditions in use in this country. One set of tests should be made with the slowest pulling speed in use, and another with the fastest speed of the testing machines in ordinary practice. This no doubt would repeat to a certain extent, the recent tests made by Prof. Unwin, but it would give some very valuable information. It might show that it would be desirable to embody in the specifications a clause to regulate the pulling speed, in order to keep all the conditions under which tests are made a little more uniform than they are at this time.

The next step, of course, is to decide on the best form of test piece for the thick eye-bar flats, say 1¾ in. and over in thickness, in order that results may be nearer those of the full size tension tests of the finished eye-bars. Other things being equal, the larger the test piece the more reliable the results; but if square test pieces equal to the thickness of bar are used, the ordinary testing machines are not large enough to pull them. The thin slice cut from the bar with the width equal to the thickness of the bar does not give satisfactory results, but it is often used. Recourse is had to the round test piece for these heavy bars, and the results of these tests are not all that could be desired. This heavy material gives more trouble than any other, and it seems as though this would be a good time to take up and thoroughly investigate the forms of test pieces best suited to give the most reliable results. In England, of course, they were not bothered with this, as they do not use upset eye-bars, while in this country it is a matter of vital importance, as the size of eye-bars increases every year.

Standard test pieces for bending have been considered by some of the committees at work on specifications, and they have generally decided on the following: "Full sized material for eye-bars and other material one inch thick and over, tested as rolled, shall bend cold 180 degrees around a pin the diameter of which is equal to twice the thickness of the bar without fracture on outside of bend." This bending test is considered by many engineers to be a much better check on brittle steel than the ordinary tension tests.

In all the present specifications allowances are made in the percentage of elongation and the requirements in the bending tests for the heavy material. They are not as severe as for steel of medium thickness, and it is an open question if engineers have not gone too far in these allowances. In other words, if much better heavy material cannot be rolled than that supplied in ordinary every day practice under the present specifications. This applies to rails as well as to any other heavy rolled material, and it opens up one of the most important questions to both the engineer and the manufacturer. It is a matter that depends largely on the amount of work in rolling put on the steel at a low heat, and the low finishing temperature in rolling. If this could be done without any additional cost, it would be a very simple matter to settle; but as it involves cutting down the daily tonnage with a corresponding increase of cost, the question comes up as to who is to pay for this. Some specifications are in use that cover this important matter of finishing temperature directly, and others cover it by increasing the requirements of the physical tests, which in turn require a much lower finishing temperature. As the importance of this becomes more generally understood these tests will come into more general use, which will result in better steel for the consumer at perhaps a slight increase in cost.

As long as train orders on which depend life and death are to be habitually written on thin paper, with lead pencils, and are to be read by the light of dim lanterns, in all kinds of weather, the duty of taking the utmost pains with the penmanship and the form of words and all other details is obvious; but agreement on just what ought to be done in particular cases is often difficult. Concerning a subject mentioned in these col-

umns recently (August 5, page 207,) a correspondent in Georgia writes:

As, according to the accident bulletins, train orders containing references to the second section of a train are peculiarly liable to be misread, the following suggestion is offered: Let all regular trains be numbered from 1 to 100. If it be desired to run a second section, of freight train No. 90, instead of designating it in train orders as "Second (2d) 90," let it be identified as 290; if a third section, 390, etc., indefinitely. Limited express No. 3 should be followed by train No. 303, 403, etc. Such a method of numbering gives a train more individuality than to bury it under such a designation as "Second (2d)," particularly when such a designation so often results in the necessity for the burial of part of the passengers and crew.

Makers of time-tables would object to any scheme limiting their train numbers to 100. On many time-tables Numbers 290, 303, etc., are already in use for regular schedules. But we should be inclined to reject our correspondent's suggestion for another reason; the reason that as a rule railroad officers will refuse to accept innovations in rules unless they are very marked improvements. Probably this attitude on their part is, on the whole, a good thing, as even a meritorious change, if adopted by only a part of the railroads, helps to break down the uniformity which the railroads have been laboring for these many years to secure. The suggestion of Mr. Forman in our issue of August 19, page 252, that the word "section" be inserted in orders, seems to us a sensible remedy for the danger referred to; but we print the communication quoted above in order to take occasion to say that the real trouble undoubtedly is, as Mr. Forman points out, the neglect of the simple precaution of checking one person's reading by another's. There does not appear to be much evidence that the rule requiring firemen and brakemen to read orders has ever done an appreciable amount of good. If collisions due to forgetfulness are any less frequent than they were ten years ago nobody seems able to demonstrate the fact. A conductor or engineman who, by reading orders to a third party, is saved from committing a costly blunder, is quite unlikely to tell of the circumstance. But the checking of each other's reading by the two principals, the conductor and the enginemen, was never as a rule enforced as it ought to be. To try to make reading by subordinates take the place of more careful reading by the principals, was, probably, misdirected effort. In many cases the brakeman or fireman would be of doubtful competency as a corrector of his superior's errors. Having orders read by four or more men is following the rule not to put all your eggs in one basket. Quite likely it would be profitable to give attention to the other man's rule—Put your eggs all in one basket, and *watch that basket.* While the use of the word "section" may cure one class of errors, there will still remain to be cured other difficulties in reading.

The increasingly frequent collisions of street cars and locomotives at crossings are giving our numerous foreign visitors a striking illustration of American energy, and the most recent one, at St. Louis, last Saturday, killing six passengers and injuring 19 of the remaining 22, was almost within sight of the World's Fair grounds, where we exhibit other American inventions. This case appears to have been accompanied by all the reprehensible or unfortunate circumstances that could be crowded together. The car conductor was experienced, but his practice has long been loose. He stopped his car and ran ahead, but apparently depended on one of the two crossing watchmen instead of his own eyes, for the locomotive was within a few hundred feet. There were gates on one side of the railroad, but these had been out of use several months. The second watchman seems to have been intended as a substitute for the gates, but the two together apparently were not equal to one good one. The habitually moderate speed of the steam engine appears to have tempted both the watchmen and the street car men to take risks. The locomotive enginemen declare that the trolley car stopped before the engine struck it. We have rehearsed these bits of evidence from the coroner's hearing, not because they explain the collision, for they are confusing and do not explain, but to emphasize once more that with grade crossings there is no safety but in complete interlocking. A carriage is measurably safe on a crossing, and its safety is partly due to the ease with which its occupants can jump out in an emergency. The horse cars were somewhat like a carriage in this respect, but with the modern large and heavy electric car we have gone beyond the limit. The duty of requiring interlocking, however, rests primarily on municipal authorities, and they usually lack the necessary courage and intelligence. The steam railroad naturally objects to having its business unfairly interfered with, and this seems to encourage city officials to take counsel of their timidity. The result is that a hundred pressing problems like that at St. Louis remain indefinitely under a cloud of neglect and uncertainty. The only certain thing about them is that fatalities will not only continue, but will increase if the right remedy is not applied.

## Proposed High-Speed Electric Line Between Berlin and Hamburg.

The two great German electrical companies which provided equipment for the high speeds attained on the Berlin & Zossen Military Railroad (the General Electric and Siemens & Halske), have presented plans for a high-speed electric line to be built and operated between Berlin and Hamburg. Berlin in 1900 had 1,888,000 inhabitants, Hamburg 706,000, and both are growing rapidly. The length of the existing railroad between them is 177 miles, the air-line distance about 155 miles. The intervening country is flat and sandy, and there is no considerable city in it. There are now 10 trains each way daily between the two places, the fastest of which covers the distance in 3 hours and 27 minutes, and there are four trains which run to Hamburg in less than four hours. The number of through passengers daily now averages about 1,150, and it has of late increased about 10 per cent. yearly. About three-fifths of these passengers take third-class tickets, which cost $3.24 one way, but only at the rate of $4.25 for the round trip; and as return tickets are good for 45 days, few but emigrants take single tickets. The second-class tickets cost one-half more; the first-class, twice as much. For a seat in what is equivalent to our parlor car there is a further charge of 24 and 48 cents for the two classes admitted. Altogether the gross receipts from the through travel for the three classes is about $3,420 per day, an average of a little less than $3 per passenger. The economic problem to solve by a high-speed railroad is to win such an amount of travel at practicable rates to pay interest on its cost, plus the profit now made on the existing railroad, allowance being made for the growth of travel and the avoidance of the capital expenditures which such growth may require on the existing railroad.

Siemens & Halske submit a design for a single-track line, everywhere separate from the steam railroads, except at the two terminal cities, by which great cost will be avoided. There would be but one intermediate station, where up and down trains would pass. The speed contemplated is not the highest attained and believed to be safe, but 160 kilometers (very nearly 100 miles) per hour, so that the journey would be made in 1 hour 55 minutes, if the crowded tracks at the termini do not cause delays. Owing to the single passing-point half-way, the number of trains would be limited to one every two hours, and there would be normally but one train at a time on a block about 85 miles long.

The other company's plan contemplates the double-track line with its own entrances and stations at the two termini, with no intermediate station, and a train despatched every half hour. The track would be of the present heavy Prussian pattern, 82-lb. rails on wooden ties in good broken stone ballast. The standard gage is adopted because of the necessity of transferring cars, but otherwise a wider gage would be preferred. The trailing cars should be of the Prussian modern through pattern on trucks, but six-wheeled trucks should be required.

As a matter of course, with trains running at such speeds, freight and ordinary passenger trains would be an element of danger and delay, as would be frequent switches, etc.

The rock on which these projects are likely to split is the economic one. The expenses can only be estimated from those of existing electric railroads at much lower speeds. The projectors estimate a cost of $16,600,000 for the single-track and about $29,000,000 for the double-track road, the latter to be increased by about $3,500,000 to fit it for a speed of 124 miles an hour. To pay expenses and interest of about 4 per cent. it is proposed to charge 16 marks per passage (only one class), or $3.81. As by far the larger number of passengers now pay but $2.13, it is not believed possible that they would give $1.68 more to save 1½ to 1¾ hours. The high-class travel between the two cities at present is too small to support such a line.

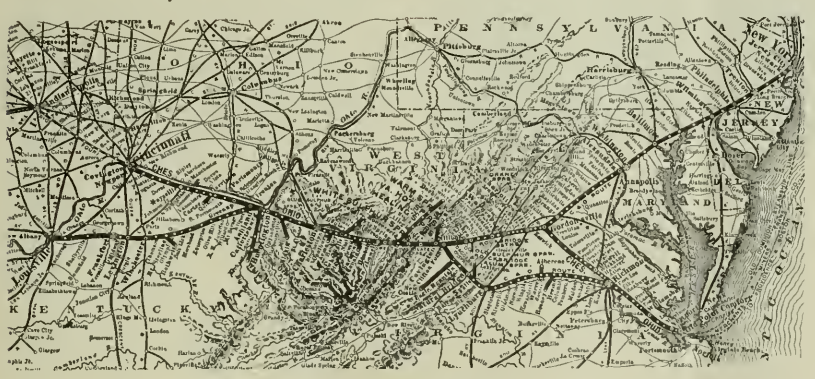
It would seem that the most favorable place in the world for speeds of this kind is between New York and Philadelphia, whose populations about double that of Berlin and Hamburg. But so long as the present river ferry is required at New York, high speed on the road is of less importance—at least it cannot make a really quick passage from house or place of business in one city to the other. With the tunnel completed it will be another story; but we should hardly expect 100 mile speeds inside of that structure.

The safeguarding of crossings of trolley and steam roads was discussed in these columns a year ago, after the Newark, N. J., crossing collision. That accident, it will be recalled, was caused by a trolley car sliding down a sharp grade and meeting a passing railroad train, with resultant loss of a number of lives. As asserted at that time, there is only one way to eliminate this class of accidents. Derailing switches and other protective agencies will lessen the chances for their occurrence, but the one sure safeguard is the separation of the grades. An accident somewhat similar to the one at Newark lately occurred in Chicago. A crowded "race-track special" on a trolley line, consisting of a motor car and two trailers, ran on a crossing ahead of a fast-moving railroad

train. Several passengers were killed and others were seriously injured. Impelled by this and similar accidents, of which there have been a number in the State lately, the Illinois Railroad & Warehouse Commission has cited officers of a large number of steam roads and traction lines to appear before it and show why all unprotected intersections of such roads should not be provided with interlocking devices. In addition to crossings in the State generally, particular attention will be given to protecting crossings of trolley and steam roads in Chicago. What means of protection for these city crossings the Commission will demand may have developed at the hearing, which was held this week, since this was written. The railroads within the limits of Chicago have, at the demand of the city, already done splendid work and have spent millions of dollars in elevating their tracks and eliminating street crossings, and therefore many trolley crossings. But this work is far from being completed and there are still many trolley crossings that are a constant menace to the safety of passengers. If the Commission succeeds in lessening the chance of accident at these until such time as they are all eliminated by elevation of the railroad tracks, it will have done commendable work. If, in addition, it succeeds in getting interlocked a considerable part of the 77 per cent. of grade crossings in towns and rural communities which its last report recorded as unprotected, it will deserve the gratitude not only of the State, but of the entire country, for the example set.

## Chesapeake & Ohio.

The year ending June 30, 1904, was a prosperous one with large increases in gross freight earnings, due principally to the bituminous coal traffic, and also considerable increases in net; and the extension and second track work was carried on vigorously. These




Chesapeake & Ohio.

extensions, in connection with the general betterment of the lines to qualify them to handle the heaviest class of traffic economically, are all being made with a view to further development of the coal traffic which has so continually increased in importance. It will be remembered that the Chesapeake & Ohio was originally a grain road, while at the present time products of agriculture only contribute about 6½ per cent. as their share of the local traffic, while coal contributes about 62½ per cent. The increase in bituminous coal traffic from 3,903,269 tons in 1903 to 6,095,025 tons in 1904 is, of course, chiefly to be attributed to the fact, noted last year, that the 1903 report followed so close after the coal strike in the West Virginia territory that the full movement had not been restored.

Gross earnings for 1904 were $19,297,525, as against $16,711,602 last year. As comparing with this increase of $2,585,923, operating expenses increased but $1,730,467, leaving total net earnings of $6,514,335, as against $5,658,879 last year. These gains are on a mileage of 1,082, an increase of 144 miles, chiefly in branches in Virginia and West Virginia, over last year. Including lines operated through stock ownership and lease and trackage worked, the average total mileage of the year was 1,657, which is practically the same as last year's total mileage, owing to the fact that the increase in lines owned is chiefly balanced off by decreases in lines leased and operated through stock ownership. The following table, comparing operations in 1894 and in 1904, shows how greatly the business of the company has been developed during the last decade. It is worthy of note that the increase in gross for the current year, following on the strike year, is considerably greater than the increase of any other year in the decade.

| | 1904. | 1894. |
|---|---|---|
| Freight earnings | $14,869,188 | $6,630,201 |
| Passenger earnings | 3,648,233 | 2,011,977 |
| Total earnings | 19,297,525 | 9,044,108 |
| Maintenance of way | 2,307,620 | 1,183,564 |
| Maintenance of equipment | 3,659,382 | 1,203,835 |
| Cond. transportation | 6,420,666 | 3,123,821 |
| Total expenses | 12,783,190 | 5,724,975 |
| Net earnings | 6,514,335 | 3,319,133 |

The number of revenue freight cars in service, their tonnage capacity and the average capacity per car, is tabulated for a series of years beginning with 1890. At that time the average capacity of the 9,572 cars in service was 22.4 tons. It increased to 25.1 tons in 1904 and then remained nearly the same for several years; but the substantial increases began again in 1898, when 14,154 cars were in service, with an average capacity of 26.2 tons. At present there are 24,000 cars in service and their average capacity is 35.6 tons, quite a remarkable increase in six years of elapsed time. The Chesapeake & Ohio has for a long time made use of equipment and car trust contracts quite freely, and the new equipment with its greater carrying capacity has been chiefly acquired in this way. On June 30, 1904, the aggregate amount due on these car trust and equipment contracts was $6,940,110.

Capital stock was increased during the past year to $62,799,400 by the issue of 22,605 shares of common stock issued in exchange for stock of the Maysville & Big Sandy railroad. The funded debt was increased to $78,674,354 by the sale of $3,239,000 general mortgage 4½ per cent. bonds and by the assumption of $2,000,000 Green Brier Railway 4s in the acquirement of that property. Of the general mortgage bonds $2,784,000 were applied for special construction and second track, and the balance used for purchase of additional Maysville & Big Sandy stock and for the retirement of Green Brier and New River 5 per cent. bonds at par.

The following table shows the principal results of operation:

| | 1904. | 1903. |
|---|---|---|
| Freight earnings | $14,869,188 | $12,510,006 |
| Passenger earnings | 3,648,233 | 3,474,905 |
| Gross earnings | 19,297,525 | 16,711,602 |
| Maintenance of way | 2,307,620 | 2,178,835 |
| Maintenance of equipment | 3,659,382 | 2,679,021 |
| Cond. transportation | 6,420,666 | 5,839,230 |
| Total expenses | 12,783,190 | 11,052,723 |
| Net earnings | 6,514,335 | 5,658,879 |
| Gross income | 6,683,607 | 5,849,253 |
| Interest on funded debt | 3,674,796 | 3,559,949 |
| Net income | 1,944,511 | *1,419,604 |

*For comparison, the principal of car trusts ($150,000) has been separated from the interest payments, which accounts for the differences between these figures and those contained in the report for 1903.

From this current net income of $1,944,511, payments aggregating $450,000 were made on account of principal of car trusts; $861,366 was appropriated for extraordinary expenditures for construction and new equipment, and $627,904 was paid in dividends.

## NEW PUBLICATIONS.

*Technology of Paint and Varnish.* By Alvah H. Sabin, Chemist for Edward Smith & Company, New York. 372 pages, 5½ x 9; illustrated. New York: John Wiley & Sons. London: Chapman & Hall Limited. Cloth, $3.

In this rather unique work the writer has sought to give a correct general outline of the entire subject of paints and varnishes, with a brief account of their modern use and of the principles involved in their manufacture and application. As the author says in his preface, many of the facts noted, though old, are practically unknown, and some of them exactly anticipate recently patented processes; their value to the public in that way is sufficient excuse for their republication. Starting with definitions, an outline early history of paint and varnish is narrated in a highly entertaining way, with free reference to the classics, as where a parallel translation of a formula for making varnish is given from Theophilus, together with the Latin. This is followed by a number of ancient formulas of considerable interest. Following the historical chapters is a thorough account of modern paint and varnish manufacture and application, which is technical and yet so written as to be at once intelligible and interesting to the layman.

*Iron and Steel Works Directory.* Compiled and published by the American Iron and Steel Association, 261 South Fourth street, Philadelphia, Pa. Sixteenth edition. Corrected to August 1, 1904. $10.

The American Iron & Steel Association has issued a thorough revision of its well-known directory to the iron and steel works of the United States, bringing it up to August 1, 1904. This directory is the largest the Association has ever published, containing 484 pages 5½ x 8 in. The directory, like its predecessors, is careful and complete, and the works are indexed alphabetically and are also classified by States and districts and by products. The directory covers the same useful field with reference to iron and steel works that Poor's Manual does with reference to railroads, and it is a compact and valuable reference book, containing within its covers information which would have otherwise to be sought out from many sources.

## TRADE CATALOGUES.

*Abner Doble Company*, San Francisco, Cal., issue as Bulletin No. 6 a thesis by H. C. Crowell and G. C. D. Lenth, of the Massachusetts Institute of Technology, entitled "An Investigation of the Doble Needle Regulating Nozzle." This nozzle is intended for

use under high heads of water for power purposes. The appearance of the stream issuing from the Doble nozzle, which was clear, transparent and polished, led to comparisons with streams issuing from various other nozzles, which had a feathery appearance. The conclusion was reached that the feathered appearance results from a difference in velocity in the particles of water, the velocity of the outer layer being decreased. The distribution of velocity in jets therefore formed a principal part of the thesis, the other and more important part of the work being a determination of the efficiency of the jets from the Doble nozzle. Data obtained from the experiments are exhibited in the form of curves and tables. There are also a number of engravings from photographs of different kinds of jets.

*S. F. Bowser & Company*, Fort Wayne, Ind., send several pamphlets devoted to their products. One of these is the Bowser self-measuring oil tank for merchants' and storehouse use. These tanks have an indicator showing stock on hand, an anti-drip nozzle, a discharge register registering each gallon pumped, and also a computer which will instantly and automatically show the money value of the oil withdrawn. The Bowser adjustable-measure oil cabinets, the subject of another pamphlet, are designed for the safe, economical and convenient storage of oil in factories, shops, power houses, mills, engine rooms, etc. They pump and measure the oil directly into the oil cans. Bowser gasoline outfits are claimed to provide a safe, convenient and economical method for handling gasoline for automobile stables, factories, shops, etc. An album of views of buildings and oil rooms equipped with Bowser oil tanks and cabinets contains a large number of half-tone engravings, and also shows views of ideal oil houses.

*The International Steam Pump Company*, New York City, are distributing a pamphlet descriptive of the pumping machinery at the St. Louis Exposition. Forty different types of these machines are shown, as well as air compressing and steam condensing apparatus, cooling towers, vacuum machines, water meters, etc. The processes in which these machines are employed on the Exposition grounds, such as timber preserving and refrigeration, are fully explained and diagrams and graphical charts are employed to illustrate the design and arrangement of apparatus. A view of the Grand Cascade is shown on the cover and the large Worthington turbine pumps by which the water is supplied are described in the text.

*The Crocker-Wheeler Company*, Ampere, N. J., sends a fac-simile of a photographic souvenir which was presented to each of the 45 members of the Associazione Elettrotecnica Italiana, who made a tour of inspection of the company's plant at Ampere. The souvenir is a photograph of a pretended page from the note book of one of the guests describing the visit.

*The Norton Grinding Company*, Worcester, Mass., is distributing its 1904 catalogue of plain cylindrical grinding machines. These machines are used for both straight and taper work. Illustrations and full detailed descriptions of the machines are given as well as illustrations of the work done and the method of doing the same.

*The Chicago Union Pacific and North-Western Line* issue a neat folder of California; it is profusely illustrated throughout with half-tones showing typical California views. An extensive list of hotels at the different California tourists resorts are also given, including the rates both per day and week.

*The Michigan Malleable Iron Company*, Detroit, Mich., is distributing a booklet descriptive of Detroit issued by the "Convention Bureau." It is illustrated throughout with a number of half-tones, which show the principal buildings, parks, places of historic interest, etc.

*The Draper Machine Tool Company*, Worcester, Mass., issue a pamphlet descriptive of its new design of lathes. Illustrations and descriptions of these tools ranging from 18 in. to 28 in. are given. All of the tools described are fitted with the quick-change feeding device.

*The Allis-Chalmers Company*, Chicago, issue a finely executed catalogue bearing the title "The Book of the Four Powers." It is illustrated throughout with notable installations of steam, gas, water and electric power that have been installed by the company.

*The Warner & Swasey Company*, Cleveland, Ohio, sends its 1904 general catalogue. This illustrates and describes hollow hexagon turret lathes and screw machines as well as turret lathes for brass work and other brass working machine tools.

*The Rust Boiler Company*, Pittsburg, Pa., issues a catalogue descriptive of the Rust water tube boiler. A full detailed description and illustrations of the boiler is given.

## CONTRIBUTIONS

### Difficulty of Getting Promoted.

Sept. 5, 1904.

To the Editor of the Railroad Gazette:

I have read with much interest the article in your issue of September 2 castigating the labor unions for the blighting effect that their rules have on the efficiency of the railroad service. Your strictures are well deserved, and everybody will agree with you as to the need of more common sense and independence among the leaders of the several brotherhoods. But the reader is, nevertheless, left with a painful sense of incompleteness; you have dealt with only half your subject. The ambitious and intelligent engineman or conductor ought, indeed, to break away from his overbearing chief, or his grievance-committee chairman, and put forth his best efforts to qualify himself to be a train-master. The only way that he can secure promotion is to hustle for himself. He has no right to expect the company to set up a training school and coddle him along into a more intelligent state of mind than he would naturally possess. And every conductor and engineer may have the satisfaction of knowing that such efforts would inure to his lasting benefit and be well worthy of the time and thought expended, even if he should never get the coveted promotion. Virtue is its own reward, and there is no good reason why an intelligent and educated conductor or engineman may not be as happy and contented as one who is narrow-minded.

But when it comes to the specific question of getting promoted; or of speaking with assurance to the trainman who aspires to promotion, what is the real situation? How much real comfort are you giving us? Is it not true that, on even terms, the conductor or the locomotive engineer can only rarely compete successfully with agents and operators and despatchers in the race to qualify for high positions? And is it not unavoidable, in the nature of the case, that this should be so? These stationary employees, if I may so call them, have a much better chance to learn by observation the thousand and one uncatalogued facts which are needed to make an all around railroad officer. A generation ago it was necessary to take conductors and enginemen for superintendents because, after all the competent agents and operators were taken, there still were places unfilled. The country was growing more rapidly than the ranks of its competent railroad men could be filled up. Now, the denser population of the eastern States and the easier communication with the old world have changed these conditions.

The fact is that the conductor and the engineman who fail of securing the promotions that they desire are kept back, the same as are other classes, by the growth of the country and the increased severity of competition. Whether we do or do not blame them for the fatuous course that they take in going to the labor union for a remedy, we must admit that the situation is one which must urgently impel these men to seek *some* remedy. They are rapidly "getting left" and naturally cast about to find in what direction lies the most hope. When one has a desperate problem to deal with, it is the part of wisdom to squarely recognize its desperateness. The conductor or engineman who wants a better place must not only do his work well but must hustle around and diversify his knowledge. The engineman who aspires to become an officer may perhaps have to go back a few years—if I may be allowed a Hibernicism—and leave his firemanship temporarily and take a job at a station. Very likely he will have to begin at the bottom again, and perhaps begin pretty near the bottom a third time when he returns to the locomotive department. If a conductor aspires to be a train master he must find some way to qualify himself to boss 50 or 500 men with as much skill as he manages five men. If, Mr. Editor, you are inclined, accuse me here of talking through my "hat," look at the records of the men whom you know who have "risen from the ranks" to important railroad positions. They have acquired experience in more than one department and they have done it at their own initiative and on their own time, and perhaps at considerable temporary money loss. Such a course is quite contrary to that of the loyal labor unionist, who continues in one rut and makes no advance except as hundreds of his brothers can be advanced with him; but is there any other or better way of accomplishing the object desired? And then, of course, conductors, station agents and all must submit to the inevitable technical graduate. The railroads get him, whether they like him or not, because they must have him.

But why do you give the unions the credit for causing all the changes that have taken place during the last ten or twenty years? The unions would not have broken down the discipline of the train service if superintendents had not weakly surrendered to them. A superintendent who swallows the cast-iron rules of the brotherhoods without putting up a strong fight against them is disloyal to his employer. It is his duty as a superintendent to give preference to his best men in spite of the seniority rule. Indeed, I think you will find that most seniority rules allow him to do this. They say that the senior man shall take the lead, other things being equal. It is up to the superintendents to show that other things are not equal. The brotherhoods and the partisans of bald seniority win too many contests by mere silence—silence made possible by the timidity

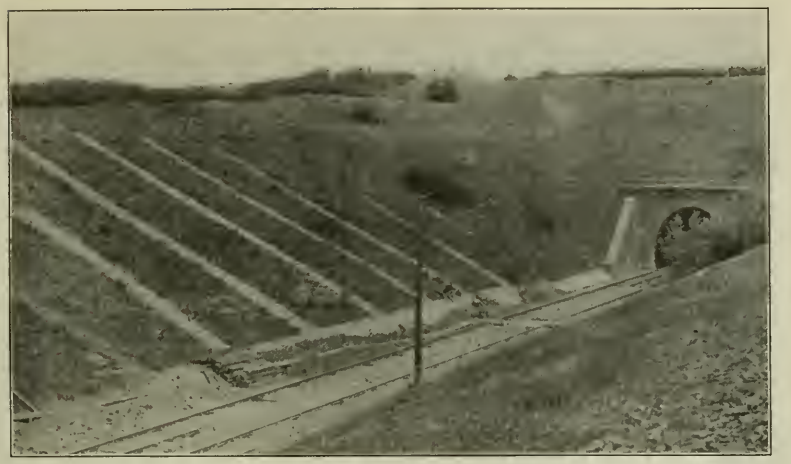


Fig. 1—Drained and Steadied Cutting at Gillingham Tunnel, London & Southwestern.

of the superintendent who does not dare to take a stand for the promotion of his best men. What brotherhood would dare to persistently oppose a strong and bold superintendent who should pick out his smart young men for promotion and in each case frankly give his reasons for the stand which he takes. The brotherhoods usually assert that the seniority rule is fair and just, and then wait for the railroad company to challenge their assertion; and the company, for some reason, does not challenge. If the men on the trains are ever to become sufficiently alert, versatile and broad minded to compete with station men who have a different experience, one in some respects better; or with the man from the schools, whose books have so improved his capabilities that his lack of experience can be endured, they must not only work with energy, and survey the field with keen intelligence; they must also be encouraged by officers who will help them to fight the vicious teachings of the brotherhood. G. S. M.

The views of G. S. M. are nearly in line with those of the editor, when he divides the causes that keep men in a rut between company officers and brotherhood officers. The difficulties which beset the engineman or conductor who would place himself on the road to promotion are all too well known. The brotherhoods have power and use it, not to further individual development, but to drive bargains, in the most short sighted manner. The employer is not blameless, as the *Railroad Gazette* has often pointed out. But the superintendent who is not equal to defying the brotherhoods and encouraging his best men, will usually be found to be doing his best. He has one, two or three superior officers who hold him rigidly to beaten paths. He is, perhaps, overworked, if he is an ordinary man, or is soon needed and taken for a higher office if he is above the ordinary. To get employees to break away from brotherhood prejudices he must be able to grant them indulgences, or premiums, or at least to make a visible exhibit of the Golden Rule, and to give assurance that his policy is to be permanent; and this is sometimes beyond his power. But these deficiencies of the management, whether chargeable to the president or the trainmaster, do not lessen the culpability of the brotherhood bully.—EDITOR.

Fig. 3—Bracing and Steadying a Fill, London & Southwestern.

### Draining and Steadying Slips.

It seems likely, from general observations, that slipping banks occur proportionately more frequently in railroad work in Great Britain than they do in the United States. Slips are apt to be caused by layers of gravel or like permeable material, overlying clay, or like impermeable material. The British engineer has learned to treat these cases heroically; to put in drains and counterforts substantially, held at the toe of the bank, at considerable cost, but in such fashion as to "be no more by them troubled." He recognizes that a blocked railroad is quite a use-

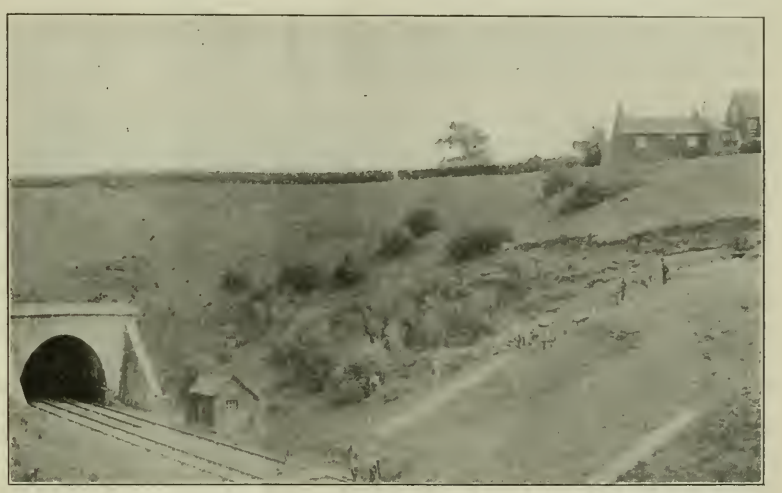


Fig. 2—A Slip at End of Gillingham Tunnel, London & Southwestern.

less tool and intends that a slipping bank or a moving embankment shall be permanently stayed as soon as possible after the possible obstruction is discovered. He does not patch; he builds for eternity.

Mr. Jacomb-Hood, chief engineer of the London & Southwestern, has many of these problems to deal with on the lines from London to the Devon and Cornwall coasts. Each case forms a problem by itself, but the general plan is well shown in the photographs. The west end of Gillingham tunnel runs through and under the sources of a considerable spring brook. The first result of the cutting was that the spring water found its way to the ditches on either side of the track, and the wells at neighboring houses "went dry." This caused some legal complications. Later the banks began to slip, and the cutting was widened and the slopes reduced until the limits of the right-of-way were reached. This, however, was not enough, as is clearly shown in Fig. 2, where a sheer break in the upper layer let the gravel slip to the roadway and made lively work in keeping the line open. Fig. 2 shows the process of draining and steadying begun on the south side, and Fig. 1 shows the completed work on the north side.

A dry stone sloping wall is deeply toed

into the foot of the bank, so as to do the double duty of holding the counterforts and of forming one side of the surface-water drainage ditch. Under this wall is a drain for the spring water which is led to it down the bank through the broken stone under the counterforts, which consist of paving blocks. The width and depth of the trenches vary with the necessities. They should be dug deep enough to reach the underlying impermeable material; they should be wide enough to take care of all the water.

The after results of this piece of work were interesting. The neighbors who had dry wells, and the community who used the water from the stream below, agreed to accept for their uses all the water which came down the south side of the tunnel approach; leaving for railroad use the water draining down the north side. This has become highly important to the company, for in this chalk and limestone region the locomotive boiler tubes are soon coated. The company's reservoir of pure water got from the mouth of this tunnel is a money-saver for the locomotive department.

Fig. 3 illustrates similar work to that described above that has had to be undertaken in order to hold landslides that have started from time to time in the fills upon which the railroad is carried.

At a point about 120 miles from London on the Devonshire line there is a long fill or embankment carrying about four miles of railroad that has given trouble by subsidence or slipping ever since the line was opened in 1860. The last winter rains were abnormal in quantity, and probably by reason of defective cross drainage under the embankment, the mass of embankment at many points became saturated with water to the extent that the slipping and subsiding became serious. To avoid purchasing more land for the railroad and to provide perfect drainage for all time, the slipping embankments have been held by a deep and wide stone revetment wall, as shown in the picture, that forms the main water carrier to the lowest point. From this work as above, subsidiary drains, fitted with loose stone rubble, have been laid into the embankment at right angles to the line of railroad that have successfully overcome the trouble.

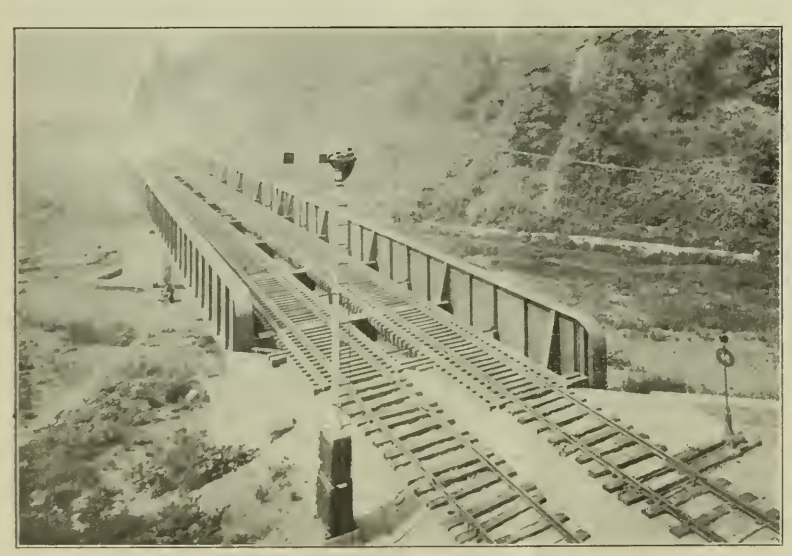
It should be explained that these expensive works are upon one of the main lines of a great English trunk railroad system between important centers, upon which the traffic is heavy and constant throughout the twenty-four hours. A constantly disturbed roadbed leads to so much inconvenience and delay to traffic that any means in reason would seem to be justified in securing a remedy.

First Crossing of the Los Angeles River, Southern Pacific.

## New Southern Pacific Bridges Over the Los Angeles River.

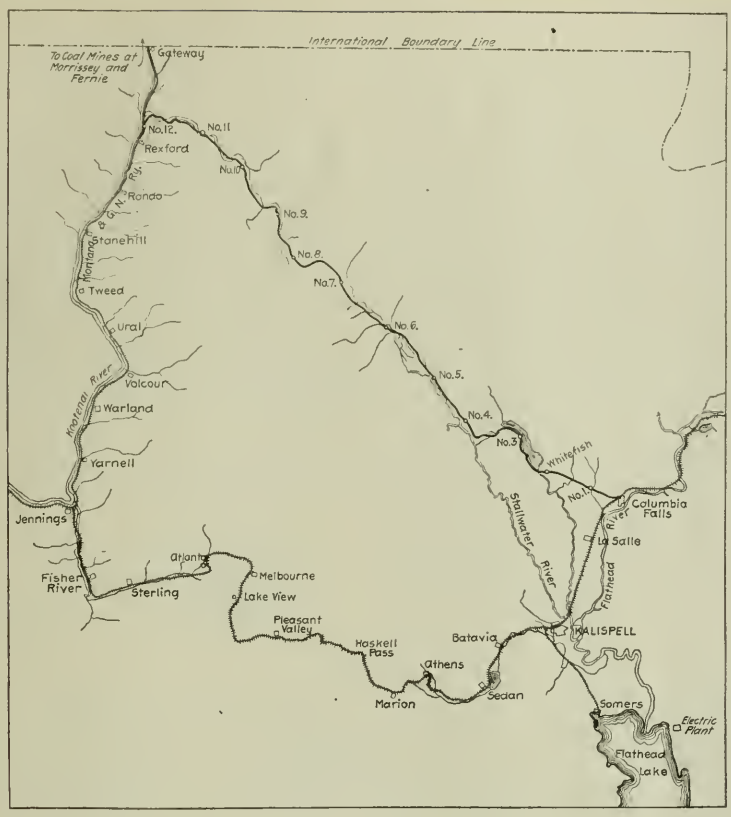
The new steel bridges of the Southern Pacific over the Los Angeles river, known as the First and Second crossings, are good examples of the heavy bridge work which this company is now carrying on throughout its entire system. The First crossing of the Los Angeles river is on the main line of the Southern Pacific just west of the city of Los Angeles, Cal., and the bridge, which has recently been built there, consists of three 96-ft., double-track, through plate girder steel skew spans, supported on concrete piers and abutments. These concrete piers, as shown in the photographs, are widened out under the bridge seat and narrowed between so that the area of the concrete and of the foundations is proportioned somewhat to the load supported. The steel work for this structure was made by the Phœnix Bridge Co., of Phœnixville, Pa., and the total weight of the bridge is about 1,300,000 lbs. The Second crossing of the Los Angeles river is also on the main line of the Southern Pacific east of the company's Arcade station at Los Angeles, and between East and West Los Angeles. The bridge over this crossing is composed of three 113-ft., double-track, through truss, skew spans supported on concrete piers, and the total weight is about 1,100,000 lbs. The steel work was furnished by the American Bridge Co. The notable feature of the construction was the extreme accuracy with which the shop work was performed by the bridge company. There were some 34,000 field rivets put in during the erection ,and it was not necessary to ream a single rivet hole. This bridge was designed and erected by the Southern Pacific in 1903. It is interesting to note that the plate girder bridge, with a total length of 58 ft. less than the truss bridge, weighs 200,000 lbs. more than the truss bridge, the assumed loading for both being the same.

We are indebted to John D. Isaacs, Engineer of Bridges, for the photographs shown.



First Crossing of the Los Angeles River, Southern Pacific.

Second Crossing of the Los Angeles River, Southern Pacific.

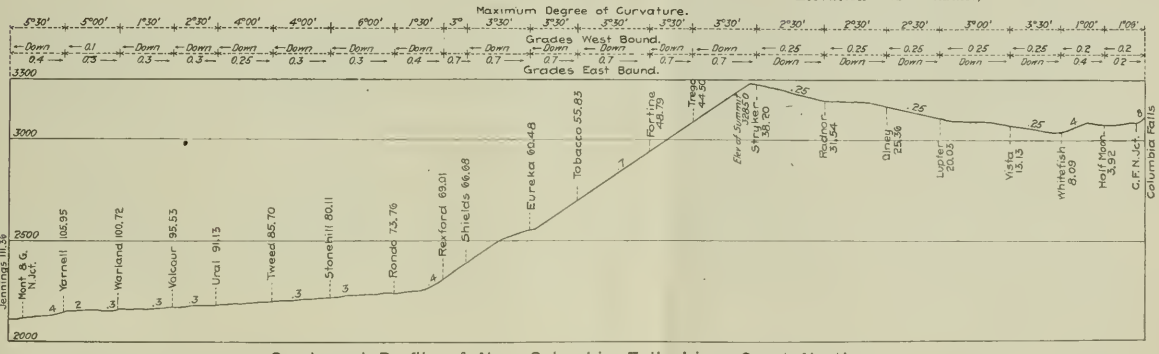



Map of Old and New Lines of Great Northern in Flathead County, Montana.

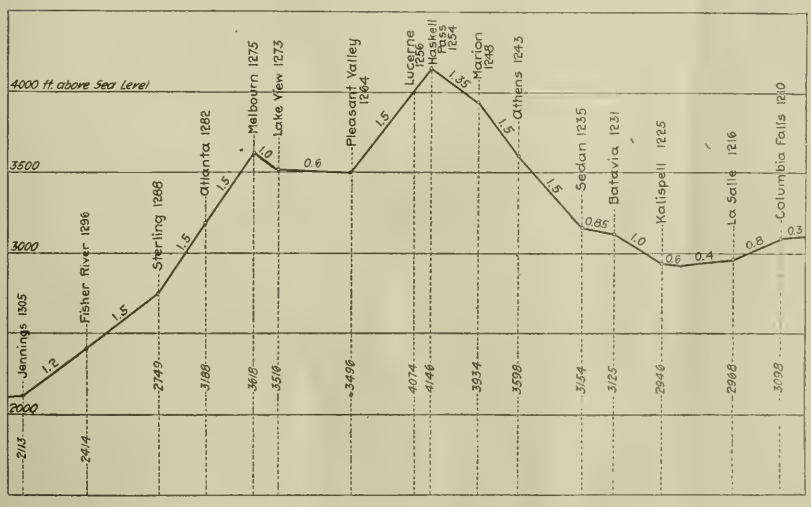
## The Columbia Falls North Line of the Great Northern.

With the completion of its Columbia Falls North Line, which will be ready for operation sometime in September, the Great Northern will convert nearly 100 miles of its present main line on the Kalispell division into a branch. Although the new line will have a much lower maximum grade and total curvature than the present route, it will be about 17 miles longer. The accompanying map shows the two routes in detail. The new line starts at Columbia Falls, elevation 3,098 ft., about 60 miles west of the Main Divide of the Rocky Mountains. It runs in a general northwesterly direction, and encounters an almost unbroken series of water courses which made possible the relatively light grades obtained. It terminates at Rexford on the Montana & Great Northern, which runs north from Jennings, on the main line, to the coal mines at Morrissey and Fernie in British Columbia. This latter line follows the Kootenai River all the way to British Columbia, giving practically a water grade. The maximum grade in either direction on the present line is 1.5 per cent., while on the new line it is .7 eastbound and .25 westbound. The highest point on the new road is nearly a thousand feet lower than the present route. The following statement gives a comparison of the important characteristics of the two lines:

| | Present Line. | New Line. |
|---|---|---|
| Maximum degree of curvature | 10 deg. | 3 deg. 30 min. |
| Total curvature | 9,646 deg. | 4,216 deg. |
| Maximum grade, westbound | 1.5 per cent. | .25 per cent. |
| Maximum grade, eastbound | 1.5 per cent. | .7 per cent. |
| Total rise and fall | 3,790 ft. | 1,490 ft. |
| Length of line | 95.2 m. | 111.9 m. |
| Elevation of summit, Haskell Pass tunnel (Datum: Sea level) | 4,148 ft. | ..... |
| Dickey Lake (summit) | ..... | 3,285 ft. |




Condensed Profile of New Columbia Falls Line, Great Northern.




Profile of Present Line between Kalispell and Columbia Falls—Great Northern.

The 70 miles of new line between Columbia Falls and Rexford involved some heavy work, necessitating the removal of approximately 5,000,000 cu. yds. of material. No large track structures were required, and the 22 bridges on the line are all very small. There are also two short tunnels. The line is laid throughout with 77½-lb. rails.

The territory traversed by the new line contains no towns. A division point named Whitefish is being established eight miles from Columbia Falls. The railroad company owns the land and has laid out a town. The terminal facilities will include a yard with capacity for 625 cars, a combination passenger and freight station, a 20-pocket coal chute, 15-stall roundhouse with 70-ft. turntable and cinder pit and oil house, water supply and a combination two-story warehouse and office building. This building and the roundhouse and oil house are built of concrete blocks. In addition to the Whitefish yards there are 11 sidings on the line, all but one of which have a yard capacity

of 108 cars and a passing track capacity of 90 cars. The exception is No. 3 from Columbia Falls, the figures for which are 113 and 96 respectively.

There are 14 towns on the present line, the largest of which is Kalispell, the division headquarters. The section of this line between Columbia Falls and Kalispell will form part of a branch extending southward to Somers at the head of Flathead Lake, where large sawmills and a timber preserving plant* are located. It is expected that this line will eventually be extended along the east side of Flathead Lake to connect with the Northern Pacific at Jocko. The remainder of the line, from Kalispell to Jennings, will probably remain in service for some time—at least until the timber tributary to it has been removed. Main line traffic will, however, be turned onto the new route as soon as it is ready.

The location and construction of the new line were in charge of Mr. Alex. M. Lupfer. The contractors for grading, track laying and ballasting were Siems & Shields, St. Paul. We are indebted to Mr. A. H. Hogeland, Chief Engineer of the Great Northern, for data.

## Notes on the Creeping of Rails.†

In January, 1903, the writer commenced a series of observations, for the Philadelphia & Reading, upon the creeping of rails at a number of points on the company's lines. This work was undertaken in order that certain questions propounded by Dr. P. H. Dudley, Reporter for America, on "Ways and Works, Rails for Lines With Fast Trains," for the Fifth International Railway Congress, could be answered as intelligently as possible. The writer is enabled to present these data to the society by the courtesy of Theodore Voorhees and William Hunter, Members, Am. Soc. C. E., with the hope that they will prove of interest and will elicit discussions on a very interesting subject to the railroad engineer.

Among the questions, in the circular letter of Dr. Dudley above referred to, were ten under the heading "Methods for preventing creeping, especially on double track lines and on steep gradients," and the investigations were made because there were no records of rail movements from which even ordinary answers could be obtained. That there is a longitudinal movement of the rails, under certain conditions, is a firmly established fact, but how it was influenced by conditions of roadbed, weight of rail, grades, traffic, etc., remained to be determined. The results of the observations, as will be shown later, are too few to establish firmly any laws, but it is hoped that what has been done and is here presented will make one link in a chain which ultimately may allow certain definite principles to be laid down. The observations were not undertaken to ascertain the best method of preventing the creeping of rails, and therefore no discussion of this interesting feature is presented.

In order to make the measurements as carefully as possible, two stakes, 3 by 1¾ in., and 24 in. long, were driven level with the ground about 15 or 20 ft. from the nearest rail, where possible, and located at right angles to the track, if on a tangent, or on a radial line, if on a curve. They were placed so as to be approximately in the center of two rails and miss any joints. In the top of each stake an ordinary surveyor's tack, with a depressed center, was driven. A transit was set up over one stake and sighted on the other, and points on the line were marked on the flange of each rail with a fine center-punch. All observations were made on double-track lines, and, on the tops of the two outside rails, similar marks were made.

From these marks on the outside rails measurements of exactly 30 ft. were made to the right and left, spanning a joint in each direction, and marked with the same center-punch. These points were placed in order to try and determine whether there was any movement in the joints due to expansion or contraction, or whether, when there was a longitudinal movement, it was transmitted through the joints to the next stake and sighted on the other. Upon returning to the office this point was transferred to the opposite side of the center line, as in its first position it indicated a reverse movement of the rail.

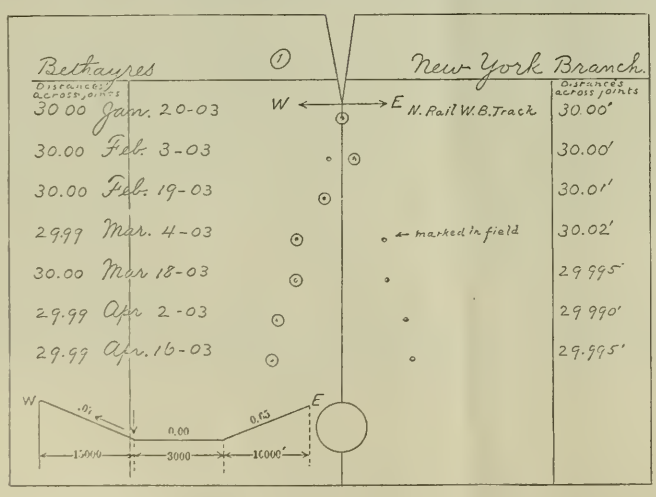
On the cards prepared for the outside rails, the distances across the joints were recorded, marked "X" when measured to the left, and "Y" when measured to the right. Temperature observations were also made and recorded, the thermometer having been exposed to the direct rays of the sun while the observations were being made. The length of time consumed in making the observations approximated about 15 min., depending upon the difficulty in finding the punch marks obscured by grease, dust, dirt, snow, ice, etc., on the rail. The work required the services of two men, one with the transit and the other handling the cards on the rails.

This method was decided upon after some discussion, and adopted because it seemed to eliminate errors in making the notes, and at the same time showed on the cards the actual movements, without the necessity of measuring small distances, with the probabilities of errors in reading.

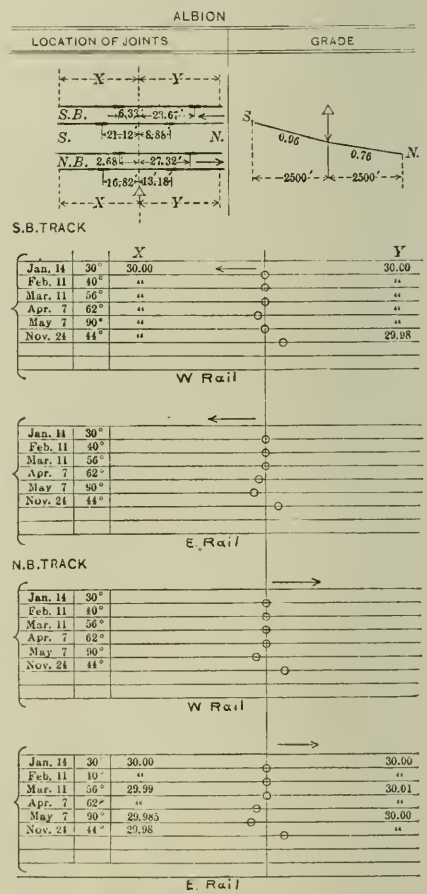
In most cases the observations were made at intervals of about two weeks with the exceptions noted in the records. On the Atlantic City Railroad, the intervals were a month apart, on account of the extremely slow movement of the rails.

The plan for making the observations contemplated the following outline, with special reference to grades and traffic:‡

1.—Lines having the greatest high speed, light tonnage and lightest grades;




Field Card for Measuring Rail Movements.




Complete Record at Albion.

rail. The division superintendents were requested to notify the repairmen to avoid these joints as much as possible during the continuance of the observations. It is safe to say that no disturbance of the track took place during the time the observations were being made, unless noted in the tables.

A card, similar to that shown in Fig. 1, was prepared for each rail. A center line was drawn across the card terminating at the top in a regular-shaped V. The card was then placed on the flange of the rail, a sharp-pointed pencil was placed in the center-punch mark and the card oriented by the observer at the transit. The card was then placed firmly against the rail, the pencil removed, and a point marked on the card on the line given by the observer at the transit which had been previously set on one

*Railroad Gazette, May 30, 1902.

†Extract from a paper by S. T. Wagner, presented before the Am. Soc. C. E., Sept. 7, 1904, and published in the *Proceedings*, page 462.

‡Space limitations have made it possible to show only a few of these tests herewith.

2.—Lines having high speed, heavy tonnage and light grades;

3.—Lines having average speed, average tonnage and moderate grades;

4.—Lines having slow speed, heavy traffic and heavy grades.

In most cases inquiry was made before the points were selected, to ascertain where creeping had been noticed, with a general purpose of selecting the points so that they would fulfill most of the requirements.

The following are detailed, and concise descriptions of the features of interest on the branch roads on which the points were selected.

*Atlantic City Railroad.*—This road is a double-track line, extending from Kaigns Point, Camden, N. J., to Atlantic City, N. J., and carries moderate traffic, compared with the other lines considered, but most of the passenger traffic is carried at high express speeds, the schedule of the so-called 60-min. trains being 50 min. from Camden to Atlantic City, a distance of 55.5 miles. The freight business is not heavy. The alinement throughout is very good, and the grades, with one exception, between Clementon and Albion, very light.

At Albion, both tracks are laid with 90-lb. rails of the section recommended by the American Society of Civil Engineers, and have stone ballast. The point was selected as being at the bottom of the heaviest single grade.

On account of the high-speed traffic, the physical condition of the road is very good.

*New York Branch.*—This branch is a double and in some cases a three-track line extending from Wayne Junction, Philadelphia, to Bound Brook, N. J., a distance of 54.9 miles. A very heavy traffic is carried, the passenger business being carried at high speeds. There are eight passenger trains daily in each direction, making the trip from Wayne Junction to Bound Brook in 58 min., while five other trains each way daily make the same run in 66 min. The line is equipped throughout with 90-lb. rails and stone ballast. The maximum grade is 0.7 per cent.

At Bethayres the point is located at the foot of a 0.7 per cent. grade which is about 15,000 ft. long from the west. There is a level stretch of about 3,000 ft. and then a grade of 0.65 per cent., about 10,000 ft. long, to the east. The point is on an embankment over low swampy ground.

*Bethlehem Branch.*—This branch leaves the New York Branch at Jenkintown and extends to Bethlehem, Pa., a distance of 46.0 miles. It is double-tracked throughout. The grades are heavier than on the New York line, the maximum being 1.13 per cent. The traffic is not as heavy nor the speed as fast as on either of the lines already mentioned. As a general thing, also, the weight of the rail is 80 lbs. Rail creeping was reported to have been noticed near a number of the points selected.

Quakertown is on a level stretch of track slightly beyond the foot of a 0.38 per cent. grade. The south-bound rail is 90-lbs. and the northbound 80-lbs. The ballast is of furnace slag.

Probably the best general discussion of the subject of creeping rails is that given by W. M. Camp, M. Am. Soc. C. E., in his "Notes on Track," and the writer has taken the liberty of extracting from it a few notes on the general principles. These are given with the object of presenting concisely the best known data on the subject, so that the results here obtained may be better understood.

There are two longitudinal movements in rails:

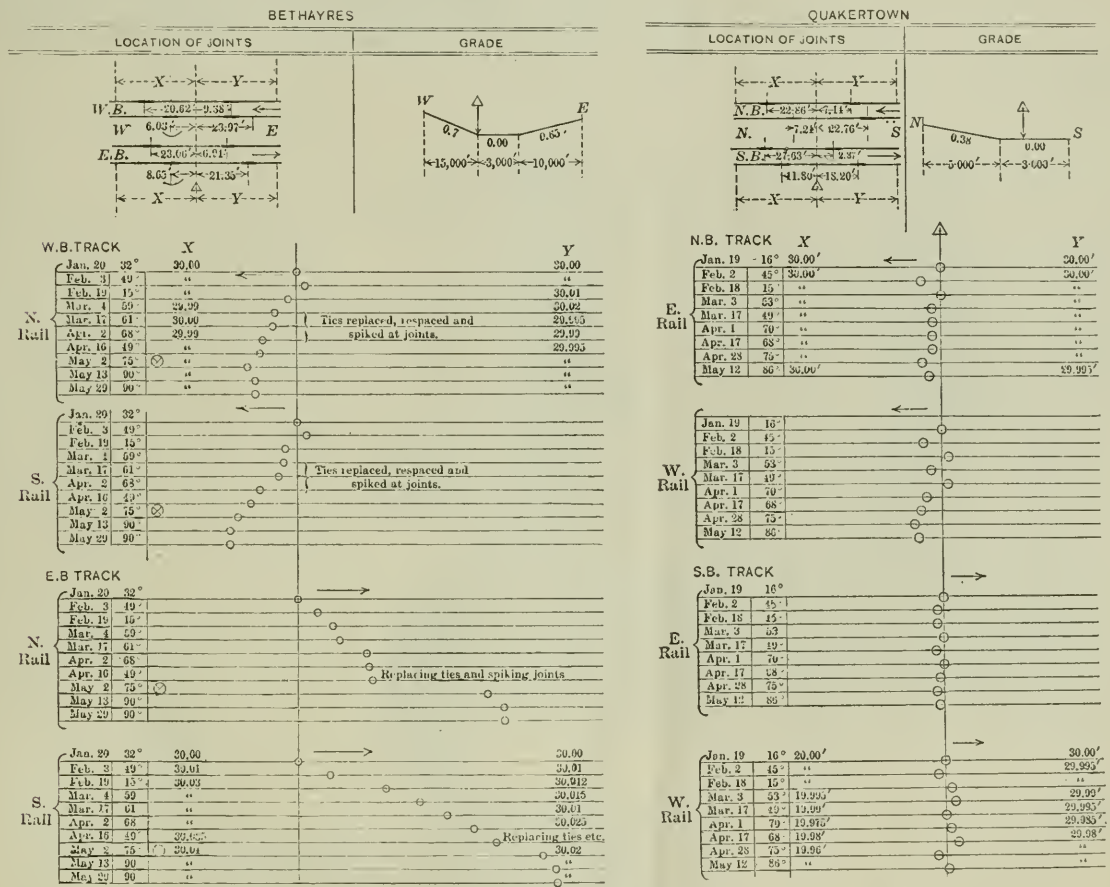
1.—A molecular movement of expansion and contraction, and

2.—A progressive shifting of the rails bodily, known as creeping.

It is now generally conceded that the principal cause of creeping is the wave motion in the rails set up by moving trains.

If each rail, under this wave motion, is not made to hold fast to the ties and the ground, it will remain shoved ahead, by a very small amount, by each passage of a train.

If it were possible to tighten the splices so as to hold against creeping, they would be too tight to allow the rails to expand easily, and much evil would result.




Diagrams from Field Cards, Reduced One-half.

Three important facts should be noted:

1.—The creeping is most rapid during hot weather;

2.—It is greater on double than on single-track; and

3.—It moves with the trains.

Rails usually creep most on embankments, especially on those newly made, and little or least on solid, hard ground, not raised above the surrounding level. Track laid on swampy or boggy land creeps worst of all.

The manner in which rails will creep, and the amount, depends on:

1.—The character of the ground or foundation for the track;

2.—The direction in which the train loads are heavier;

3.—The proportion of the weight distributed on the two rails;

4.—The speed of the trains; and

5.—The manner in which the ties are spiked.

A very brief summary of what seems to be shown by the observations is as follows:

1.—At 32 different points to determine which rail moved the most, the right or the left, the following was found:

| Location. | Alinement. | Bearing. | Rails. | | Ballast. | Joints. | Cut or fill. | Traffic. N. B. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| ALBION: | | | | | | | | 27 Passenger, | |
| Between station and 14 M.P. | Tangent. | N. 37° 45' W. | S. B. | 90-lb. | Stone. | All joints spiked on ties. | Embankment, 12 ft. high. | 4 Freight. S. B. | Subgrade—gravel and sand. |
| | | | N. B. | 90-lb. | Stone. | | | 28 Passenger, | |
| At tel. pile 458. | | | | | | | | 5 Freight, Daily. | Alinement and surface good. |
| BETHAYRES: | | | | | | | | E. B., | W. B. track, ties respaced and spiked between March 17 and April 2 at Bethayres. |
| West end, bridge over Paul Brook. | Tangent. | N. 79° 30' E. | E. B. | 90-lb. | Stone. | Spikes not in joints of E. B. track: W. B. track spiked at joints. | Embankment, 15 ft. high. | 41 Passenger, 19 Freight, W. B., 49 Passenger, 20 Freight, Daily. | E. B. track do. do. April 16. Subgrade—earth fill on marsh. Alinement and surface good. Decided evidence of creeping on E. B. track. Will be spiked as soon as ties can be replaced. Newtown crossing moved 1½-in., all rails spiked and ballast in. |
| | | | W. B. | 90-lb. | Stone. | | | | |
| QUAKERTOWN: | | | | | | West rail of S. B. track not spiked on account of creeping. All other joints spiked to ties. Standard joints. | | N. B., | Alinement and surface fair. |
| 30 ft. north of Hall signal, 825 ft. north of yard switches. | Tangent. | S. 25° E. | S. B. | 90-lb. | Slag. | | No cut or fill. | 12 Passenger, 11 Freight. S. B., 12 Passenger, 11 Freight. Daily. | Shortage of ballast between ties. Subgrade—earth. Foreman reports west rail of S. B. track creeps to south. Last summer it moved 12-in. ties at joints showing creeping. |
| | | | N. B. | 80-lb. | Slag. | | | | |

At 21 points there was no practical difference.

At eight points the right rail moved most.

At three points the left rail moved most. The right crank leads on all engines.

2.—In seven cases out of 12 the greatest creeping is shown on descending gradients; on the remaining five there is practically no difference.

3.—Decidedly more creeping is shown where the roadbed is carried on embankment over swampy ground, than in other places.

4.—More creeping is generally shown on imperfectly maintained track, than where it is kept in first class condition.

5.—As far as the observations went, it was shown that there was less movement than was expected from the reports of the repairmen, although, in some cases, the points were not at the exact locations of the worst reported creeping.

One of the most interesting points of the series is that at Bethayres, on the New York Branch. At the time the points were located new rails had just been laid, in cold weather, and it had been impossible to space the ties so as to spike all the joints to them. The result was a considerable amount of motion. Between March 17th and April 2d, the westbound track was fixed, the ties respaced and all the spikes driven in the joints. In spite of this, the movement continued, and was probably due to the disturbance of the roadbed. The Philadelphia, Newtown and New York Railroad crosses this branch a short distance east of this point with a grade crossing, and when the eastbound track was fixed up, about May 2d, the rails were disturbed between the point of observation and the crossing, but the motion continued afterward. The excessive motion is probably due to the fact that at this point the track is not as rigid, longitudinally, as at other points, on account of the crossing frogs at the Newtown crossing and, also, chiefly on account of the swampy ground under the embankment.

The next most serious movement seems to be at Pleasantville, on the Atlantic City Railroad, over the salt marsh, where the movement has been continuous and regular on a nearly level line. These two points seem to bear out the principle that creeping is most to be feared when the character of the foundation permits the amplification of the wave motion. The speed of all trains at both of these points is high. There are a number of facts shown in the tables and diagrams which are very hard to explain, but it is hoped that they may throw some light on points where other records are wanting. It is to be regretted that more observations were not made on curves, in order to ascertain the effect of the unequal distribution on the two rails caused by heavy, slow-moving freight trains passing around a curve having the proper superelevation for the higher speed of passenger trains.

## Railroad Shop Tools.

(*Continued.*)

BORING MACHINES.

The locomotive rod boring machine, Fig. 1, is made by the Niles-Bement-Pond Company, New York. This type of tool is especially designed for rod boring, but is adapted to a variety of other work. In many cases one man can bore two separate pieces of work with this tool. This machine will bore a hole up to 20 in. in diameter and 20 in. deep. The spindles have a vertical adjustment of 24 in., and the maximum distance between the spindles is 13 ft. 4 in. The spindles are counter-weighted and are driven by tangent gearing. They are supplied with power feed, hand feed and quick hand return. The heads are moved along the cross rail with a ratchet lever and rack and pinion. The heads are held in position by clamp bolts. The work table is 32 in. wide by 16 ft. long, and is supplied with bolt slots for holding work.

The illustration, Fig. 2, shows a double drilling or boring machine designed for drilling connecting rods, bridge chords, etc. The machine consists of two drill presses which are adjustable along a heavy work table. The presses are secured to the table by bolts. They have a spindle 3½ in. in diameter and a vertical adjustment of 12 in. The distance from the center of the spindle to the face of the column is 12 in. The spindles are counterbalanced and are fitted with power feed and quick hand movement. The presses are driven by independent motors,

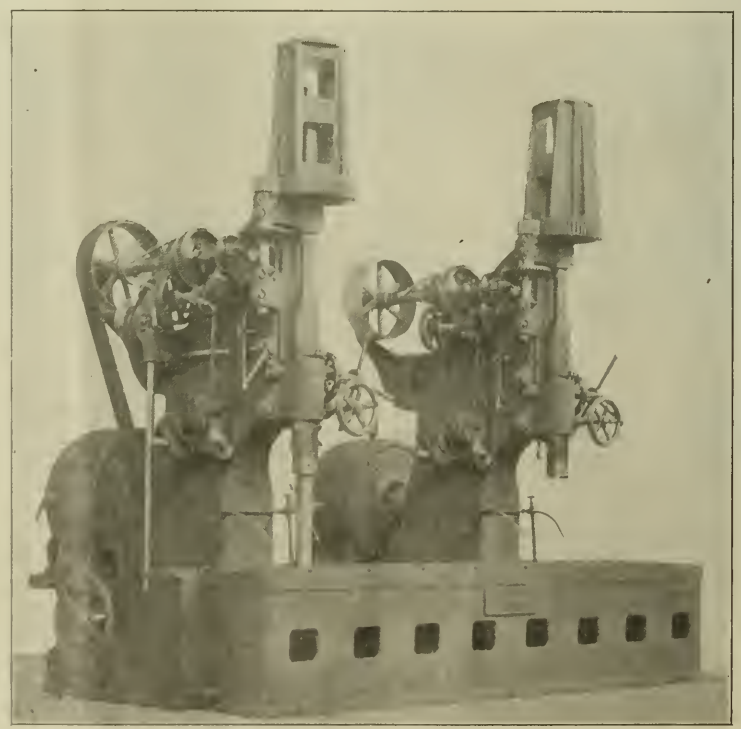


Fig. 4—The Baker Bros. Double Spindle Boring Machine.

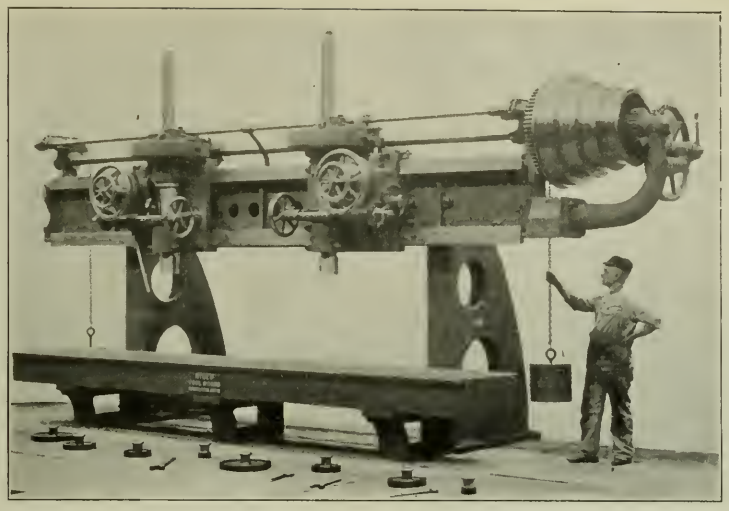


Fig. 1—The Niles-Bement-Pond Locomotive Rod Boring Machine.

in. in diameter and 6½ in. face. It is triple back geared, the greatest ratio of gearing being 51 to 1. In addition to the three changes obtained by the back gears, the motor, which is a Westinghouse type "S," 13 h.p., 110-220 v., has a speed variation of 4 to 1. The controllers, which are not shown in the photograph, are placed at the ends of the long table. These have 15 steps for the forward speed, and six steps for the reverse speed, making with the back gears, 45 speed changes forward and 18 speed changes reverse, giving a speed variation from 3 r.p.m. to 90 r.p.m.

Both spindles are adjustable along the base; one by hand and the other by power. The maximum distance from center to center of spindles is 9 ft. 6 in., and the minimum distance between centers is 3 ft. 4 in. The distance from the frame to the center of the spindles is 17½ in. The maximum distance from the spindle to the table is 25¼ in., and the minimum distance is 11¼ in. The spindle feed is 14 in. and the distance from the floor to the top of the table is 28 in. The machine requires a floor space of 13 ft. x 11 ft. 6 in., and the weight is 32,000 lbs. Baker Bros., Toledo, Ohio, are the makers.

*(To be continued.)*

or they may be driven by a countershaft. This machine is made by William Sellers & Co., Philadelphia, Pa.

The duplex locomotive rod boring machine, Fig. 3, is made by the Newton Machine Tool Works, Philadelphia, Pa. The machine is of recent design and is especially adapted for the use of modern tool steels. The spindles are 4 in. in diameter and are driven independently. They are counterweighted and have an automatic feed of 16 in. obtained by a positive gear which has four speed changes. The feed motion is taken directly from the spindle sleeve. The heads are adjustable on the rail, having a minimum distance between centers of 4 ft. and a maximum distance between centers of 11 ft. 9 in. The maximum distance between the work table and the end of the spindles is 26 in.

The illustration, Fig. 4, shows a double spindle boring machine designed for boring locomotive connecting rods, and other heavy facing and counterboring operations. This machine is a combination of two boring machines which are mounted on one base. The bedplate has a working table 11 ft. 2 in. x 2 ft. inside the oil grooves. The inside of the table is hollow and forms an oil tank from which lubricant is supplied to the cutting tool. Each spindle is provided with a separate pump.

The machine has a spindle feed of 24 in., and is belt driven. The driving pulley is 20

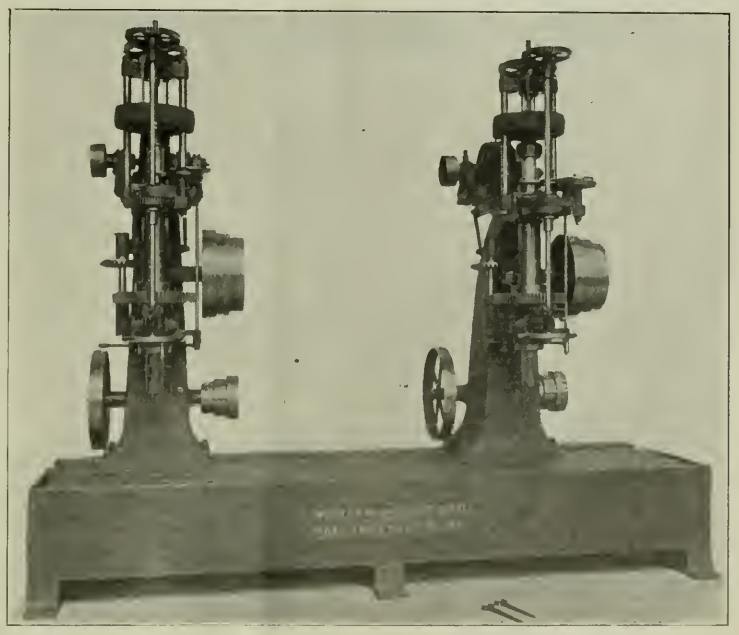


Fig. 2—The Sellers Locomotive Rod Boring Machine.

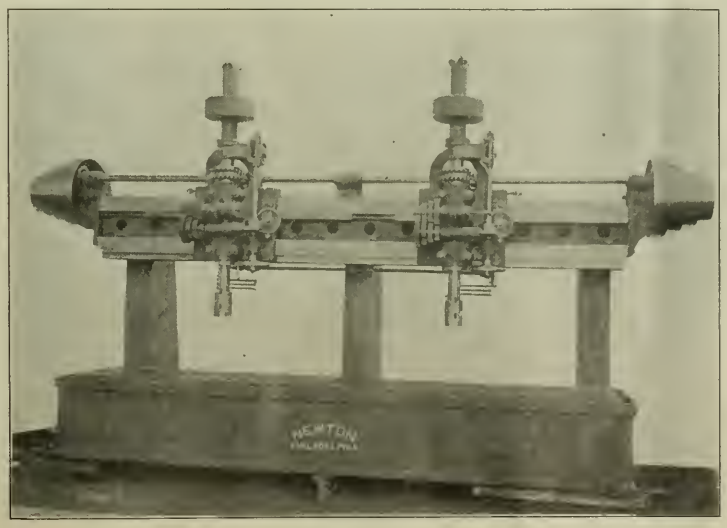


Fig. 3—The Newton Double Spindle Locomotive Rod Boring Machine.

## How to Handle Freight Safely.*

(*Concluded from page* 298.)

In taking orders and receipts for freight, a stamped or printed signature is no good. There isn't a bank that will honor a check with a stamped signature. We wouldn't take a check with the signature stamped or printed on it, but every day you take these orders with stamped and printed signatures. We are in the same position as the bank. Now if a man gives an order or a receipt we are entitled to have his name on it or that of someone authorized in writing. Don't take any more of them. We don't want them. They aren't worth the paper they are written on.

Whenever any summons, notice or legal document of any kind is served you are to

*Extracts from an address by R. C. Richards, General Claim Agent of the Chicago & North-Western, recently delivered at meetings of the agents of the company.

notify the General Counsel and not the General Claim Agent, by wire and send these papers to him by first train. Now don't keep on sending them to me. There is never a day goes by but what I get a garnishee summons, replevin writ or something of that kind from some one.

While on this subject I want to call your attention to operating department rule No. 892, which prohibits any employee acting for the company procuring a warrant for the arrest of anyone without first consulting the law or claim department. This is to prevent arrests being made on insufficient evidence and thus avoid suits for false arrest or malicious prosecution.

We have an immense amount of trouble and loss with order and notify shipments. We have frequent claims on shipments billed to ORDER or NOTIFY that were delivered without the bill of lading. Just how much we lose every year on account of agents failing to comply with that rule I don't know, but we get a great many claims. They are invariably for large amounts. They run from $100 up to $2,000. The reason the shipper has that freight billed to order or notify is because he don't trust the man he sells the goods to. *The bill of lading must be endorsed.* When you get the shipment the consignee comes and says to you: Now, just think of the amount of business I do with you each year, look at this bank account. I am perfectly good for the amount of the shipment and I will pay the draft when it comes—you have all been through it, every one of you that has run a station has had this experience. Well, when we deliver that shipment without a bill of lading we know what happens. We are chasing the other fellow. About nine times out of ten we don't get the money, just as long as we have the goods in our possession they will be chasing us, but the minute we deliver the goods without the bill of lading we will be chasing them and the chances are we won't get our money. There is no reason why, if the shipper don't trust the consignee, we should. He knows more about him than we do. It don't make any difference if it is the biggest man financially in your town, don't deliver it to him. If he makes a kick about it refer him to me. Tell him you had a talk with the General Claim Agent, put the responsibility on me, but under no circumstances, no matter who the man is, do not deliver the shipment to him *without the bill of lading properly endorsed.*

We must not receive shipments to the order or notify consigned to places where we have no agent. When it gets there nobody is there to take up the bill of lading. The rule says not to do it. The conductor is not as familiar with these instructions as you ought to be, and he unloads the stuff there. He don't know what to order or notify means because he hasn't been told about it. If you do by mistake get it, always bill it to the station beyond. And if any conductor gets a shipment like that he must not deliver it, and it don't make any difference if the consignee is there but take it to the next station. Shipments of large value for prepaid stations should not be unloaded unless the consignee is there himself.

Perishable freight that is refused by the consignee must be sold; don't sell it to the consignee. If you sell it to the consignee and don't get the invoice price for it the shipper will say that it was a put up job. Sometimes trees and nursery stock which should be prepaid, come from connecting lines and there is not enough money to prepay through. Don't hold those goods, but send them along. Now then, why is this necessary? The stuff is sold by an agent and if it don't get there by the time the agent does and the farmers come in to receive it—nine times out of ten they don't want the stuff. They only ordered it because the agent talked them into it and are just looking for a chance to refuse it—but if it don't come the day the agent agreed to have it there they won't take it. Then what happens? I will leave that for you to guess. Every time we get a claim because it was delayed. It is better to take chances on getting $4 or $5 charges than to have a claim of $90 or $100 just because we didn't send it along. If there are any charges lost on it I will back you up.

When you load a car take the old seals off and don't leave them there until they grow whiskers. Put on your station seals and when you load these cars fasten the end doors inside with a cleat. That is where our robberies occur. That is the reason we want them cleated before sending the car forward. And when you take a seal record take the lock and seals on all the cars. That don't mean only every third or fourth car, but every car that comes. Some roads seal all cars; lime, horses, lumber, ties, posts, and if such a car passes over our line and there is a loss from it and we haven't got the seal record then we have got to pay the claim. If, however, we have the seal record and a claim has to be paid it is divided between the two roads. We are getting claims all the time from our friends that seal all cars and we haven't got the seal record. The agent says: "I didn't take the seal record because there was lumber in the car." And the vents on refrigerator cars and the doors on ice boxes; we want a record of those doors and vents whether they are open or shut just the same as the seal record.

I recall a case that illustrates carelessness in checking at transfer points. The claim was for $1,875, the value of a box of rugs and bric-a-brac, the wedding presents of an army officer shipped from San Francisco to Washington. It got to Wood street, was transferred there into a car for the Pennsylvania, and they checked it short and so receipted for it. When the box did not show up at destination, the owner and all his friends between San Francisco and Washington got after me. We searched every transfer house in Chicago, had the stations at Washington examined, but no box. Finally it occurred to us that as there were other household goods for Newark, N. J., in the car in which we claimed to have loaded this box, that it might have been forwarded with that shipment so we sent a man down there. That consignment had been sent to a warehouse, and there was our box with it. We sent it to Washington by express as should have been done originally and the owner actually wrote me a letter thanking me for my trouble. That letter I am going to get framed when my salary is raised 700 per cent. Now if the box had belonged to the man who checked it short he would have checked over everything that came out of the same car to find it. Had he done so it would have been found. If the man who loaded the Newark shipment, the man who unloaded it at Newark, or the man who delivered it to the warehouse had checked it carefully, the Washington box would have been found. Surely there must be gross carelessness and lack of system or supervision, or mistakes of this kind would not be made by four different men handling the same consignment. The Pennsylvania is not the only line on which such mistakes occur.

When it comes to the matter of handling horses in carload lots, it makes me tired. We had claims for $11,900 in the last twelve months on horses. Just because we didn't handle them right. If a shipment of horses is going to some place and we have poor connections, notify the Train Despatcher to get the car into some train that will get it to destination. And when you do the switching, don't use a car of horses for a bumping post. Don't make a flying switch with a car of horses. Don't use it next to the engine because it has a good air-brake, but handle horses the same as you would babies. Handle them the same as if they belonged to you. This matter of claims on horses is getting to be a nightmare with me.

Bear in mind the important part of a claim is not the man's name or way-bill reference, or car number. It is the amount of it. That is what makes up this $330,000 a year. If you are unable to furnish the information asked for on form No. 135, explain why. In the presentation of claims on all local shipments, if you will give me the information called for on that blank and furnish the necessary papers, the chances are that we can tell you the next day whether it will be declined or paid. I think last month we had about 5,300 freight claims and over one-half of them were claims on local shipments. Now, out of the 2,500 local claims there were some 1,400 that came in the shape so they should be paid or declined that day. If you will present your claims as you should we will pay them promptly or we will decline them promptly. We cannot do that on freight that is lost or damaged on other roads, because we don't know whether they will pay. It is a good thing to have a reputation of paying claims promptly. The women all say they trade with Marshall Field because he adjusts their complaints promptly. And we want the same reputation in dealing with our customers. If you have claims that don't receive prompt attention, write me personally, and I will find out what the trouble is. We will either have the claim paid or give some reason why. We want to prevent the claimant from going to the other road. We want to keep all of the business. That is what we have got our sign out for. If there is anyone connected with my department that does not attend to business; that is discourteous and don't answer your communications, write me a personal letter and I will apply the remedy.

Frequently a shipper presents a claim on account of delay in shipments getting to destination. . . . We don't want to make agreements for time in transporting property. If we do make an agreement and there is a claim, for God's sake tell me, give me the information and don't have any fairy tales. Just give the facts. If we are to blame in the matter we want to know it. The same way when you get a claim that is perhaps a little doubtful; we don't want to antagonize a man for a couple of dollars. . . . If a man comes to you with an unmeritorious claim talk him out of it, but if you can't talk him out of it send it to me immediately. . . .

Now I have shown you how many of the losses occur; I shall tell you how I think many of them could be avoided. "*An ounce of prevention is worth a pound of cure.*"

Handle the company's business the same as your own.

In case of doubt always (not sometimes) take the safe course.

Speed must give way to safety. Expedition in the handling of traffic must give way to accuracy.

Read and reread the book of rules so that you will know what they are, the same as you did the first letter you got from your superior officer commending some good act you had done, or that first letter you received from your first sweetheart. . . . And when you are up against some proposition that you do not understand, and you cannot find the desired instructions or ad-

vice in the book of rules, ask your neighbor agent. If he does not know ask the Superintendent or other proper officer.

When a passenger or employee is injured have them properly cared for; call a surgeon to attend them. If we have a doctor at the place he should be called at once. If not, call the nearest one, and if the company's surgeon is too far away and attention is necessary before he can arrive, call a local doctor and the company will pay for it. Next comes the traveler on the highway. He should be cared for in the same way until you are notified to the contrary.

If any tramps are injured or killed in stealing rides on trains or walking on the track, turn them over to the town authorities. . . . But if the authorities won't take care of them don't let them lie in the street. Take care of them until we can make arrangements.

When an accident occurs report it on Form 148, and report all accidents, not just those you think the company is to blame for, report everything. Rule 914 says that an employee, whether on duty or not, who witnesses an accident, must report it. Please comply with the rule. If you do that then you have done all the company requires. Get the names of all the witnesses, especially of outsiders. When people get killed away from a station the trainmen sometimes are at a loss to know what to do with the body. They have an idea that they mustn't touch or move the body until the coroner or some other official is called to see it. That is not right. We should pick the body up as kindly and as carefully as we can and take it to the next station and notify the authorities. We don't want to leave it on the ground. Put the body on the train and bring it in. Think how you would feel if it was your brother, sister, father or mother that was killed. Transport the body to a station in the county where the accident occurred. Never take it out of the county if you can help it. If there is no station in that county, take it to the nearest station in the next county.

If an employee or passenger is killed the company will pay the reasonable funeral expenses, for just such a funeral as the family would have if they were to pay for it. Don't ever tell an undertaker to spare no expenses; if you do he will simply give the same service he would have done without the order but when he makes up the bill there will be nothing spared in the way of expense.

## Buffet Parlor Car for Interurban Service.

A buffet parlor car for electric interurban service is an innovation that has been introduced by the Aurora, Elgin & Chicago. At first it will be used only in special service, being available for special parties who may wish to charter it. It will probably be in demand by golfers traveling between Chi- and Wheaton, 21 miles out, where the Chicago Golf Club is situated, and for theatre parties. It is the intention to put it in regular service later on, and should results justify it, other cars will be added.

Exterior of Buffet Parlor Car—Aurora, Elgin & Chicago.

In external appearance the car is similar to the standard cars of the company, except for the oval window seen in the exterior view. The kitchen, which is 6 ft. wide, is located at this point and separates the interior into two compartments, the smaller of which is a smoking room. There is room in the parlor compartment for six tables, three on each side, set staggered. Three persons can be seated at a table. Also there is space for two tables in the smoking end, so that 24 persons can be served at one time. A buffet luncheon is served, the cooking being done on an electric stove.

The interior appearance of the car is most attractive. It is finished in Flemish oak stained an apple green, with neat inlaid borders of maple and holly. The ceiling is canary yellow trimmed with gold. The electric lights have frosted globes. The carpet is green, harmonizing with the woodwork.

The idea originated with Mr. L. J. Wolf, President of the company. The car, which weighs 84,000 lbs., was built by the Niles Car & Manufacturing Company, Niles, Ohio, and cost about $12,000.

Interior of Buffet Parlor Car—Aurora, Elgin & Chicago.

## Specifications for Structural Steel.

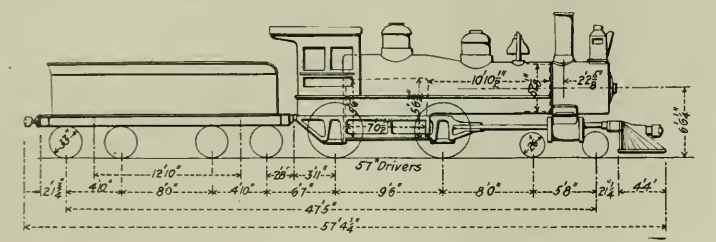
The following abstract of an editorial from *Engineering*, July 22, 1904, is of particular interest at this time in view of the efforts which are being made to adopt international standard specifications for structural and rail steel. Further comment will be found in the editorial columns:

Although British and Continental engineers have, since the use of mild steel commenced, chiefly employed only one grade of the material, such has not been the case in America, where, until quite recently, two grades—viz., soft steel and medium steel—were almost universally specified by engineers, the grade selected depending, of course, on the special duty which the steel had to perform. If we look through the specifications for structural steel drawn up by any of the leading American engineers, or bridge-builders, we find that the two grades—soft and medium—are always mentioned, and are used for distinct purposes, in a way which points to a strong faith in their different qualifications. Take, for instance, the American Bridge Company's general specifications for steel highway bridges. In this there are both soft and mild steel specified, and, in addition, a quality of steel of an extra ductile quality, to be used for rivets. For soft steel the ultimate strength ranges from 52,000 lbs. to 62,000 lbs. per square inch, with an elongation 25 per cent. in 8 in., and it is required that a test-piece shall stand bending 180 deg. flat on itself, without fracture. For medium steel the ultimate strength is fixed at from 60,000 lbs. to 70,000 lbs. per square inch, the elongation 22 per cent., and the bending test 180 deg. to a diameter equal to the thickness of the test-piece, without fracture on the outside of the bent portion. For rivet steel an ultimate strength of 48,000 lbs. to 58,000 lbs. per square inch is specified, with an elongation 26 per cent. in 8 in., and a bending test of 180 deg. flat on itself, without fracture on the outside of the bent portion.

Now in English practice there is usually

only one grade of steel used for structural purposes, and that grade corresponds very closely with the "medium" steel used in America; it is specified to have an ultimate tensile strength of from 27 to 32 tons per square inch, with an elongation, measured in a length of 8 in., of not less than 20 per cent.

It is also usual to specify a bending test, such that a specimen piece shall, when heated to a cherry red and cooled in water having a temperature of 82 deg. Fahr., bear bending double, when cold, round a curve, the diameter of which is not more than one-and-a-half times the thickness of the piece, without showing any signs of fracture. Rivet steel is, as in America, usually specified of a softer kind, and must have an ultimate tensile strength of from 26 to 30 tons per square inch. It must also be capable, when cold, of being bent double on itself without showing signs of fracture.




| | | | |
|---|---|---|---|
| *Weight, total* | 93,300 lbs. | *Heating surface, flues* | 1,085 sq. ft. |
| *Weight on drivers* | 61,700 lbs. | *Heating surface, total* | 1,206 sq. ft. |
| *Diameter of drivers* | 57-in. | *Grate area* | 20 sq. ft. |
| *Diameter of cylinders* | 19-in. | *Tractive force* | 11,172 lbs. |
| *Stroke of cylinders* | 22-in. | *Boiler pressure* | 145 lbs. |

Fig. 1—8-Wheel Passenger Engine, Standard in 1895.

Of late years a feeling has grown up among American engineers that the "soft steel" usually mentioned in their specifications might very well be omitted, because the limits mentioned for the two classes of steel—both "soft" and "medium"—always overlapped in the higher limit for the "soft" steel and the lower one for the "medium," and because both grades of steel could be made from the same ingot, and were practically alike. The American Bridge Company fix the limit for soft steel at from 52,000 lbs. per square inch ultimate tensile strength to 62,000 lbs., and for "medium" steel from 60,000 lbs. to 70,000 lbs. Mr. Theodore Cooper specified, in 1901, a range of from 54,000 lbs. to 62,000 lbs. for "soft" steel, and from 60,000 lbs. to 68,000 lbs. for "medium" steel.

At a meeting of the American Society for Testing Materials, held at Atlantic City last year, the question as to the desirability of specifying a single grade of open-hearth structural steel for bridges of ordinary span was discussed by some of the leading bridge designers and builders, and the matter very fully gone into, with the result that the general opinion of these engineers appears to have been that it was desirable to specify in future only one grade of steel for structural purposes, rivet steel, of course, not being included in this. The wisdom of this decision will appeal to English engineers who in their practice have always been satisfied with one grade of steel, having an ultimate tensile strength ranging from 27 tons to 32 tons per square inch.

Another argument in favor of the adoption of one grade of steel in America appears to be that at present a large percentage of the structural steel is made by the basic process, and it seems probable that this process will be the one of the future for ordinary structural steel. There is a prejudice against basic steel in certain quarters in this country, which prejudice we do not consider is supported by facts, but in America no such feeling exists; basic steel, having an ultimate strength of from 58,000 lbs. to 60,000 lbs. per square inch, if properly manufactured, being looked upon as a highly satisfactory material for structural purposes. There is another argument also in favor of one-grade steel, which is, that by its adoption a more uniform practice all over the world may be established, and engineers who issue eccentric specifications will not receive much consideration from steel manufacturers.

Granting the advisability of adopting one grade of steel, the question has arisen among American engineers as to what is the proper grade of steel to use. Much discussion has taken place on the subject in the States, and most of the leading engineers there have expressed themselves on the subject, some arguing in favor of a continuation of the use of two grades of steel, while others (and they the majority) advocate strongly the adoption of only one grade, and that of the higher quality. After all, however, when the views of these men are examined and compared, there seems to be a wonderful unanimity. The prevailing impression left in the mind is that it is a case of Tweedledum and Tweedledee, and that the most suitable steel to adopt is one having an ultimate average tensile strength of about 60,000 lbs. per square inch. The other properties of the material, such as the yield point, and the percentage of elongation, to be fixed to suit this range of tensile strength.

The preceding figures do not refer to rivet and pin steel, the former having to be soft and ductile, particularly for rivets put in during erection, and ranging between 50,000 lbs. and 58,000 lbs. ultimate tensile strength per square inch; while the pin steel must be quite hard, with a tensile strength between 75,000 lbs. and 85,000 lbs. per square inch.

The decision arrived at by the American Society for Testing Materials has been that a one-grade steel having an ultimate strength of from 55,000 lbs. to 65,000 lbs. per square inch, is, on the whole, very desirable; and that this decision will no doubt bear fruit, to the advantage both of the manufacturer and the consumer. It has been clearly demonstrated that such steel is quite reliable, and may be used with advantage for all structural purposes; for it can stand more abuse than the best double-rolled wrought iron, and can be punched and sheared with no greater injury than such treatment would inflict on the latter metal, if the thickness does not exceed ⅝ in. We feel sure that American engineers are wise in having come to so important a decision.

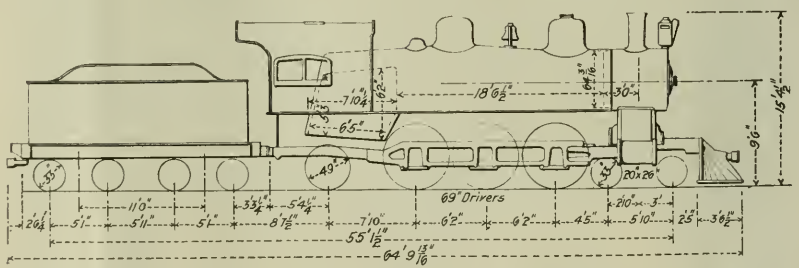
## The Growth of the Missouri Pacific.

### III.

(*Continued from page* 266.)

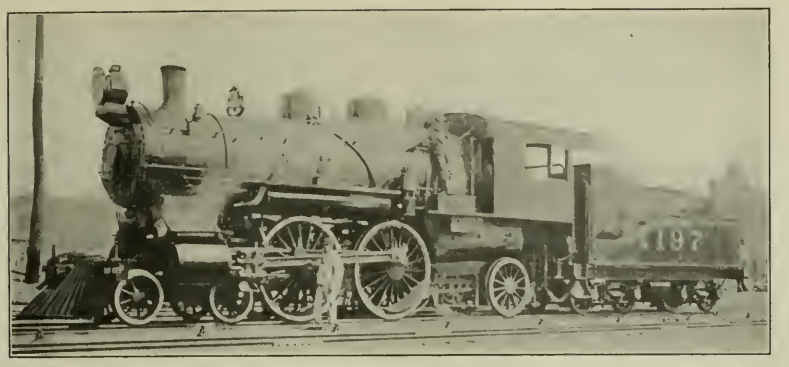
The improvements made on existing lines and the large amount of new construction which were briefly described in the previous article have taken nearly six years to complete, and by the end of this year the entire scheme will have been worked out, and with the exception of ballasting the new lines in some places, all of the lines will be in shape to carry heavy traffic. It has been the aim of the management to derive the benefits from these extensive betterments at the earliest opportunity, and each part of the system as it was reconstructed or opened for traffic has been utilized to the fullest extent to increase economy of operation. The work being so scattered, however, results have not as yet begun to show themselves beyond a steady increase in the average train load. As the new lines develop business and operating conditions become stable, the real value of the improvements will be felt.

It was necessary, in order to realize the full benefits of the grade reduction work, which was started in 1898, to provide modern heavy motive power for both freight and passenger service, and beginning with 1901 large additions were made to the motive power on the system. As fast as the improvements were completed and bridges and track brought up to standard, this new equipment was assigned, and the train loads increased correspondingly with the reduced grades and increased hauling power of the engines put in service. The accompanying drawings show the standard types of freight and passenger engines in use prior to 1899 and at the present time. Fig. 1 shows the standard 8-wheel passenger engine in use prior to 1895. Somewhat heavier engines of the same type were in use up to 1899, but these have since been replaced on all important trains with the Pacific type engines shown in Fig. 2, and with the Atlantic type engines shown in Fig. 3. Most of the old light engines have either been sold, scrapped or assigned to local trains on branch lines. Fig. 4 shows the standard 10-wheel engine for heavy freight service which was in use up to 1899, and in comparison with it, the 12-wheel engine in use to-day is shown in Fig. 5. The latter has nearly double the




| | | | |
|---|---|---|---|
| *Weight, total* | 185,000 lbs. | *Heating surface, flues* | 2,779 sq. ft. |
| *Weight on drivers* | 118,000 lbs. | *Heating surface, total* | 2,954 sq. ft. |
| *Diameter of drivers* | 69-in. | *Tractive force* | 25,623 lbs. |
| *Diameter of cylinders* | 20-in. | *Boiler pressure* | 200 lbs. |
| *Stroke of Cylinders* | 26-in. | *Grate area* | 42.37 sq. ft. |

Fig. 2—Pacific Type Locomotive for Heavy Passenger Service.



| | | | |
|---|---|---|---|
| *Weight, total* | 184,000 *lbs.* | *Diameter of drivers* | 79-*in.* |
| *Weight on drivers* | 100,000 *lbs.* | *Grate area* | 45.8 *sq. ft.* |
| *Diameter of cylinders* | 20-*in.* | *Tractive force* | 24,670 *lbs.* |
| *Stroke of cylinders* | 26-*in.* | *Boiler pressure* | 200 *lbs.* |

Fig. 3—Atlantic Type Engine for Fast Passenger Service.

tractive power of the former. The following table shows the increase in motive power during the last five years.

*Locomotives Owned by the Missouri Pacific System in 1899 and 1904.*

| Year. | 1904. | 1899. |
|---|---|---|
| 0-6-0 | 96 | 62 |
| 4-4-0 | 150 | 192 |
| 4-4-2 | 15 | .. |
| 2-6-0 | 96 | 97 |
| 4-6-0 | 314 | 183 |
| 4-6-2 | 21 | .. |
| 2-8-0 | 217 | 85 |
| 4-8-0 | 19 | .. |
| Total | 928 | 619 |

It will be noted that the largest increase is in the consolidation and 10-wheel types, these classes of engines being used almost exclusively for heavy and fast through freight service respectively.

Equally important and extensive additions to the rolling stock of the system have been made during the last five years to care for the large increase in business which has come about through the development of the territory traversed. The following tables show the equipment in service in May, 1899, and in May, 1904:

*Freight Equipment.*

| Capacity. | Flat 1904. | Flat 1899. | Gondola 1904. | Gondola 1899. | Box 1904. | Box 1899. | Furniture 1904. | Furniture 1899. |
|---|---|---|---|---|---|---|---|---|
| 15 | 179 | 435 | 491 | 547 | 1,047 | 1,914 | .... | ... |
| 20 | 295 | 747 | 3,389 | 3,722 | 5,540 | 6,272 | .... | ... |
| 25 | ... | 245 | 111 | 11 | 311 | 159 | .... | ... |
| 30 | 1,778 | 519 | 3,763 | 1,779 | 18,240 | 6,094 | 1,019 | 484 |
| 40 | ... | ... | 1,465 | ... | ... | ... | .... | ... |
| 50 | ... | ... | 500 | ... | ... | ... | .... | ... |
| Totals | 2,257 | 1,725 | 9,719 | 6,059 | 25,138 | 14,439 | 1,019 | 484 |

*Passenger Equipment.*

| | 1904. | 1899. | Increase. |
|---|---|---|---|
| Baggage | 105 | 64 | 41 |
| Coach and baggage | 28 | 32 | .. |
| Baggage and mail | 58 | 38 | 20 |
| Mail | 37 | 35 | 2 |
| Coach and mail | 16 | 13 | 3 |
| Coach baggage and mail | 23 | 22 | 1 |
| Coach | 269 | 193 | 76 |
| Chair | 67 | 57 | 10 |
| Dining | 15 | .. | 15 |
| Cafe | 2 | .. | 2 |
| Sleeping | 58 | 65 | .. |
| Special | 23 | 17 | 6 |
| Total | 701 | 536 | 165 |

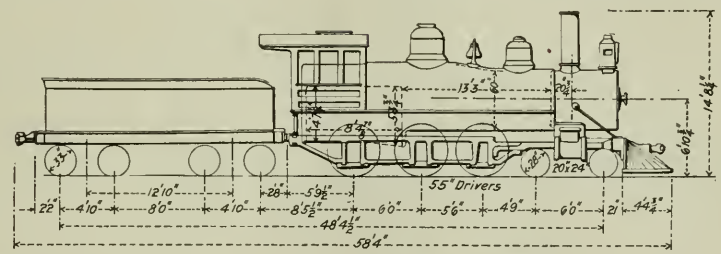
The totals in the above tables include all of the Missouri Pacific leased and operated lines.

In the five years between 1899 and 1903, inclusive, the Missouri Pacific spent $4,028,000 on new motive power and $14,560,000 on new freight equipment to take care of the new business which was being developed and to replace old and wornout rolling stock. Some of the money for this purpose was drawn directly from income, but most of the new rolling stock has been bought through car trusts. Equipment for the Missouri Pacific and branches is secured through the Missouri Pacific Equipment Association, and for the Iron Mountain and branches through the Iron Mountain Car Trust. The total amount of the notes outstanding on Dec. 1, 1903, was $11,759,800, divided about equally between the two associations. Payments on these notes are made out of income and are not charged to capital account.

In order to care for this new and constantly increasing equipment, the very inadequate shop and engine terminal facilities have been greatly enlarged at several of the most important points. New brick engine houses and repair shops have been built at Van Buren, Ark.; Kansas City, Mo., and Coffeyville, Kan. The principal repair shops of the Iron Mountain at Baring Cross, Ark., just across the river from Little Rock, were destroyed by fire in 1901, and have since been entirely rebuilt. The buildings are of brick and the new shops are modern in every respect. All of the heavy repairs to engines on the Iron Mountain are now done at this point, and the car repair shop is also located there. The main shops of the Missouri Pacific at St. Louis are old and not capable of handling the heavy repairs to engines on that part of the system. Work is now in progress on new shops at Sedalia, Mo., which will cost more than a million dollars. When they are completed, all the heavy repairs now done at St. Louis, Osawatomie, Kan., and at the present shops at Sedalia will be done in the new shops, and the shops at the two first mentioned points will be used for light and running repairs.

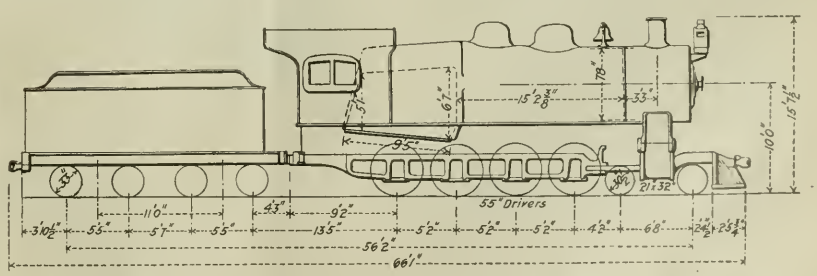
The mechanical department has been slowly carrying out a scheme of standardization in the rolling stock of all of the lines included in the system. This includes not only the general design, but as far as possible all of the details of car and locomotive construction. The standard box car, for instance, is now of the American Railway Association standard inside dimensions, with a capacity of 60,000 lbs. For the general traffic on the system this has been found the most economical and satisfactory class of box car, and large numbers of them have been built during the last five years. The 273 locomotives received since Oct. 1, 1901, were fitted with seven different styles of cross-head centers and five styles of gibs. They have all since been fitted with one style of cross-head and two styles of gibs, and similar standardization has been accomplished in other details. All of the supplies for this and other departments are purchased by and accounted for on the books of the Missouri Pacific Railway Company, and charged to the accounts of the leased or operated lines when given out on requisitions. This makes only one set of supply accounts necessary.

*(To be Continued.)*



| | | | |
|---|---|---|---|
| *Weight, total* | 126,800 *lbs.* | *Heating surface, flues* | 1,751 *sq. ft.* |
| *Weight on drivers* | 100,450 *lbs.* | *Heating surface, total* | 1,888 *sq. ft.* |
| *Diameter of drivers* | 55-*in.* | *Grate area* | 22.5 *sq. ft.* |
| *Diameter of cylinders* | 20-*in.* | *Tractive force* | 23,740 *lbs.* |
| *Stroke of cylinders* | 24-*in.* | *Boiler pressure* | 160 *lbs.* |

Fig. 4—10-Wheel Freight Engine, Standard in 1899.



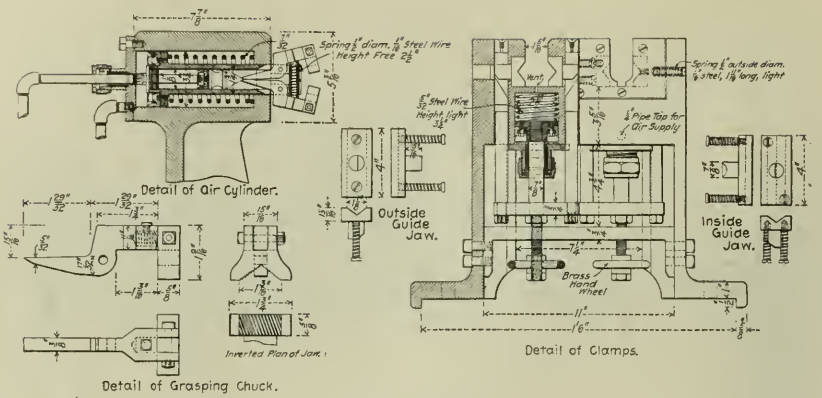
| | | | |
|---|---|---|---|
| *Weight, total* | 208,200 *lbs.* | *Heating surface, flues* | 3,127 *sq. ft.* |
| *Weight on drivers* | 172,000 *lbs.* | *Heating surface, total* | 3,383 *sq. ft.* |
| *Diameter of drivers* | 55-*in.* | *Grate area* | 62 *sq. ft.* |
| *Diameter of cylinders* | 21-*in.* | *Tractive force* | 43,622 *lbs.* |
| *Stroke of cylinders* | 32-*in.* | *Boiler pressure* | 200 *lbs.* |

Fig. 5—12-Wheel Engine for Heavy Freight Service.

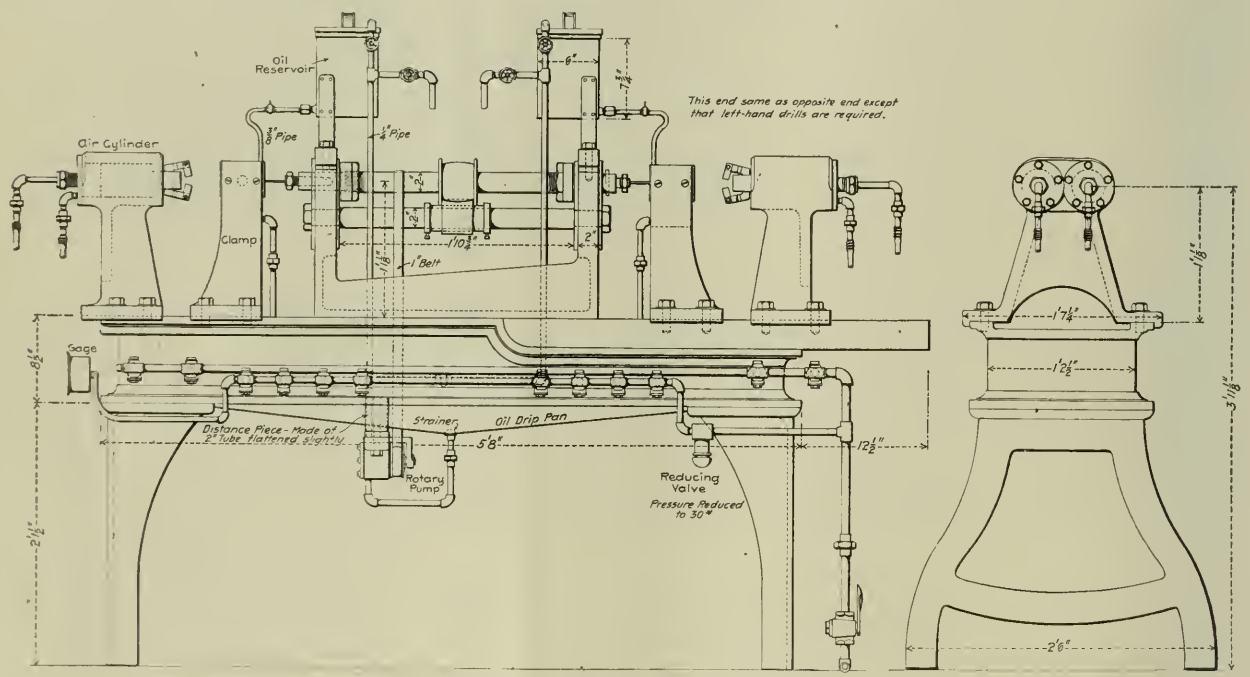
### Machine for Drilling Tell-Tale Holes in Stay-Bolts.

The machine illustrated in the accompanying engravings is used in the Union Pacific shops at Omaha for drilling tell-tale holes in stay-bolts. A discarded pipe-cutting machine was reclaimed from the scrap pile and equipped with two parallel shafts having sockets at each end for drill chucks. These shafts are mounted in suitable bearings and are provided with ball-bearing collars which act as thrust bearings to reduce the friction from pressure on the drills.

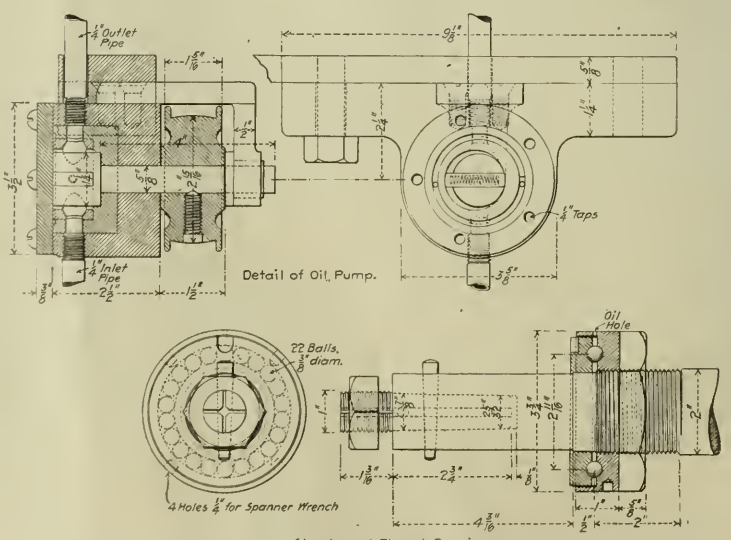
At each end of the machine are two air cylinders formed side by side in one casting. On the end of the piston rod of each are two small chuck jaws with a spiral spring between, which holds them apart normally. These jaws grasp the stay-bolt at one end. The piston rod, which is hollow, is also an air cylinder, the piston of which moves a wedge for closing the chuck jaws. The supply pipe for this latter cylinder passes through a stuffing-box at the back of the larger cylinder and moves back and forth with the piston of the latter, a flexible connection on the outside permitting this. Between the air cylinders and the drills are guide blocks. These are pneumatically operated and are equipped with V-shaped guides capable of being adjusted to suit the different diameters of bolts. The drills are lubricated by means of oil reservoirs. The oil is returned to these reservoirs by means of a rotary pump placed under the bed. The machine can drill four bolts at one time. At the side of the bed and convenient to the operator is a series of air valves for each end of the machine. These valves are numbered from 1 to 6 on the drawing. The different parts of the machine controlled by each valve are as follows: Nos. 1 and 2 control the supply to the inner or rod cylinders, to operate the grasping chucks. No. 1 being for the rear cylinder. Nos. 3 and 5 control the supply to the outer cylinders for operating the feed, No. 3 being for the rear cylinders. No. 4 controls the near jaws of the clamp guide and No. 6 the far jaws.




Details of Staybolt Drilling Machine.




Staybolt Drilling Machine—Union Pacific.




Details of Staybolt Drilling Machine.

The size of the drill used is $^{5}/_{16}$ in. and the depth of the hole is 1½ in. In the hands of a skilful operator six bolts a minute can be drilled on the machine. The entire process of preparing and applying the bolts is as follows: The iron is first cut off 1 in. longer than is required. The tell-tale holes are drilled and the threads cut, after which the bolts are nicked in a machine at the proper length for cutting off. They are then screwed into place in the sheets from the fire-box side with a special chuck, after which the nickel ends are broken off with a hammer and the ends of the bolts peened.

The stay-bolt drilling machine was designed by W. H. Mulcahy, one of the department foremen at Omaha. He has applied for a patent on it.

## Lightning and Automatic Block Signals.*

BY H. S. BALLIET.

The most annoying interruptions to automatic block signals in summer are those due to induced lightning discharges, which destroy fuse wires and the windings of electro-magnets. Sometimes these discharges are of sufficient potential and volume to heat the relay points and contacts so that they become fused together. Still another effect is the melting of line and other wires controlling the circuits. The total number of interruptions of the track circuit, due to a heavy downpour of rain or continued wet weather; broken bond wires; defective relay magnets; poor zinc in track batteries; exhausted track batteries and many other possible causes, is usually less than the number chargeable to induced or direct discharges of lightning.

Before describing some of the methods employed in an effort to reduce these interruptions, it may be well to consider their origin. Lightning is only the discharge of a Leyden jar on a large scale—a scale on which Nature often performs her operations. The air is almost constantly electrified by the friction of moving clouds and winds, and by heat and chemical changes, all of which disturb its equilibrium. The discharge of opposite electricities between two clouds separated by non-conducting air has no effect upon electrical circuits near or beneath the surface of the earth, because when the tension becomes sufficient to overcome the resistance introduced by the air between the clouds the two forces rush together with a flash, but the discharge will not be felt beyond the cloud line. If, however, the attraction between the positive electricity of the clouds and the negative electricity of the earth is of sufficient tension to overcome the resistance of the intervening air gap, there will be a discharge just above the earth's surface, or objects thereon. These discharges generally take place where there are large bodies of water either on or close to the surface of the ground, or in swamps, and on certain trees, principally oak and elm. Few cases are recorded where signal or track circuits, signal posts or poles carrying line wires for signal purposes have been in line of such a discharge; for, generally speaking, there is some nearby object which has a better ground connection. It is only the induced electrical action that manifests itself on the wires.

A good illustration of the effects of the electricity drawn up by induction from earth to the clouds and not vice versa, is shown by Benjamin Franklin's famous kite experiment in Philadelphia in 1752. In his experiment, the electricity flowed from the earth over the Leyden jar and key attached to the kite string, as indicated by the sparks created at the gap between the jar and key. As early as 1750, Franklin began experimenting with lightning rods with which to protect dwellings, barns, churches, etc. A letter written by him to a friend, dated July 29, 1750, refers to an opinion formed by him. He wrote: ". . . By directing us to fix on the highest points of those edifices, upright rods of iron made as sharp as a needle, and gilded to prevent rusting and from the point of these rods a wire run down the outside of the building into the ground or down round one of the shrouds of the ship, or down her side till it reaches the water. Would not these points probably draw the electrical fire silently out of the cloud before it came nigh enough to strike and thereby secure us from that most sudden and terrific mischief?"

This is the first recorded suggestion of a lightning rod and it will be noticed that the function of silent restoration suggested was merely a supposition and not an established fact. As a matter of record, it may be of interest to note that Franklin erected the first lightning rod on his house in Philadelphia in the month of September, 1752. He did not depend on the results to be achieved by making periodical examinations of the rod and its point after lightning storms in order to note the effect upon them, but by means of bells connected to these rods, he observed the induced effects during the progress of the storm. Franklin anticipated many of the theories which are to-day accepted as the proper interpretation of the mysteries surrounding lightning discharges.

The atmospheric phenomena attending electrical storms are well defined in Mr. H. W. Spang's book entitled "Perfect Railway Signaling." He classifies them as follows:

1.—"A terrific lightning discharge in a somewhat concentrated form usually between a high cloud and a body of water or an isolated object upon the earth, and especially in line with an underground water or gas main, railroad tracks, wire fences and overhead and underground electrical circuits, the discharge being attended usually with great destruction."

2.—"A lightning discharge in its greatly diffused form usually in connection with a low cloud and great rainfall and by numerous ramifications in line with a forest or a number of buildings or objects, especially those located in rural districts where there are no long metallic conductors."

3.—"Small discharges which take place in connection with electrical circuits, simultaneously with a concentrated or diffusive lightning discharge, and especially when taking place between the clouds and the earth within a distance of about three miles of an electrical current."

4.—"Small discharges upon electrical circuits arising from a greatly increased air potential and without a lightning discharge, sometimes produced by high wind, and especially in connection with sand, dust and snow storms, escaping steam from a locomotive, etc., or induced thereon by powerful electrical currents upon adjacent electric light and other similar lines. These are usually known as sneak currents and are sometimes of sufficient intensity to fuse the fine wires of telephone, telegraph and other similar apparatus."

Observations taken at various points along different railroads indicate that signal circuits running east and west are disturbed for greater distances than those running north and south. Occasionally a storm will extend parallel with a north and south circuit, but these exceptional cases seem to be confined to wires of great length. It is an easy matter to demonstrate this by comparing the difference in the discharges from the various line wires comprising an overhead line circuit signal system, as registered on an ordinary saw tooth arrester. If the common return wire is from 15 to 30 miles in length, the induced lightning on it keeps up a continual sparking, whereas, the indicator home and distant controlling circuits only show a spark of a flash at infrequent intervals. By a careful study, one may closely estimate the length of the common return wire, as compared with the shorter circuits, by noting the intensity and frequency of the discharges.

Signal circuits (not track circuits) are sometimes operated by using the ground for the return; there again is opportunity for comparison—lightning discharging more readily to such circuits than to those before mentioned. Where signal circuits are run from the line underground either through cable or rubber insulated wire, there is greater susceptibility to lightning discharges. Defective insulation in underground wires is often due to lightning discharges to earth. After the discharge has broken through the insulation, electrolysis sets in and destroys the wire. These breaks are not easily located, though if corrosion has not set in, the insulation remains intact and the break can usually be located with a galvanometer or portable Wheatstone Bridge. I have never known of a case where the discharge arced to the earth through the rubber insulation of the wires connecting the rails to the relay magnets. On underground connections to the rails corroded wires are rarely found. On some railroads the number of feet of wire in use for track circuit connections and for line connections is about equal; and, generally speaking, not more than two corroded wires will be found in track circuit in a year (these probably due to kinks) against about 50 in the signal wires.

Some good judges claim that direct lightning discharges, damaging to electrical circuits, are increasing year by year, and that they are becoming more destructive. An experience extending over a period of ten years in an extended territory does not confirm these assertions. Lightning discharges, or more properly the induced effects, are irregular, and we have no records that indicate their frequency. The season of 1904 is, from records available, the most troublesome in the past five years. Our most frequent difficulty is that due to small discharges. These do not usually destroy apparatus, but where the fuses are from 0.3 to 1.0 ampere capacity, they are burned out, signals fail to clear, trains are delayed.

Frequently lightning is traceable on track circuits; as near as can be determined, this condition is most likely to occur before the rain falls and while the ground connection to higher objects is poor. Rarely is a case reported in which apparatus connected with the track circuit is deranged after the rain has begun to fall.

*(To be continued.)*

*Articles by Mr. Balliet on the performance of automatic signals under unfavorable conditions were published in *The Railroad Gazette*, of Feb. 26, March 25, April 15, May 20, July 1, July 8, and Sept. 2.

At a meeting of the Swiss Natural History Society recently a member of the Council of the Confederation, Mr. Sulzer-Ziegler, in a lecture on the geological survey for the Simplon Tunnel and the practical experience in excavating it said that if the geologists, basing their opinions on the experiences in excavating the Mont Cenis, the Arlberg and the Gotthard tunnels, had not made such positive statements on the character of the rocks, the temperatures, etc., which would be encountered in the Simplon Tunnel, that great work would probably never have been undertaken; at least it would not if the difficulties actually encountered had been suspected. Difficulties altogether unanticipated

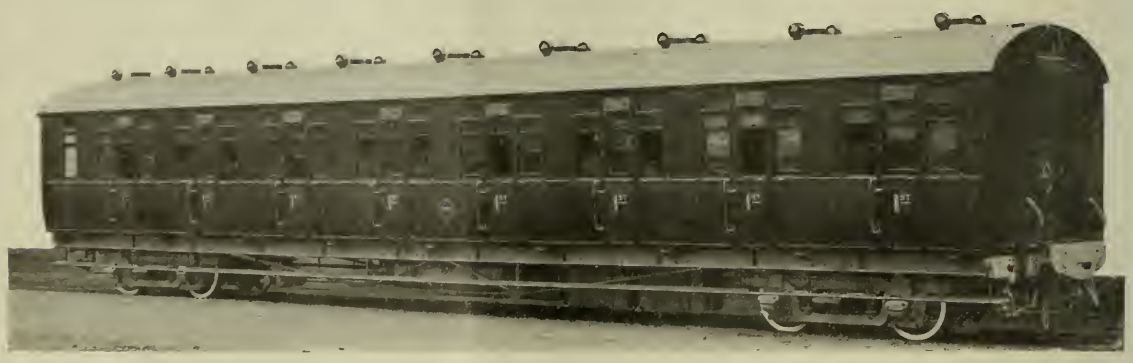
five different times threatened to put an end to the enterprise. Among the most formidable of the obstacles was the pressure from the sides inward and from the bottom upward in a certain section of the south end. Great oak timbers used to resist this pressure were bent, split and broken like matches, and heavy T beams with which they were replaced were sometimes bent. The greatest danger to the workman was where the rock was soft or decomposed. The harder the gneiss or granite the more safely and also the faster the excavation advanced. At a distance of 32,700 ft. from the south entrance, the supports had to be advanced for every inch of advance in excavation. The geologists had announced a maximum temperature of 118 deg.; the actual maximum was 131 deg. The drainage of the great springs was another serious obstacle, gushing out at the rate of 240 gallons per second; but worst of all were the hot springs, which compelled the abandonment of drilling on the north end after the summit had been passed, pouring out a great stream at a temperature of 151 deg. to 162 deg. When the two headings were yet nearly 2,000 ft. apart, the blasts at the north could be heard at the Italian end; and it is believed that this indicates solid rock between, which is encouraging.

## New Cars for the Central South African Railroad.

During the past eighteen months some extensive orders have been placed in Great Britain for new rolling stock for the Central South African Railroad, to replace that which was damaged or destroyed during the recent Boer war, and also with the aim of dealing more economically with the rapidly increasing traffic between the seaports of Natal and the extensive mining properties in the Rand. Operating conditions in the Transvaal and Orange River Colonies are more nearly like those found in America than those which are to be met with in Great Britain. The haul is long, the consignments are in large bulk as a rule, the clearance limits are large, and many of the mines which receive and ship large quantities of freight have arranged their loading and unloading platforms and plant to suit the requirements of high-capacity cars of modern design. The track is 3 ft. 6-in. gage, which is standard in South Africa, and is laid for the most part with 60-lb. rails of Vignoles section, although in some places there are stretches of 52-lb. rail. Good ballast, in plentiful quantities, is obtainable, and the rails are laid on steel and wood sleepers. Much of the 60-lb. rail is now being replaced with 80-lb. rail.

While the line was still under military administration during the latter part of the war it was seen that more rolling stock would be required, and it was decided to order a large number of new cars, suitable for the traffic which was to develop. Orders were accordingly placed for a number of cars of two types; a high-sided steel gondola of 60,000 lbs. capacity and a tare of 30,500 lbs.; and a pressed steel hopper bottom coal car of 60,000 lbs. capacity and a tare of 29,600. The cars of the first type were built in Great Britain, and the cars of the second type were built in the United States. These orders were immediately followed by an order for 1,250 more of the gondolas with a capacity of 70,000 lbs. Of these, 1,000 were built of structural shapes and have a tare of 30,200 lbs., and the remaining 250 cars were built of pressed steel with a tare of 29,200 lbs. As the number of unloading platforms suitable for hopper cars was increased, additional orders were placed for 100 cars of this type, built of structural shapes, and 150 cars of pressed steel. This last type of cars have a capacity of 80,000 lbs. and a tare of 36,500 lbs.

40-Ton Steel Hopper Coal Car for the Central South African Railroad.



First Class Corridor Car for the Central South African Railroad.

The accompanying illustration, Fig. 1, shows one of these latest 80,000 lb. pressed steel hopper cars which are just being put into service. They have the following dimensions: Length over buffers, 39 ft. 3 in.; length inside, 36 ft. 5½ in.; width inside, 7 ft. 5⅜ in.; height from top of rail, 9 ft. 9 in.; center to center of trucks, 25 ft. 6 in.; cubic capacity, 1,428 cu. ft.; ratio of dead load to paying load, 45.6 per cent. These cars were built by the Leeds Forge Company, Leeds, England, and are fitted with Fox pressed steel underframes and trucks, and Central South African standard draw and buffing gear. They have longitudinal hopper doors operated by a form of gear which locks automatically when the doors are closed. The operating gear consists of a transverse shaft in the center of the car, which can be turned with a socket crank from either side of the car. This shaft is geared through a worm and wheel to a longitudinal shaft mounted between the center sills. The discharging doors, two on each side, are hinged at the top and incline out toward the side of the car. They are held closed by a pair of toggle links at each end of each door, which extend across under the bottom of the car. These toggle arms are connected at their joint in the center with a short vertical toggle link fastened to an arm keyed to the longitudinal shaft. When the crank arm on the side of the car is turned, the longitudinal shaft is revolved and the short toggle arms are bent together. This draws the door toggles up in the center and allows the doors to swing in and give any desired opening for discharge. When the doors are fully closed the toggle arms lock themselves. Before being shipped to South Africa, one of these cars was loaded with a test load of 240,000 lbs., and received no permanent set or injury in any way as a result. The satisfactory results obtained from the high-capacity cars now in service have led the management to decide upon the adoption of 100,000-lb. cars with a tare of 39,400 lbs. and a length over all of 38 ft. 9 in. for handling the rapidly increasing coal traffic.

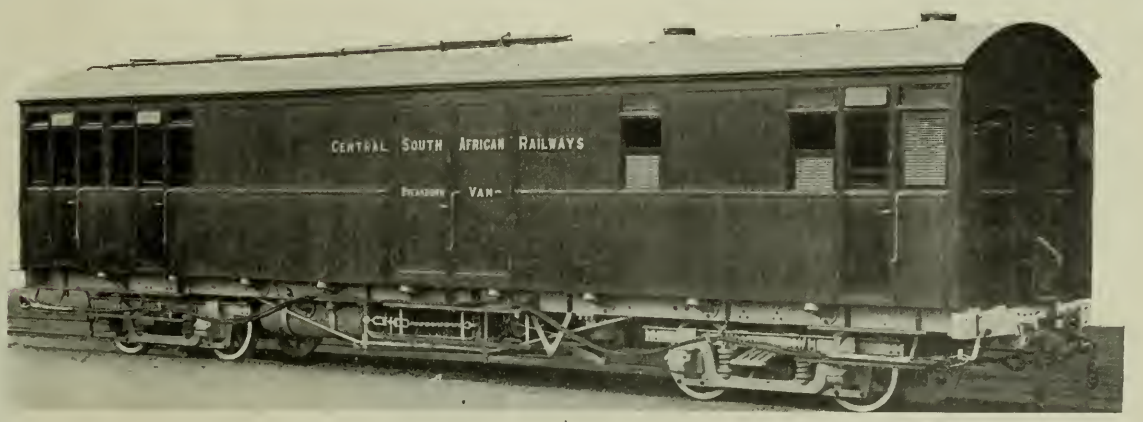
In addition to a large number of passenger cars for through trains, which were ordered some time ago, the Central South African has also ordered a number of first and third-class corridor coaches for local and suburban service in the Rand. One of the first-class coaches built by the Gloucester Railway Carriage & Wagon Co., of Gloucester, England, is shown in Fig. 2. These cars are 60 ft. 1¼ in. long over body, 59 ft. 9 in. long over underframe, 6 ft. wide over underframe, 9 ft. 1¾ in. wide over body, 11 ft. 1 in. high from top of rail, 2 ft. 10¾ in. from top of rail to center of buffers, unloaded. They have steel channel and angle bar underframes, stiffened with truss rods, and are mounted on steel frame equalized trucks with teakwood bolsters, which are very similar to the usual practice in the United States. The wheels have open spoke wrought-iron centers and steel tires, and the

journals are 4¼ in. x 9 in. The body of the car is framed with teak with steel panels. It is divided into eight compartments seating eight persons each, with an open corridor running through the center. A lavatory is placed at each end of the car and the main water supply is carried in tanks slung under the car, from which it is pumped as required into service tanks fixed in the roof over each lavatory. The cars are heated by steam with a heater coil under each seat, and are lighted throughout with electricity generated from the axle; oil lamps are also provided in each compartment.

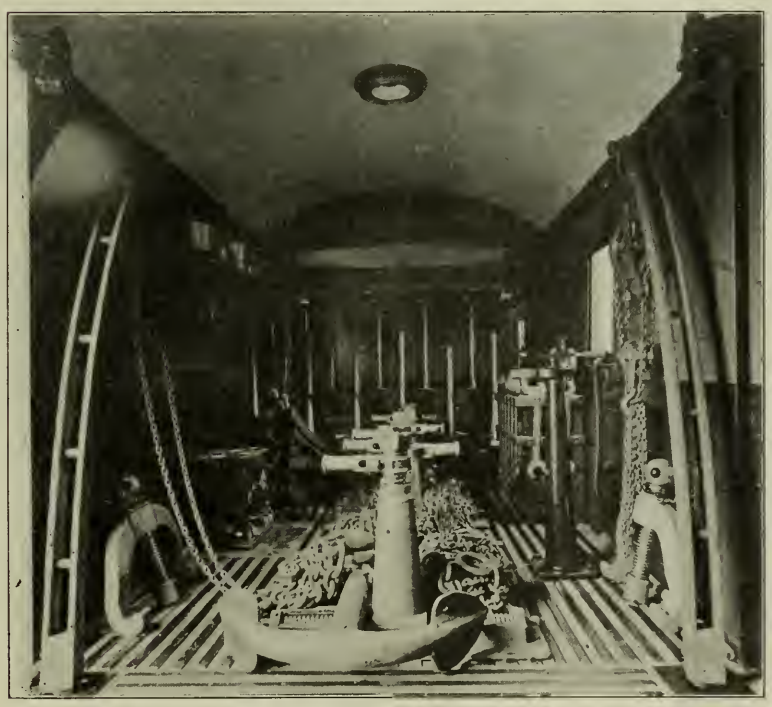
compartments are finished in the plainest manner, being lined with painted matchboarding and polished teak mouldings; the seats are plain deal, painted. These third-class cars weigh about 56,000 lbs., and the first-class cars weigh about 64,000.

The Gloucester Railway Carriage & Wagon Company has also furnished the Central South African with a number of breakdown vans or wrecking cars, one of which is shown in Figs. 3 and 4. They are 45 ft. 1¼ in. long over body, 45 ft. long over underframe, 6 ft. wide over underframe, 8 ft. 3 in. wide over body, and 11 ft. 11½ in. high from

hydraulic jacks of from 10 tons to 30 tons capacity, a heavy anchor for holding guy ropes and tackle, chain cables, hooks, sheave blocks, rail benders, shovels, picks, axes, mauls, sledges, saws, sets of spanner wrenches, car replacers, and numerous small tools, including a Wells light for night work. Wire cables are slung on hooks on the underframe outside the car, and a cradle underneath the floor carries a supply of 9-in. x 4-in. blocking. In the tool compartment there are also a stretcher, two surgical chests containing instruments and drugs, a medicine cupboard, cook stove and work bench with




Breakdown Van or Wrecking Car for the Central South African Railroad.



Tool Compartment in Wrecking Car.

The interior finish is plain and simple, to prevent the accumulation of dust. All of the woodwork is polished teak and the ceiling is lined with lincrusta tinted a light coffee color. The seats are upholstered with dark-green buffalo hide without buttons, and the floor is covered with linoleum with carpet rugs between the seats.

The third-class cars have six compartments and will seat 72 persons. They also have a baggage compartment with two doors and a guards' compartment. The passenger

top of rail. They are divided into three compartments, a sleeping compartment at one end for the white men, a workshop and storeroom for tools in the center, and a double compartment at the other end for the Kaffir laborers. The tool compartment has large double folding doors on each side, and at each door on the inside of the car is mounted a jib crane with a 1-ton chain block hoist, which may be swung out to the side of the car. The equipment also includes an assortment of traversing screw jacks and

vise and the necessary tools carried in racks. The body of the car is framed with teak with matchboards of the same material on the exterior, and inside lining boards of red deal. The car is lighted with oil lamps and weighs about 50,000 lbs. All of the company's new rolling stock, both freight and passenger, is fitted with automatic vacuum brakes, and the passenger cars all have automatic couplers.

## Telephones on Railroad Telegraph Lines.*

The Chicago, Milwaukee & St. Paul has experimented between Chicago and Milwaukee, 80 miles, on copper and iron metallic composite systems, which experiments at first were not entirely satisfactory, due to the natural impedence in the underground cables in the cities of Chicago and Milwaukee. This disturbance, however, was overcome by the substitution of a twisted pair of wires through the telephone company's underground cables. This circuit is carried on a pole line with all kinds of simplex and multiplex telegraphs where the disturbances are greater than in any other locality except New York city.

The Lehigh Valley has a specially constructed and fully transposed copper metallic composite circuit between Jersey City and South Bethlehem, 90 miles. The same road has two composite single line circuits; one 14 miles in length with four intermediate telegraph offices. It is equipped with the American Telephone & Telegraph Company's magneto ringing composite, No. 227, the wire being No. 9 iron, 94 miles long with the telephone introduced in the center. There are four adjoining telegraph wires on the poles, but no multiplex systems, electric light or power line disturbances in the field.

The second grounded circuit on the Lehigh Valley covers a distance of 43 miles with five intermediate offices equipped with

*From Committee Report on Composite Circuits made to the Association of Railway Telegraph Superintendents at Indianapolis.

the American Telephone & Telegraph Company's ringing composite, known as No. 236, on a No. 9 iron wire, 105 miles long, with two telegraph wires on the same poles for the greater portion of the distance, and six to seven wires in a distance of ten miles. The composite was introduced at the northern end of the line where there are no disturbances. Both of these circuits are working satisfactorily.

The Chicago, Burlington & Quincy has, during the past year, made quite a considerable use of the railroad composite apparatus, and the results have been reasonably satisfactory. The first circuit installed connected a transfer point with a trainmaster's office, 23 miles distant, and soon after this circuit was extended to the end of the division, making the circuit 69 miles long. There are on the poles carrying this line, from 17 to 28 wires, nine of them quadruplex circuits. The wire in use is a single telegraph circuit.

Another Burlington circuit that is working satisfactorily, connects the division superintendent's office and master mechanic's office at the division headquarters with an important junction point 24 miles distant, and with the division terminal, 31 miles further on. This circuit has recently been extended by hooking up another instrument distant 49 miles still further on on a different wire; the two wires being connected together through a condenser. This makes the total length of the circuit 104 miles. The line is employed largely as a means of general communication, and from blind sidings it is used by trains which may require help from the despatcher. There are 13 wires on the poles through most of this territory, five of them being quaded wires.

The Burlington has three circuits radiating from a division headquarters, all three being hooked together by means of condensers. Two circuits connect the division headquarters with blind sidings, one circuit being 40 miles in length, the other 37. The third circuit is 74 miles long. All instruments work with one another without trouble. On the poles carrying these circuits, are from seven to 12 wires, the maximum number of quaded wires being four.

Some time since the Burlington road equipped a pile driver with two sets of instruments, and as it was necessary that signals be passed both ways, two sets of style No. 236, were used. The seven cells of Edison battery for each instrument were placed in a tray with handles to facilitate handling, the cells being sealed with paraffine wax. The results obtained were so satisfactory that the road named will make considerable use of the scheme in connection with work trains. It is hoped, however, that our friends, the telephone companies, will develop a set of instruments capable of receiving signals and still be a little more portable than the No. 236 type above mentioned.

Recently the Burlington had a bad bank slide which required several weeks' use of the steam shovel to repair damage. In this instance the telephone was employed in place of the telegraph to control the movements of the work train.

All the circuits of the Burlington road are on iron wires. Experiments with copper wires have indicated that better transmission for greater distances can be secured through their use, but all copper wires are quadruplexed, and as some little disturbance was felt on the quads through efforts to use them for telephone purposes, no regular use is now being made of those circuits.

The Erie has, perhaps, the longest single line composite system in operation up to the present time. In August, 1903, an installation was completed between Cleveland and Galion, with intermediate telegraph and telephone offices at Leavittsburg, Kent and Akron, or five stations in all. One of the wires used was a No. 11, or 210-pound copper wire, worked single between New York and Chicago, 1,000 miles, with a side line composed of a No. 8 iron wire through a repeater at Leavittsburg, thence 50 miles to Cleveland. This No. 8 iron wire between Leavittsburg and Cleveland was used as one side of the circuit in the original experiments. The second wire was composed of 174-lb. copper wire extending as a telegraph circuit from Cleveland to Chicago via Leavittsburg, 459 miles. Both wires passed through two miles of underground cable in Cleveland. The American Telephone & Telegraph Company's No. 227 hand generator ringing sets were used, polarization cells were bridged around intermediate relays, and flat condensers around intermediate offices.

It was impossible to get good commercial talk from Cleveland to Galion, 169 miles, or from Cleveland to Akron, 87 miles, although it was good from Cleveland to Kent, 61 miles, and to Leavittsburg, 50 miles, notwithstanding the unbalanced condition of the wires. A test made from Newburg, Ohio, four miles beyond the underground terminal in Cleveland, gave very fair transmission to Galion, 163 miles, but the disturbances on the telegraph side from ringing and the inequality of the two wires caused the Erie to change on Oct. 15, 1903, to a grounded circuit; building up such circuit to consist of 174-lb. copper wire the entire distance except through cables.

The hand generator ringing sets, No. 227, were exchanged for the battery ringing type, No. 236, with seven cells of type BB Edison battery. This arrangement eliminated the disturbances on the telegraph and gave the Erie a satisfactory talk from Cleveland to Galion, 169 miles; but they could not find an adjustment of the ringing apparatus which would enable them to ring Galion from Cleveland, although intermediate stations could ring each other.

The frequent punctures of condensers by lightning was very considerably reduced by the substitution of Argus lightning arresters, and the Erie now has a fairly reliable telephonic communication for 169 miles, using the telegraph to call the distant terminal to the telephone and relieving the telegraph side of conversation which used to tie up the telegraph wire an hour at a time.

The conditions surrounding the Erie circuit are as follows: Two miles of underground cables; 48 miles of poles carrying 37 telegraph wires used in simplex, multiplex and automatic telegraph systems; 119 miles of pole line carrying seven telegraph wires with no electric light or power transmission wires paralleling. A composited wire belonging to the Cleveland, Akron & Columbus parallels the Erie wire for about one-half mile and "cross talk" was audible on May 3, 1904, but not of sufficient volume to destroy the privacy of the circuit.

It is the sense of your committee that the composite system is of considerable value as an auxiliary to the telegraph in railroad service, under favorable conditions; that, in its present stage, it is limited to one circuit on any one pole line and cannot be considered as a satisfactory intercommunicative system worked in connection with a public or private branch exchange.

## A New Pipe Cutter and Pipe Wrench.

The accompanying illustrations show two new tools recently put on the market by the Headson Tool & Manufacturing Company, Lafayette, Ind. The Headson pipe cutter is illustrated by Fig. 1, which is from a photograph of a sectional model of the tool so as to show the details of its construction. The object of this cutter is to do away with the necessity of reaming the inside of the pipe to remove the burr formed by the usual types of wheel cutters. Furthermore, the pipe is cut squarely without crushing or otherwise damaging the material of the pipe. The cutter consists essentially of a high grade tool-steel cutting tool, (o), fastened rigidly to the tool holder (4) by means of the cap and screws, (7). The tool holder is free to slide back and forth in the holding block (3), its motion, and hence the feed of the tool, being controlled by turning the handle (6) which is rigidly fastened to the feed rod. The tool is adjusted to the pipe by merely pushing forward on the handle until the anti-friction rolls, which guide the cutting tool, come in contact with the pipe, after which a slight turn of the fluted handle (5) brings the pipe in firm contact with the jaws (10) and the rolls. The cutter is then operated in the usual manner, the tool being gradually fed in by means of the feed rod which passes through the hollow rod controlling the motion of the holding block (3). The cutter can be opened to its full width by releasing the split nuts at the rear of the main frame and pulling back on the handle. It is claimed that the cutter also saves a good deal of time owing to the ease with which it can be adjusted and to the finished character of the work which it does.

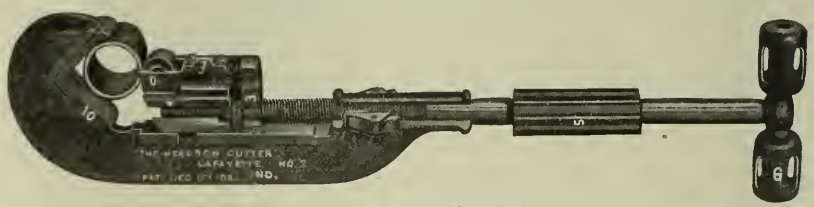



Fig. 1—The Headson Pipe Cutter.

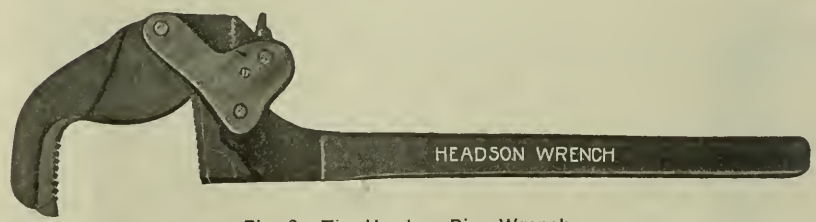



Fig. 2—The Headson Pipe Wrench.

The Headson pipe wrench shown in Fig. 2 is simple in construction and quick of adjustment. The handle is merely moved forward to adjust the jaws to any size pipe. A firm grip is obtained, it is impossible to crush the pipe, and the wrench does not stick. The inserted jaw in the handle can be replaced if necessary and all parts are made of drop forged steel and are interchangeable.

## RAPID TRANSIT IN NEW YORK.

When the Ninth avenue elevated road was built in 1876 as far north as Fifty-ninth street and was followed in 1878 by the Sixth avenue line built as an independent project, and in 1879 and 1880 by the Third and Second avenue lines respectively, the citizens of New York congratulated themselves that they had secured true rapid transit for all time. For a brief period, persons living in the northern part of the city and going to business daily in the southern part were enabled to make the trip not only quickly but comfortably, and the surface lines reflected the better facilities offered by the elevated roads in a marked falling off of traffic; but New York, shaped like a lead pencil, with the business done at the point, outgrew the capacity of its elevated lines many years ago, while the surface lines, spreading in extensions and ramifications unthought of in 1876, not only regained many times the lost traffic but became so congested by the movement of cars alone, apart from street obstructions, that in the words of President Vreeland, they no longer attempt to furnish rapid transit, and do not really compete nor desire to compete for the through travel. In a paper printed in the *New York Sun* last year, Mr. Samuel Whinery made a forecast of New York's future transportation needs which was at once startling and pessimistic in view of what it is apparently possible to accomplish. He quoted Mr. W. W. Wheatly to the effect that while in 1860 the average number of rides per capita in what is now the Borough of Manhattan was only 47, in 1880 it had risen to 182, in 1900 to 388, and in 1903 to over 400. At the same general rate of increase, the rides per capita in Manhattan Borough alone would reach about 550 by 1915. Although when the entire population of Greater New York is included, the number of rides per inhabitant is somewhat less, Mr. Whinery believed it safe to estimate that this number in 1915 would not be less than 400. (*Railroad Gazette*, Nov. 20, 1903). On this basis, with a conservative allowance for increase in population, the number of passengers to be provided for eleven years from now would reach the stupendous figure of 2½ billions, or just about double the number that now rides.

Much space has been given in the present issue to a description of the New York Rapid Transit Subway, which is now nearly ready for public use. Its construction was a remarkable engineering feat, for it was necessary to cut for a considerable part of the distance through solid rock, and to build a tunnel structure close to the surface of streets extremely congested with surface traffic, so that even slight obstructions caused by the work created a serious difficulty. It was necessary to use the methods of heavy railroad construction in a rocky country as modified by the extremely onerous limitations of the most crowded American city; but the work was completed, so far as essentials are concerned, considerably ahead of the contract time, in spite of the strikes which may be so confidently counted on to obstruct any kind of construction work done on a large scale in the city of New York.

The Rapid Transit Subway, like the new elevated lines of 25 years ago, may be expected to relieve the congestion of traffic only for a brief time. Geographically, Greater New York does not cross the Hudson river, but the cities of Jersey City, Hoboken, Bayonne and Newark pour their thousands into the Metropolis every day. These four cities had a population of 407,564 in 1890 and of 544,589 in 1900, an increase of over 33 per cent. Every town in Hudson, Essex and Bergen counties contributes to the myriads for which the railroad system of New York must furnish transportation. These counties had a population of 579,450 in 1890 and of 823,541 in 1900, an increase of over 42 per cent. From the west bank of the Hudson to the cities of Elizabeth and Paterson, distant 13 and 16 miles respectively, the intervening territory may be described as one continuous city, where dwell at least one million people. It is estimated that in 1902, 108,500,000 persons were brought to the city by the Hudson river ferry fleet. The subway may be expected to have a capacity on its four-track section of some 350,000 passengers a day, or perhaps 125,000,000 a year, to be added to the present carrying capacity of all local transportation lines in Greater New York, estimated at approximately 1,167,124,000 a year. The utter disparity of these combined figures with the number of rides which it may be reasonably expected will have to be provided for only eleven years hence, according to Mr. Whinery's conservative estimate, is the true measure of New York's transportation problem, in which scheme of transportation the subway is only a single link.

The principal engineering features of the subway were so fully described in the last report of the Rapid Transit Commission, a full extract of which was printed in the *Railroad Gazette* of Sept. 4, 1903, that they have only been touched upon in the series of articles in the present issue. The work has so many sides and so many different aspects of interest that it has seemed best to describe it in five separate articles, so that each of the main topics will be found complete in itself. These topics deal with early transportation in New York, with the history and physical aspects of the subway, with its traffic features, its power equipment and its safety devices. In addition, a paper is reprinted from the Proceedings of the Institution of Civil Engineers of London, describing the method employed in building the tube railroad in that city by tunneling with a shield through the stiff blue clay. This work affords an interesting contrast with the building of the New York subway.

## THE ENGINEERING STANDARDS COMMITTEE.

The English Engineering Standards Committee has been doing much more work than is generally known in this country, and it has covered more ground than any one of our societies here. On page 348 we give a diagram, or tree, starting with the Main Committee, and showing how the sub-committees have branched out from it. The Committee on Electrical Plant has grown both ways from the center, and is now sprouting out at one end. It bids fair to equal all of the others combined if it keeps on growing. The Main Committee has complete control of this work, and is composed of men well fitted to carry it through to successful completion. They are as follows:

James Mansergh, Esq. (chairman); Sir William White, K.C.B.; Sir Benjamin Baker, K.C.B.; Sir John Wolfe Barry, K.C.B.; Sir Douglas Fox, J. A. McDonald, Esq. (Midland Railway); Prof. Unwin (City and Guilds of London Central Institution). *Nominated by the Institution of Civil Engineers.*

E. Windsor Richards, Esq. (Guest, Keen & Nettlefolds, Ltd.), William H. Maw, Esq. *Nominated by the Institution of Mechanical Engineers.*

G. Ainsworth, Esq. (Consett Iron Co.); Arthur Cooper, Esq. (North-Eastern Steel Co.) *Nominated by the Iron and Steel Institute.*

Archibald Denny, Esq. (Wm. Denny & Bros.); Francis Elgar, Esq. *Nominated by the Institution of Naval Architects.*

Sir William Preece, K.C.B.; Col. Crompton, C.B. (Crompton & Co.). *Nominated by the Institution of Electrical Engineers.*

Dr. Tudsbery (Hon. Sec.) Institution of Civil Engineers; Leslie S. Robertson, Esq. (Sec.), 28 Victoria Street, S. W.

The first work undertaken by the committee was the standardization of rolled sections used in shipbuilding, etc. This work was completed some time ago and issued in convenient form for use. It covers equal angles, unequal angles, bulb angles, bulb tees, bulb plates, Z bars, channels, beams and T bars.

This was followed by a very complete set of tables, giving "Properties of British Standard Sections." These are both well known in this country, and many have wrongly drawn conclusions that the matter of specifications and the testing of materials were not being considered by the committee; but, as a matter of fact, this is a very important part of their work, and several specifications have already been issued, as shown by the following: Specifications and Sections of British Standard Tramway Rails; Report on the Influence of Gage Length and Section of Test Bar on the Percentage of Elongation, by Professor W. C. Unwin; British Standard Specification for Tubular Tramway Poles; Forms of Standard Test Pieces; British Standards for Electrical Machinery. In addition to these the committee is now working on specifications and tests for steel castings and forgings used in marine work, and specifications of locomotive steel plates, tires, axles, steel springs, steel bull-head rails, flat bottom rails, etc.

Mr. Leslie Robertson, Secretary of the Main Committee, is now in this country to learn at first hand what has been done here toward standardizing specifications, and to give our engineers full information as to what has been done by his committee up to this time, and what work they now have under consideration. These meetings will be held in New York City and Chicago. They are, in a sense, preliminary meetings to decide on subjects that can be taken up to the best advantage at the Engineering Congress in St. Louis. It is expected at that time that there will be a general discussion on the most important features of specifications for

structural steel, rails, etc. The importance of the work which the committee is doing is, perhaps, not fully appreciated. We have already commented on the desirability of international standards for testing materials, but after all such standards are but a preliminary step towards the adoption of international standard shapes, etc. If the work which the committee is promoting is carried to a successful end, it will have served a useful purpose, and the ends desired certainly warrant the hearty co-operation of all interested in the manufacture and design of engineering materials.

## MUTATIONS OF RAILROAD INVESTMENT.

The mutations of railroad investment in the United States may be divided into four periods, each with pretty distinctive lines of demarcation. The first takes us through what may be classed as a kind of "empirical" and speculative epoch, reaching from the first railroad ventures in the thirties down to the close of the Civil war in 1865. As the adjectives prefixed to the period imply, the railroad building and railroad projects of the time were, for those days, venturesome. The great future of American railroads was unforeseen or seen but dimly; as new investments railroads were rated as hazardous, if not extra-hazardous; the dividend rate which could carry the market price of a railroad stock to par had to be high—as high, sometimes, as eight or ten per cent.; and the few bonds issued at a period when bonds were unclassified and usually simple first mortgage securities, also had to carry a seven per cent. return to lift them to the par point of 100. Consolidation had hardly begun; but the basic stems had been laid for the great systems which were to come.

The second period reaching, in a general way from the close of the Civil war down to 1880, inclusive, is historically perhaps the most interesting of all to the student of railroad investment. Its leading features—the onset of the fever of railroad building, the first important steps in consolidation, the struggles of rivals for territory and all leading up logically to the panic of the autumn of 1873 and the years of stress that followed—are too familiar to need rehearsing at length. But two investment features of that period never seem to have attracted due attention. One was the persistency with which railroad bonds of high security continued until somewhat later than 1873 their profitable return to the investor of six or even seven per cent.; and a second feature was the fall of that return to a point usually between 4 and 5 per cent. during the latter part of the "long drag" between 1873 and 1881. First class railroad stocks that continued their dividends fell decidedly during the stressful years following the great panic; but, in general, first class railroad bonds slowly but pretty steadily rose. The seeming anomaly had, however, its explanation in the psychology of railroad investment. Hard hit by losses in stocks and with fears of other losses to come, the railroad investor turned to gilt-edged bonds, and the demand reduced the return on them to the 4 per cent. rate, which has never since been exceeded except for a few months at the very bottom of the depths of financial depression. In this steadiness of the better classes of railroad bonds reaching now through almost three decades of time is to be found the strongest pledge of the intrinsic soundness of the American system of railroads in its relations to investment capital.

The third period, spanning some eighteen years following 1880, had also some impressive characteristics. Consolidation became active—though not, as in later years, stupendous—and with the extinction, in many cases, of local rivalry came the epoch when questions of rates were transferred from legislatures and State railroad commissions to federal jurisdiction. Railroad construction leaped about 100 per cent.; and the dividend and interest return for the investor ran steadily down until the holder of old 7 per cent. bonds found his income reduced one-half. To the latter part of this period belongs, too, the electric railway rivalries with steam and an entirely new set of problems for the steam railroads to solve; problems which are not solved yet—the electric roads meanwhile creating not merely a form of competition in traffic but in investment also.

So we have reached the fourth and present epoch with its "high finance," in which the investor fronts a set of conditions, in many respects quite new and often puzzling. During the last four or five years he has gone to bed at night deeming himself the owner of a certain block of shares of high-grade railroad stock with voting power; he has waked in the morning to find his voting power passed over to a holding company and "blanket mortgage" bonds displacing his stock. He has gone to business in the morning as a shareholder in one company and returned home in the afternoon to find his personality lost in a corporation of other interests and bearing another name; and, to generalize broadly, he has found his individuality merged, faded and all but eclipsed in the mazes of new combination, carrying sometimes an Ossa upon Pelion of new obligations. If the railroad investor is a holder of an old bond of quality, whether senior or junior, he can go to bed and sweet rousing; otherwise, with the risk of awaking to rude surprises. In the second period of our study—a period of adversity—the stockholder was apt to be snuffed out by foreclosure of the underlying mortgage; in the last period—a period of prosperity—he has been snuffed out by the reverse process of plastering a mortgage over stock. In what we may call, in perhaps too stilted terms, the four ages of railroad investment—Projection, Reaction, Expansion and Consolidation—the last, while much the shortest, has also been the most dramatic.

Will the dramatic age prove also a tragic one? Will "high finance" and the changes wrought by great aggregations of capital in few hands and too often used selfishly spell the downfall of the smaller individual railroad investor? We do not think so. Sharply as the device of the too often speculative "holding company" is to be criticized in certain directions, it has not always involved large increase of new stock; the character of the stock is known; and the foreclosure powers of the new and great issues of bonds, if exercised hereafter, is likely to be at the expense of the holding company, and the old shareowners will merely come again to their own. Over and above all else is that immutable law of the final conservatism of capital by which sane reaction invariably follows speculative action and overtakes it. The railroad investor who has lived in manhood for a third of a century or more has seen many shiftings of railroad conditions, and he will probably see more—for example, some striking readjustments in the relations of railroad securities to the market and to each other as the steam-electric problem moves toward solution—but his property is there in concrete shape and under conditions of value both intrinsic and enduring.

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The construction of the New York subway necessitated the tearing down of a 12-story steel building at Broadway and Forty-second street. This building, although built early in 1899, gives nevertheless some interesting facts concerning the permanence of structural steel. When the building was built the steel work was given two coats of paint composed of carbon and linseed oil. Some of the columns and girders were incased in shells of brick and some in terra cotta. Where terra cotta was used the space between the steel and the terra cotta was filld in with brick and cement mortar. Inspection showed that the steel work was in first class condition; the few rust spots evidently having been on the metal at the time of erection and were due to abrasion of the paint. The outer columns and girders were also in good condition. Of course, accurate conclusions cannot be drawn from these observations owing to the short time which the building stood. It is pretty well known, however, that the permanence of structural steel depends greatly on the condition of the metal before the preservative coating is applied. Paint will not stop the destructive action of a rust spot. The surfaces of the metal should be thoroughly cleaned before the paint is applied, otherwise oxidation once started will continue to eat its way into the material beneath the surface of the paint.

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### Denver & Rio Grande.

The most profitable year in the history of the company, so far as net earnings are concerned, was that ending June 30, 1902, when, with gross earnings of $17,036,828 net earnings were $6,705,286, on the 2,347 miles of road worked; an average of $2,857 net per mile. In 1903, although gross earnings increased nearly $268,000, operating expenses increased still more, so that net earnings were somewhat smaller than in 1902, and this current year the road has had to bear the brunt of the protracted Colorado miners' strike, amounting to little less than civil war in some localities; but, although gross earnings were reduced to $16,446,435, expenses were also reduced, so that the decrease of $858,125 in gross only cost the road $286,718 in net. As a matter of fact, owing to the omission of the charge against net income for extraordinary betterments and for worn out narrow gage equipment, a surplus of $234,413 was carried to the credit of profit and loss, as against $185,765 last year.

The Denver & Rio Grande has for many years been unique in that with a system made up partly of standard gage and partly of narrow gage the narrow gage mileage has approached that of the standard gage. Ten years ago the system included 1,201 miles of standard gage and 962 miles of narrow gage. In 1899, with an increase of the standard gage to 1,234, the narrow gage had been increased to 1,034; but since then the standard gage mileage has been increased evenly, while the narrow gage mileage has been almost as evenly decreased, until, at the pres-

ent time, over 62 per cent. of the total mileage is standard gage. The company has had it constantly in mind that its narrow gage lines were likely to be of more or less temporary duration, and consequently it has freely written off the value of its narrow gage equipment, but has hesitated to buy any new cars and locomotives of this type. As a result, it was mentioned in the report last year that a considerable part of the narrow gage freight equipment was 25 or more years old, and that it was at once desirable and economical to replace much of it with modern equipment, in spite of its temporary nature. To accomplish this, during the last fiscal year an equipment trust was arranged, covering 1,700 narrow gage freight cars in addition to 500 standard gage coal cars and a small amount of passenger equipment. The securities issued bear 4½ per cent. interest and aggregate $1,500,000 par value, to be met, principal and interest, by 20 semi-annual payments.

The railroad company has now transferred its express business to the Globe Express Company, incorporated under the laws of Colorado and controlled by the Denver & Rio Grande through ownership of the entire capital stock. As a result of this transaction, both earnings and expenses from express traffic have, of course, fallen off during the year. General freight earnings decreased $883,387 from the preceding year, amounting to $11,398,104. Passenger earnings, however, increased $131,327, to a total of $3,959,252. Of the decrease in operating expenses to an aggregate of $571,407, $300,872 is accounted for by the smaller cost of conducting transportation. Express expenses, as explained above, decreased $116,483, while maintenance of way and structures decreased nearly $120,000. The charge for maintenance of equipment also was slightly smaller than last year.

The Denver & Rio Grande reports are always full and explicit, so that it is possible to trace accurately the betterment work done, and observe the account to which it was charged. Last year, as previously stated, $417,547 was charged net income for extraordinary betterments; $630,628 was charged to operation, *i.e.*, maintenance, and $287,478 to cost of road, making a total betterment expenditure of $1,335,652. This year the total expenditure under this head, including everything not otherwise specifically charged to equipment or to maintenance, amounted to $873,300. Of this, $445,168 was charged to operation. The remaining $428,132 was divided into three parts; $236,980 was taken care of by the improvement fund from tracks taken up; $111,621 was charged to cost of road, and $75,530 to the improvement fund from inventory surplus.

The principal statistics of operation were as follows:

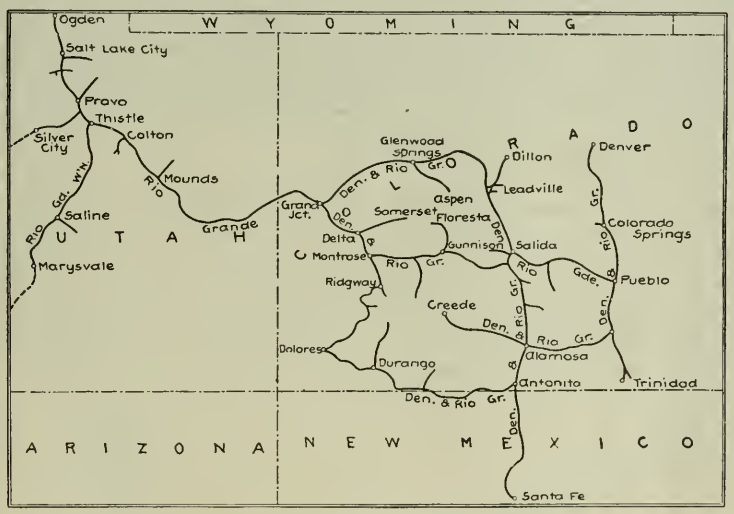
| | 1904. | 1903. |
|---|---|---|
| Mileage Worked | 2,398 | 2,378 |
| Gross earnings | $16,446,435 | $17,304,560 |
| Freight earnings | 11,398,104 | 12,281,492 |
| Passenger earnings | 3,959,252 | 3,827,924 |
| Operating expenses | 10,058,444 | 10,629,850 |
| Conducting Trans | 5,469,145 | 5,770,018 |
| Main. way and struc. | 2,174,828 | 2,293,465 |
| Main. of equipment | 1,919,519 | 1,942,914 |
| Net earnings | 6,387,991 | 6,674,709 |
| Net income | 6,602,336 | 6,884,426 |
| Fixed charges and taxes | 3,787,779 | 3,694,395 |
| Surplus for year | 2,574,413 | 2,962,561 |
| Betterment appropriat'n* | 120,000 | 537,547 |

*Including renewal fund.

## NEW PUBLICATIONS.

*Details of Bridge Construction. Part I. Arch Spans.* By Frank W. Skinner. New York: McGraw Publishing Co., 1904. Price $3.

This is the first volume of a series of books in which the purpose of the author is "to present the development of advanced practice and its standard details, to illustrate the classes of structures adapted to different conditions, show some of the characteristic differences between American and foreign designs and illustrate some primitive or obsolete constructions besides recording important and well-known examples so as to have their principal data easily accessible." The types of bridges which can be classed as arch spans are treated in this volume under four heads, wood and iron spans, steel and iron spandrel braced arches, steel and iron arch trusses and steel and iron plate girder arches. Some 80 examples have been selected from among structures of this class situated in widely different parts of the world, and the characteristic features of each are briefly pointed out in connection with the illustrations from drawings and photographs. The author has refrained from theory or speculative comment and has included little mathematical or analytical data in the descriptions. In many cases only the details of construction which distinguish any one bridge from others of the same class have been selected, and as a whole the book presents a collection of data and information valuable alike to the engineer, contractor, student, draftsman or municipal officer. It is essentially practical.




Denver & Rio Grande.

## TRADE CATALOGUES.

*Chicago Tool & Supply Company*, Chicago, sends a circular of its "Green" pneumatic hammers. The hammer is shown complete and also unassembled, there being but 10 parts to it. A description is given and also a table of sizes with piston diameter, stroke in inches, capacity, weight in pounds, length in inches, blows per minute and cubic feet of free air consumed. The circular is neatly printed in black and red.

*The McClintic-Marshall Construction Company*, Pittsburg, Pa., are distributing an illustrated pamphlet descriptive of some of the foundries and machine shops which it has built. It has an appropriate cover artistically executed in colors. Among the full page half-tones shown are illustrations of the exterior and interior of the machine and erecting shop of the P. & L. E. R. R. at McKees Rocks, Pa.

*The Glacier Metal Company*, Richmond, Va., are distributing an illustrated post card which gives an outline of the political situation up to the present time. It mentions that there are about 131 doubtful States. Notwithstanding this the company is not at all uneasy about the situation, for they feel that the whole country is solid for "Glacier."

*The C. W. Hunt Company*, New York, sends an illustrated catalogue descriptive of its coal handling machinery for use in power stations, boiler rooms, coaling stations, etc. Industrial railways, electric locomotives, etc., are also described.

# CONTRIBUTIONS

### Steel Car Design.

Belleville, Pa., Sept. 7, 1904.

To the Editor of the Railroad Gazette:

In the *Railroad Gazette* for July 22 in the article on Steel Car Design, should not the equation for moments at any point in the center sills due to the weight of the car body be

$$M_x = \frac{p_1 x}{2}\left(\frac{x}{l} - 1 + \frac{c}{x}\right)$$

instead of

$$M_x = \frac{p_1 x}{2}\left(\frac{l}{x} - 1 + \frac{c}{x}\right)$$

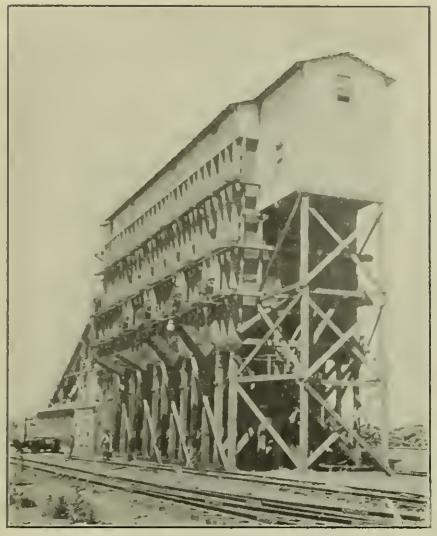
E. Hermansen.

Our correspondent is right. The error was a typographical one and does not affect the subsequent equations or values in the tables. —Editor.

### The Telautograph in Railroad Service.

Gray's Telautograph, a telegraph instrument which records a message at the receiving end in the handwriting of the sender, and with which the readers of the *Railroad Gazette* are already acquainted, is now in use at the Union Station, at St. Louis, for announcing at various points in the station the prospective arrival of trains, and we understand that the apparatus is giving marked satisfaction.

The sending operator is in the signal tower at the entrance to the station yard, and he writes (sends) his message announcing each train as soon as the train comes within sight; and as all trains run past the tower and are backed in, this gives the men in the station about five minutes advance notice. During the busy hours of the morning and evening the sending operator

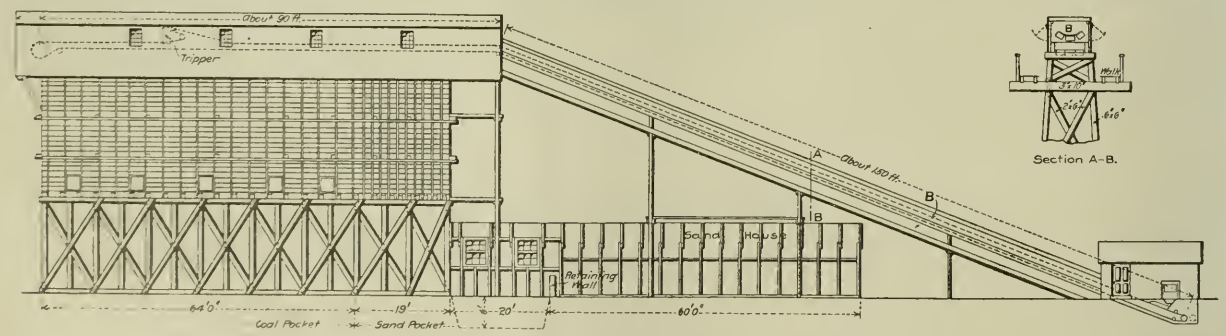


Locomotive Coaling Station—Central Railroad of New Jersey.

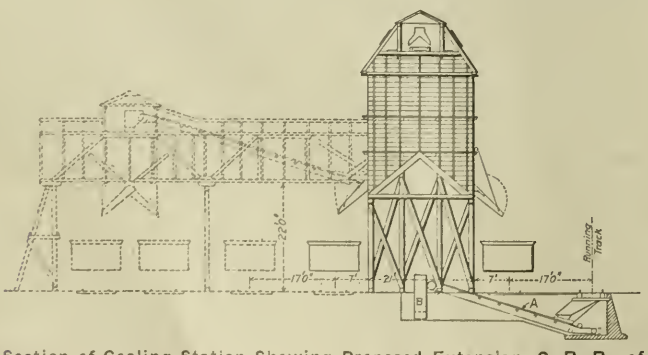
keeps his line at work almost continuously. There are receiving instruments (which substantially serve the purpose of bulletins) in the station master's office, the baggage room, the information bureau, and a number of other places at which prompt information concerning incoming trains is desirable. For each train the number of the track on which it will come in is given in the message. The advantage of this method of communication over the telegraph is in the fact that no operator is necessary at the receiving end; and, as compared with the telephone, there is not only this, and the advantage of accuracy, but the person at the receiving end needs give no particular attention to the apparatus. With a sending operator who writes a clear, legible hand, the apparatus assures clear and legible bulletins at all the receiving stations. The sending operator has a receiving apparatus connected to the line in his own office so that he always sees the record of what he is sending. Any intelligent person who can write can send the messages, and the receiving instrument is self-registering, so that there is no delay if the person at that end is absent from his office.

## Locomotive Coaling Station for the Central Railroad of New Jersey.

The Robins Conveying Belt Company, New York, has just completed a 800-ton capacity coaling station for the Central Railroad of New Jersey. The plant is at the Elizabethport shops and is built parallel to the Newark branch road. It is the railroad company's intention in the near future to build a section across this road, as shown by the dotted lines. The building is of timber and consists of one large coal pocket and a sand pocket. The coal pocket has partitions for the division of the several kinds of coal to be stored, and it is provided with eight coal chutes, four on each side of the building. These chutes are of a new design, and are operated from the engine tender. There are two sand chutes, one on each side of the sand pocket. Two 24-in. belt conveyors are used. The belts have a $^{3}/_{16}$ pure rubber cover at their centers. The conveyor "A" is 35 ft. between centers and is driven by a 5 h.p. D. C. Sprague motor. Conveyor "B" is 240 ft. between centers and is driven by a 30 h.p. motor. The coal is discharged from hopper-bottom cars into the track hopper, thence upon a grizzly and thence to a short conveyor which dumps at right angles upon the long conveyor "B," which in turn discharges into any part of the coal pocket desired by means of an automatic tripper. Any




Side Elevation of Locomotive Coaling Station, C. R. R. of N. J.




Cross Section of Coaling Station Showing Proposed Extension, C. R. R. of N. J.

lumps of coal larger than 8 in. drop on to a shaft at the lower end of the grizzly where they are broken up and fall on to the conveyor "A." The troughing, return, and guide idlers are of cast iron and run on hollow cold drawn steel tube shafts. These are lubricated by means of patent compression grease cups mounted on their ends. The tripper is of the Robins automatic reversible type, and can be operated automatically by means of a lever on the side of the tripper and stops placed on the rails, or by hand from either side of the machine, the power being taken from the conveyor belt in both cases. The tripper can also be made to operate in a fixed position by throwing out the automatic attachment and clamping the machine to the rails. The carrying portions

of the belts are kept clean by means of automatic rotary brushes. The driving pulleys at the conveyor ends have extra high crowns and are secured to their shafts by both keys and set screws, as are also the cast iron gears. The track hopper and chutes are of yellow pine lined with steel. The sand pocket is lined inside with Paroid roofing paper, and the floor is of 1½ planks doubled, with roofing paper placed between. The plant is electrically driven throughout, and the speed of the conveyor belt is 377 f.p.m.

## A Long Run Without a Stop.

BY H. A. B. CAMPBELL.

On July 1, 1904, the Great Western of England started the running of one train each way per day, between London and Plymouth, 246 miles, without a stop, and the following page taken from the railroad's time-tables shows the running times of these two trains.

| Distance from London, miles. | | A. M. | Pass., A. M. |
|---|---|---|---|
| ... | London | Dep. 10:10 | ..... |
| 35 | Reading | | 10:46 |
| 53 | Didcot | | 11:03 |
| 77 | Swindon | | 11:27 |
| 93 | Chippenham | | 11:43 |
| 106 | Bath | | 11:56 |
| | | | P. M. |
| 116 | Bristol (East Depot) | | 12:06 |
| 118 | Bristol (Pylle Hill Junction) | | 10:10 |
| 137 | Uphill Junction | | 12:29 |
| 162 | Taunton | | 12:53 |
| 193 | Exeter | | 1:27 |
| 208 | Teignmouth | | 1:46 |
| 213 | Newton Abbot | | 1:52½ |
| 217 | Dainton | | 1:59 |
| 222 | Totnes | | 2:05½ |
| 227 | Rattery | | 2:13 |
| 231 | Wrangaton | | 2:19 |
| 238 | Hemerdon | | 2:28 |
| 245 | Plymouth | Arr. 2:35 | P. M. |

| Distance from London, miles. | | P. M. | Pass., P. M. |
|---|---|---|---|
| 245 | Plymouth | Dep. 12:35 | |
| 238 | Hemerdon | | 12:46 |
| 231 | Wrangaton | | 12:55 |
| 227 | Rattery | | 1:00½ |
| 222 | Totnes | | 1:07 |
| 217 | Dainton | | 1:13½ |
| 213 | Newton Abbot | | 1:19½ |
| 208 | Teignmouth | | 1:26 |
| 193 | Exeter | | 1:45 |
| 162 | Taunton | | 2:16 |
| 137 | Uphill Junction | | 2:39 |
| 118 | Bristol (Pylle Hill Junction) | | 2:58 |
| 116 | Bristol (East Depot) | | 3:02 |
| 106 | Bath | | 3:13 |
| 93 | Chippenham | | 3:27 |
| 77 | Swindon | | 3:44 |
| 53 | Didcot | | 4:07 |
| 35 | Reading | | 4:24 |
| .. | London | Arr. 5:00 P. M. | |

Such a run is remarkable, because, first, it is done daily by two trains, one up and one down. Second, because for 70 miles of the distance the grades are exceptionally severe. Three, because a high average speed is maintained throughout, namely, 56 m.p.h. This run of 246 miles has been done without a stop with a five-car train at an average speed of 66 m.p.h. On May 9, 1904, with a mail special of five postal cars, the run was made at an average speed of 70½ m.p.h. with one stop to drop a car. Such runs are a proof that the present daily performance is well within the limits of both the locomotives and the permanent way. The following runs are from the company's time-tables of daily trains:

| Trains per day. | | Miles without stop. | Av. speed, miles per hour. |
|---|---|---|---|
| 2 | London to Plymouth in 265 mins. | 245 | 55.6 |
| 4 | London to Exeter in 205 mins. | 193 | 56.7 |
| 4 | London to Birmingham, 137 mins. | 129 | 56.6 |
| 2 | London to Bristol, in 120 mins. | 118 | 59.1 |

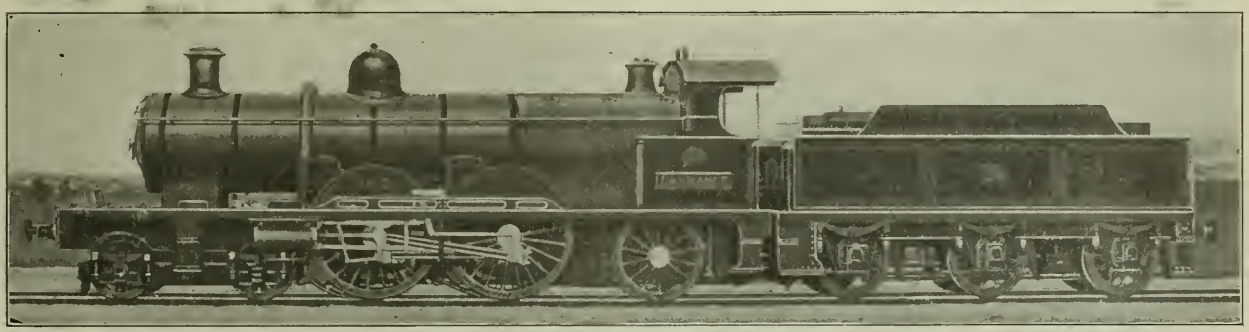
To take up the first run in detail let it be considered as to, first, the roadbed and grades; second, the train and locomotives; third, the running speeds maintained.

The Great Western was built by I. K. Brunel (the designer of the steamship Great Eastern), regardless of cost. Tunnels, viaducts and bridges were used to make the road as nearly straight and level as possible. But in spite of this a glance at the profile of the road will show that it is not level. Starting from London the first 70 miles have a very slight rise. The road then falls on gradients from 4 to 50 ft. to the mile to Bristol. Then follows nearly 40 miles of level running, to be succeeded, however, by a rise of 390 ft. in 10 miles on grades of 30 to 58 and 66 ft. per mile. Then there is a fall of 300 ft. in the next 10 miles to Exeter. But from Exeter on for the remaining 52 miles to Plymouth the road even to an American must be considered mountainous. These are the grades which have to be met.

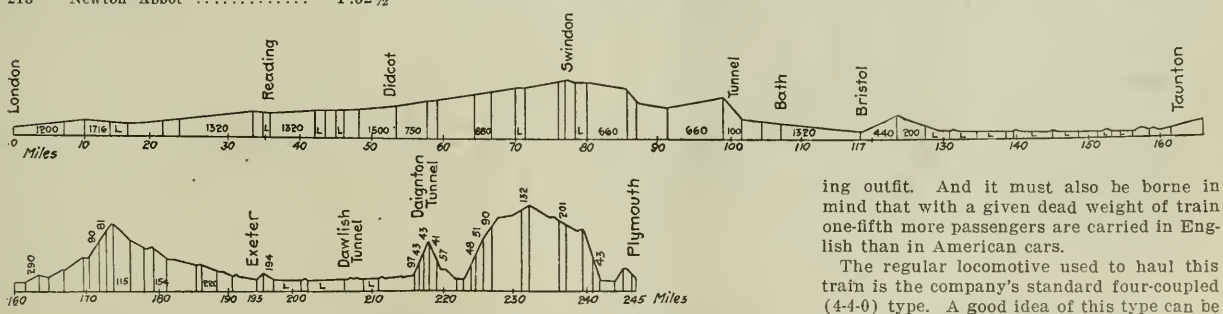
| *To Plymouth.* | Per mile. | *From Plymouth.* | Per mile. |
|---|---|---|---|
| 2⅓ miles | 66 ft. | 1⅝ miles | 132 ft. |
| 2¼ miles | 123 ft. | 2⁷/₁₀ miles | 96 ft. |
| 4¼ miles | 110 ft. | ¼ mile | 71 ft. |
| 1⅓ miles | 73 ft. | ⅛ mile | 68 ft. |

The track is laid with rails weighing 95 lbs. to the yard, 32 ft. long, and with 13 ties to the length. A heavy cast iron chair holds the rail to the tie. The road is stone ballasted throughout, four-tracked as far as Bristol and two-tracked from there on to Plymouth with the exception of the 1½ miles through the five Dawlish tunnels, which is single track. The block system of signals is used throughout, and water troughs are laid at three different points along the road. Each train consists of six cars of the side corridor type, and with vestibules between each car and made up in following order: 1. Composite baggage third. 2. Third class. 3. First class. 4. Dining car (72 ft. long). 5. Second class. 6. Composite third. Excepting the diner the cars are 52 ft. long with steel underframes and carried on four-wheel bogie trucks. The equipment includes steam heat, electric lights and call bells, automatic vacuum brake and pneumatic train signal. The train has a total seating capacity for 200 passengers.

The total weight of the cars loaded is 189 tons, and the gross of engine and train is 283 tons. Such a train is by no means a racing outfit. And it must also be borne in mind that with a given dead weight of train one-fifth more passengers are carried in English than in American cars.



De Glehn Compound Used on the Great Western.




Profile of the Great Western between London and Plymouth.

The regular locomotive used to haul this train is the company's standard four-coupled (4-4-0) type. A good idea of this type can be seen from the illustration. It has

| | |
|---|---|
| Cylinders (single expansion) in. | 18 x 26 |
| Diameter of driving wheels, in. | 80 |
| Weight on driving wheels, lbs | 75,000 |
| Boiler pressure, lbs | 200 |
| Heating surface, sq. ft. | 1,800 |
| Grate area, sq. ft. | 21½ |
| Tank capacity, Imp. gal. | 4,000 |
| Coal capacity, tons | 5 |
| Total weight engine and tender, tons | 93 |

As an experiment and for the sake of comparing the work done, the French de Glehn Atlantic type (4-4-2) was put on to haul this train. The illustration shows the engine as adapted to English service and with the company's standard tender. It has

| | |
|---|---|
| Cylinders, in | 13⅜ and 22 x 25¼ |
| Diameter of driving wheels, in | 80 |
| Weight on driving wheels, lbs | 71,000 |
| Boiler pressure, lbs. | 227 |
| Heating surface, sq. ft. | 2,325 |
| Grate area, sq. ft. | 29.5 |

Water capacity, gal .....4,000
Coal capacity, tons ..... 5

In running the 246 miles in 265 min. without a stop the following reductions in speed have to be made, and English railroad laws are obeyed to the letter.

Bath station (curve) .....15 m.p.h.
Bristol avoiding line (s. curves).....10 m. p. h.
Taunton .....15 m. p. h.
Exeter ..... 5 m. p. h.
Dawlish tunnels (single track).....25 m. p. h.

The first six miles out of London are a veritable network of switches. The run may be taken in three ways: London to Plymouth, 246 miles, in 265 min. at an average speed of 55.6 m.p.h.; London to Exeter, 193¾ miles, in 195 min. at an average speed of 59¼ m.p.h.; Exeter to Plymouth, 52 miles, in 70 min., at an average speed of 44½ m.p.h.

In order to keep up such a high average speed the following logs of the runs of June 30, 1904, and July 1, 1904, will speak for themselves. All speeds are average. The train consisted of six cars hauled by the English built engine. From London to Plymouth, a distance of 245 miles, the time was 264 minutes, or an average speed of 55.8 m.p.h. From London to Exeter, a distance of 193 miles, the run was made in 194 minutes, or an average speed of 59.6 m.p.h. From mile post 5 to 105, a distance of 100 miles, the time was 92 min. 50 sec., or an average speed of 64.6 m.p.h. From mile post 4 to 205, a distance of 200 miles, the time was 200 min. 30 sec., or an average speed of 60 m.p.h. The maximum speed was 75 m.p.h.

From Plymouth to London, a distance of 245 miles, the time was 258 min., or an average speed of 57 m.p.h. From Exeter to London, a distance of 194 miles, the time was 187 min. 30 sec., including a dead stop, or an average speed of 62.1 m.p.h. From mile post 203 to 2, a distance of 200 miles, the time was 197 min. 20 sec., or an average speed of 61 m.p.h. From mile post 97 to 6, a distance of 91 miles, the time was 77 min. 55 sec., or an average speed of 70 m.p.h. The maximum speed was 81 m.p.h.

The fact that one locomotive hauls 289 tons for 245 miles without a stop, and at speeds but little below those maintained by the world famous Camden-Atlantic City trains, shows that the locomotive must be considered a fine machine whether built in England, America or France.

## Early Transportation in New York.

BY HENRY E. ARMSTRONG.

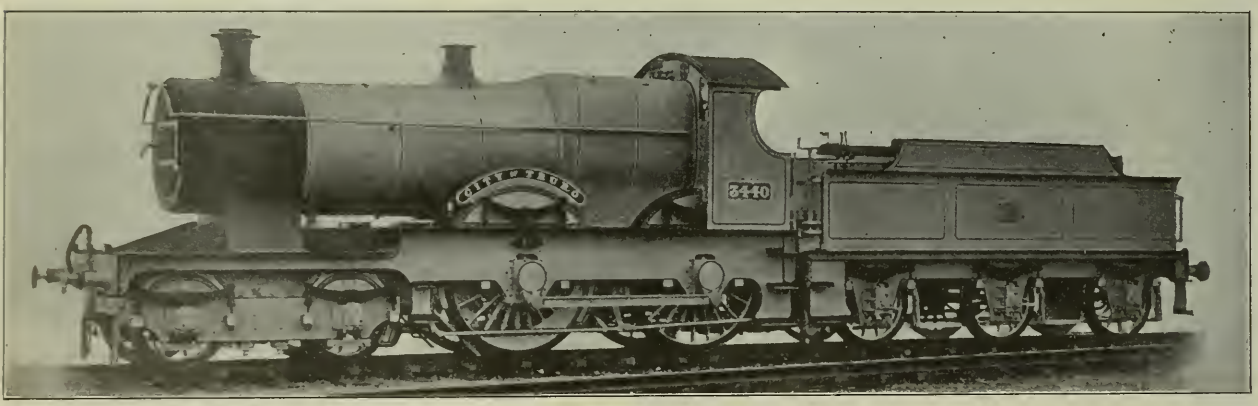
Between 1682, when Gov. Stuyvesant died on his farm, "the Great Bouwerie," and the Revolution, the growth of New York was slow for a city of its destiny. There was an average increase of population of only 150 a year. In 1774 a census taken by the authorities showed a total of 22,861 souls. Not until after the War of Independence do we find passenger transportation on a commercial basis. In 1783 the rate for a carriage ride from the Battery to Murray Hill was fourteen shillings—about two dollars and a half. For two shillings more the traveler could reach Gracie's Point, opposite Hell Gate. For the same amount, 16 shillings, he might go up to Apthorpe's, on the west side of the island, about where Ninety-second street is now. The journey to Harlem was a day's excursion and cost 38 shillings. When the Subway is open for traffic the New Yorker of 1904 will be able to go to Kingsbridge in half an hour for five cents.

The first serious effort to furnish transportation in New York was the stage line which was put on between Bowling Green and Bleecker street in 1830. Competition soon became brisk. Coaches in all the glory of high colors, and embellished with portraits of celebrities, traversed the city from river to river, and from the point of the island, where the Aquarium (formerly Castle Clinton) stands to-day, to Greenwich Village and Yorkville. The most pretentious stages were drawn by four horses and bore such honored names as Lady Washington, George Washington, and De Witt Clinton. New York still boasts a line of busses on Fifth avenue, and the sight of them in an age of electric traction carries the mind back to a day when the Post Road to Boston ran through Madison Square, and what is now Central Park was sacred soil, wantonly wild and famous for the revolutionary relic of McGowan's Pass.

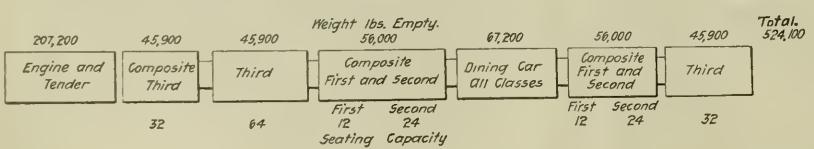
Seven years before Madison Square was laid out, or in 1831, a great stride was made in transportation by the introduction of the horse-railroad. In that year the New York & Harlem Railroad Company was organized. The pioneer of all street cars, the John Mason, named for the founder of the Chemical Bank and the first president of the world's first horse-railroad company, made its initial trip between Prince and Fourteenth street on Nov. 26, 1832. It carried the Mayor and Common Council of the city and John Stephenson, the builder. When the subway of the Rapid Transit Construction Company is opened to traffic the occasion will be a red-letter day in the history of urban transportation, but it will not arouse and interest the people of New York as did the passage of the first horse-car through the streets, in 1832.

After the Civil War, when the city began to spread north of Central Park, which had been laid out in 1856, it became evident that the horse-car service was behind the times. The Hudson River Railroad landed its passengers at Thirtieth street and Ninth avenue, it was true, and the New York & New Haven and the Harlem railroads had termini in the neighborhood of Madison and Fourth avenues and Twenty-sixth street, but to avoid accidents trains had run as slowly as the horse-cars. Agitation for quicker transportation to the foot of the island resulted between 1868 and 1870 in the incorporation of two underground railroad companies. One of them built an experimental section beneath Broadway from Warren to Murray street. The excavation was made by a shield forced ahead by hydraulic pressure. Into the tunnel was introduced a steel casing 8 ft. in diameter, which was to hold a car as the piston fits in the cylinder. By powerful fans the car was to be blown on its way. This novelty was known as the Beach pneumatic road. A public exhibition was set for April 26, 1870, and 18 daring men crowded themselves into the car and were pushed majestically from Murray to Warren. The company boldly announced that it would build 100 cars and soon have them running from the Battery to Harlem. But that hole in the ground was soon abandoned, and the ambitious scheme to shoot business New York to Harlem pneumatically came to nothing.

Then there was the Arcade Railway, a picturesque idea that was never put into effect. The tracks were to be laid in a long arcade over the sidewalk the length of Broadway; but property owners along the route vigorously objected, and the promoters, calculating that the expense of construction would be altogether too great for a dividend-payer, withdrew the scheme. A Viaduct railroad to run through private property and cross intervening streets on substantial bridges shared the same fate. Another project, the Greenwich Street Elevated Railroad, begun in 1866, had better luck; but never were promoters more abused or their public-spirited prospectus more derided. One




English Built Express Locomotive—Great Western.




Plan of Make-up of Train—Great Western.

is reminded of the famous protest of Admiral Sir Isaac Coffin when the application for a charter for the Liverpool & Manchester Railway was before the House of Commons. "Was the House aware," asked that fine old Tory, "of the smoke and the noise, the hiss and the whirl which locomotive engines, passing at the rate of 10 or 12 miles an hour, would occasion? Neither the cattle plowing in the fields, nor grazing in the meadows, would view them without dismay. Iron would be raised in price 100 per cent. or more probably, exhausted altogether. It would be the greatest nuisance, the most complete disturber of quiet and comfort in all parts of the kingdom that the ingenuity of man could invent."

But the promoters triumphed in spite of the Manhattan Coffins of 1866. A one-track road was built from Battery Place through Greenwich street, and on July 2, 1867, New York was invited to ride on an air-line operated by cables. Although steam locomotives were soon substituted the first elevated railroad in New York had a hard time of it. Damned up-hill and down, the butt of newspaper wits, and neglected by the traveling public, it struggled along against contumely and ingratitude until the sheriff got it. That was in 1871.

The legislature was asked at the session of 1872 for two rapid transit charters. Dr. Rufus H. Gilbert, the applicant for one of them, proposed to suspend a pneumatic tube from lofty arches, and very much on the principle of the Beach device cars were to be slid through it noiselessly. The roaring and grinding and creaking of the Greenwich street elevated trains was the chief objection to them. New York is not so sensitive to noise now. A steam railroad built up at the sides to save the modesty of second-story tenants was substituted for the fantastic plan of Dr. Gilbert, and then there was a return to the elevated railroad on Greenwich street. The legislature of 1875 tackled the irrepressible problem again, passing the Husted bill for the appointment of a commission to decide as to the necessity (!) of rapid transit in New York, and, if it existed, to propose desirable routes. A commission of Joseph Seligman, Louis B. Brown, Cornelius H. Delamater, Jordan L. Mott, and Charles J. Canda, recommended on July 13, that elevated steam railroads be built upon Second, Third, Sixth and Ninth avenues, and invited the Gilbert Company and the New York Company, the latter at the time operating a none too robust elevated road on Greenwich street, to enter upon the work of construction. Before the end of 1876 the New York Company (now the Ninth avenue line), although assailed on all sides by litigants with extravagant damage claims, had pushed its tracks up to Fifty-ninth street, and was advertising "40 through trains" a day. Cyrus W. Field, the Atlantic cable magician, invaded the rapid transit field in 1877, and bought a controlling interest. By June 5, 1878, the Sixth avenue road was in operation from Rector street to Central Park. The West Side lines were consolidated under the name of the Metropolitan Elevated Railroad. The Third avenue line was operated as far as Forty-second street on August 26. It was 1880 before the Second Avenue reached Sixty-seventh street, but by the end of that year the elevated roads on both sides of the city, later known as the Manhattan Railway Company, had been extended to Harlem.

Some years before this there had been another consolidation, and a public work was completed which accomplished great things for rapid transit. That was the assembling of the downtown stations of the Hudson River, New York & New Haven, and Harlem companies at Forty-second street under the colossal dome (for 1871) of Cornelius Vanderbilt's Grand Central terminus. Four years later the railroad tracks were shut in or removed from the streets below the Harlem River by tunnel and stone viaduct, an engineering work which cost $6,000,000. Half the expense was borne by the city.

After the completion of the fundamental lines of the east side elevated roads, in 1879-1880, there was no progress of especial interest in New York rapid transit until the Broadway horse-car line was equipped with a cable, in 1892, to serve only a scant six years before its removal and the substitution of the conduit system of electrical traction, in 1898. But surface cars on the crowded streets could furnish rapid transit only in name, although materially aiding in handling the crowds, and the demand for fast time from the residence part of town to the business section was so great that before the Ninth avenue elevated road had been open a year, it was reported in the *Railroad Gazette* that people had to be "turned away" during the rush hours, from stations north of Warren street. So far as real rapid transit is concerned, therefore, there is a gap of 24 years—from 1880 to 1904, in the provision of new facilities for getting from one end of Manhattan Island to the other.

## History and Physical Aspects of the New York Subway.

[WITH AN INSET.]

In 1894 was created the present Rapid Transit Commission—it had two predecessors which fizzled out without accomplishing anything. The Mayor, Comptroller, President of the Chamber of Commerce and five citizens named in the enabling act were authorized to sell a franchise to a private corporation, or to engage in municipal construction, as the voters should decide. They declared for the latter method overwhelmingly. The Commission, consisting besides the Mayor, Comptroller and President Charles S. Smith, of the Chamber of Commerce, of Alexander E. Orr, Woodbury Langdon, Morris K. Jesup, George L. Rives and John H. Starin, selected a route, made surveys, prepared plans for an underground railroad, estimated cost, and called for bids. Mr. Andrew Onderdonk offered to build and equip the road for $39,300,000, and Mr. John B. McDonald underbid him by $4,300,000. The bid of Mr. McDonald, whose fitness for the undertaking was attested by his construction of the great tunnel for the Baltimore & Ohio Railroad under the city of Baltimore, was accepted. There was hardly a dollar's difference between his bid and the estimate of Mr. William Barclay Parsons, the Chief Engineer of the Commission, who had made 6,000 borings to determine the nature of the soil in which the subway must be built.

The quarter of a million passengers transported to the business district by the elevated and surface cars during the morning rush have been thus accounted for: 75,000 come down from above Twenty-third street by the four elevated lines and 67,000 by the surface electric roads; 31,000 are brought from Long Island and Staten Island by the ferries, and 33,000 cross on Brooklyn Bridge cars to resume their journey in Manhattan Borough; New Jersey contributes 32,000, and 12,000 reach the Broadway and avenue cars by cross-town traction. Consider that 50 per cent. of these passengers have to stand in the cars, enduring the greatest discomfort. To suppose that when the subway is running seats will be found for all who desire to ride is to be blindly optimistic. As for the surface cars, they will be as congested as ever, since they cannot handle long-haul traffic now and do not want it.

But though it be a foregone conclusion that the Rapid Transit Railroad of Manhattan Island and Bronx Borough, in view of the constantly increasing traffic, will fail to solve for any considerable time the vexed problem, let us make no mistake about the greatness and grandeur of the undertaking, the difficulties to be overcome in building it, and the incalculable service it will render the community. The contract between the Rapid Transit Commission and Mr. John B. McDonald was a document of 55,000 words. For the personal performance of his agreement he had to deposit $1,000,000 in securities with the Comptroller of the city, and also to file with him a $5,000,000 bond with sureties for the construction and equipment of the road. The main line was to be seven miles in length, and it was to have two branches each of seven miles. In the course of the work not less than 1,700,288 cubic yards of earth would have to be excavated, 773,093 to be filled back, 921,128 of rock to be excavated and 368,606 to be tunnelled. The steel to be used in construction was reckoned at 65,044 tons, the cast iron at 7,901, concrete 489,122 cu. yds., brick 18,519 cu. yds., and the waterproofing 775,795. Forty-three local and five express stations would have to be built and ten passenger elevators.

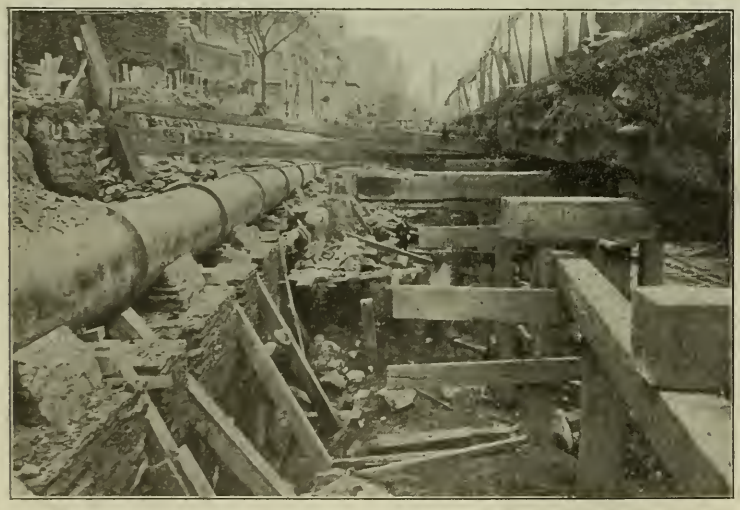
The contractor agreed to build the road without stopping street traffic or damaging the labyrinth of electric conduits, sewers, water mains, gas and steam pipes and pneumatic tubes below the surface of the ground. Considering the enormous difficulties which everywhere confronted him, he has been very successful in this, although there has been serious congestion of traffic at times. He was to shore up buildings, protect monuments, support street railroad tracks, keep one side of the street open, afford access to hydrants and fire alarm boxes, and to replace each tree belonging to the city which was cut down. It became necessary to move gas and water pipes and electric conduits, and to lower sewers and to make new connections. A sewer at Canal street, nine feet by six, which drained many hundred acres into the Hudson River proved such an obstacle in the path of the tunnel that a new sewer draining off to the East River was built at great labor and expense, the old one being abandoned.

Owing to the opposition of property-owners on Broadway the route avoids that thoroughfare below Forty-second street. It begins with a loop at the post office and runs under Park Row, Center street, New Elm street, Lafayette Place, thence to Fourth and Park avenues, to Forty-second street opposite the Grand Central Station, under that street west to Broadway, and under Broadway to 104th street. There are four tracks to this point, but here the road forks, two tracks running under and over Broadway to Kingsbridge, and two running east to Central Park, passing under the northwest corner of it to Lenox avenue, continuing to 141st street, tunneling under the Harlem river, and finally running through Bronx Borough to Bronx Park and the Zoological Gardens.

The heaviest tunneling on the Subway is the passage through a hill of gneiss from 158th street to the vicinity of Fort George. This tunnel is approximately two miles long, and next to the Hoosac on the Fitchburg railroad in Massachusetts, the longest tunnel in the United States. The drilling machines were supplied with compressed air by a plant on the bank of the Hudson. Two passenger elevators give access to the tracks at this point, and the lift of each is approximately 100 ft. below the surface. But for great stretches the Subway road will belie its name, running on a viaduct across Man-

hattan valley between Bloomingdale and Washington heights, and as an elevated road on the east side from 149th street to the terminus, and on the west side from 125th street to 133rd, and from Fort George to the end of the line. For miles on Manhattan Island it is a covered-in-trench, and not a tunnel, with glass-roofed and therefore well-lighted stations at short intervals. Of the Rapid Transit railroad's total length of 21 miles 5.14 miles will be carried on elevated structures and one-half mile on a steel viaduct. The inner two of the four tracks south of 104th street are to be used for express service, trains running 30 miles an hour and stopping at stations a mile and a half apart. Thus, for the express trains, it will be a trip of 14 to 18 minutes to the end of the main line, including stops. The speed of the locals will be about 14 miles an hour, and there will be four way-stations to the mile. Every express station is connected with the way-station by bridges, so that passengers may change from one train to another, as suits their convenience. As the four tracks approach, the outer ones on each side will curve enough to allow space between them and the middle pair of tracks for an "island station"; the stations for way trains will be on the outside of the system

Rapid Transit under Difficulties.



Method of Supporting Street Car Tracks (Right of Picture).

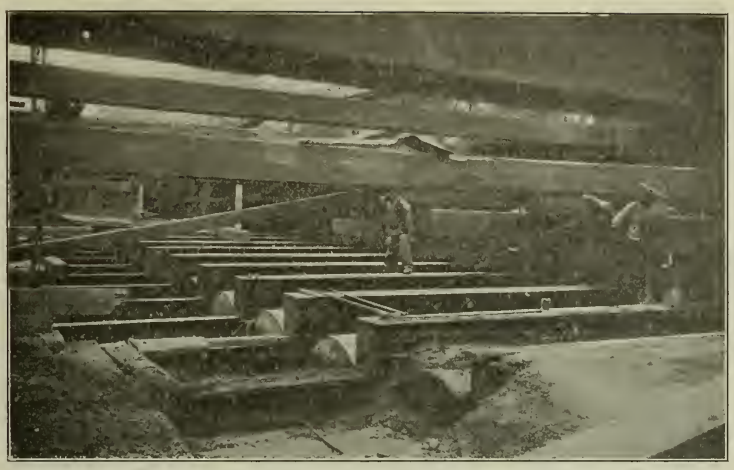
of tracks. The west side branch above 104th street is to have the use of a third track as far as 145th street, which was not in the original plan. The Commission having recommended that between 137th and 145th streets a side-track be built to accommodate cars in the storage shed, it was decided to extend the track south to 104th. It will be used for express service during rush hours.

The most difficult part of the work next to the piercing of the rock ridge near Fort George, was the passage of the Harlem River by the eastern branch at 145th street. The stream here is 900 ft. between bulkhead lines; the greatest depth is 20 ft. below low-water mark. Two tubes, 15 ft. in diameter, and lined with cast-iron imbedded in concrete, were laid almost flush with the river bottom. The tubes were sunk by the caisson method in sections to avoid interference with navigation. Just as one side of a street was left open for traffic, so there was always room on the Harlem for river craft.

The accompanying paper on the London tube road illustrates the contrast in the materials with which the engineers had to work. The London blue clay offered no problems like the rock, clay, sand and quagmire of the New York subway. There are three styles of section in the subway proper: the rectangular for the covered-in-trench, the barrel-vault for tunnels, and the circular, or tube, where the tracks go under the Harlem river. When the excavation for the trench had been made to a depth of 20 ft., a floor of concrete was laid. Upon this, at intervals of five feet, riveted steel beams were erected to carry the weight of the street surface and to resist the side pressure. Between these ribs a wall of concrete was built. Cross-pieces for the roof are joined to the uprights and similarly treated with concrete. Imbedded in the concrete at the sides, above and below, are alternate layers of felt and asphalt to keep out moisture.

The accompanying illustrations show a number of characteristic stations. The City Hall station, the present southern terminus until the extension to the Battery is completed, has a platform 200 ft. long by 14 wide, reached by curving stairways from east and west. The ceiling is divided into semi-circular arches, giving a dome effect. The station is decorated in the Romanesque style with colored tiles, and light-wells. The contract contained the stipulation that, as the railroad and equipment constituted

Deep Rock Cut, Forty-Second Street near Fifth Avenue.



Finishing Roof, Cut-and-Cover Section.

a great public work, all parts of the structure where exposed to public sight should be designed with a view to the beauty of their appearance, as well as to their efficiency.

By the terms of the contract Mr. McDonald is to equip the road as well as to build it, that is to say, he must furnish motors, engines, passenger cars and all rolling stock, electric power, conduits, wires, mechanism, and apparatus for lighting, signaling and ventilation. When built and equipped, he is to operate the road under a lease from the city for a term of 50 years, every year paying a sum equal to the interest on the bonds issued for construction and a further annual sum for a sinking fund equal to 1 per cent. upon the whole amount of the bonds. At the end of 45 years the principal can be retired by the accumulations in the sinking fund. By giving notice of not less than one year before the expiration of the lease Mr. McDonald, or his assigns, may claim an extension of 25 years. By this financial arrangement the city ultimately comes into possession of the subway, but it must buy the equipment from the contractor, or from the operating company.

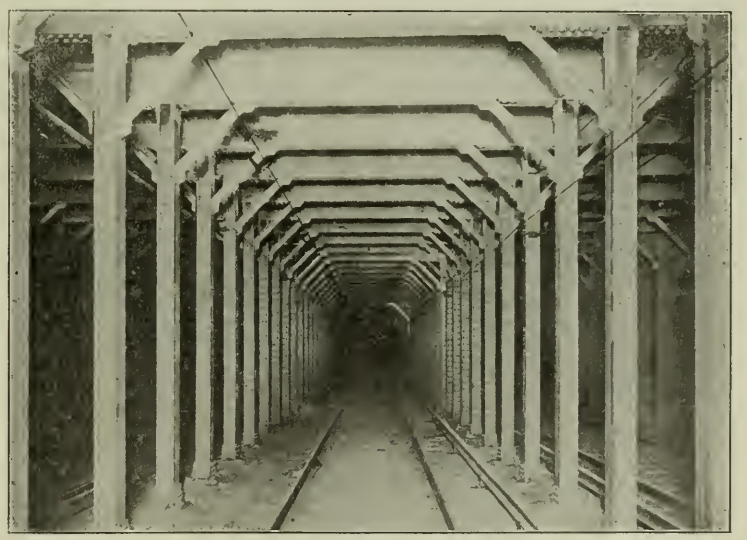
Mayor Van Wyck began the work of construction in front of the City Hall on March 24, 1900, by turning up a spadeful of earth. The road was to have been completed by Sept. 24, 1904, and in all essentials it was completed some time earlier, except for some minor details and a general "tuning up." Both Mr. McDonald and Chief Engineer William Barclay Parsons indulged the hope at one time that it would be open for traffic to the end of the main line by Christmas, 1903, but they had left labor troubles out of their reckoning. Five months were lost by strikes on the power house at Fifty-ninth street and Eleventh avenue, and the rockmen and excavators have proved a very uncertain quantity. Up to May 1, 1903, four-fifths of the excavating had been done and more than half of the rock had been blasted. On Fourth avenue from Tenth street to Thirty-third the Subway was completed and ready for the rails, although the stations at Fourteenth, Twenty-third and Thirty-third streets had not been built. On Broadway from Forty-seventh to Sixtieth streets the tracks were down and men were whitewashing the subway walls. Under Elm street the work was practically finished. The City Hall loop had been completed and the switches under Park Row. The tunnel under Central Park was ready for the rails, as was the Lenox avenue section between 110th and 135th streets. Foundations for the elevated pillars in Manhattan valley were down.

As many as 10,000 men have been at work on the Subway, in day and night shifts, at one time, including engineers, machinists, riveters, carpenters, masons, calkers, drill-runners, diggers, blasters, and teamsters.

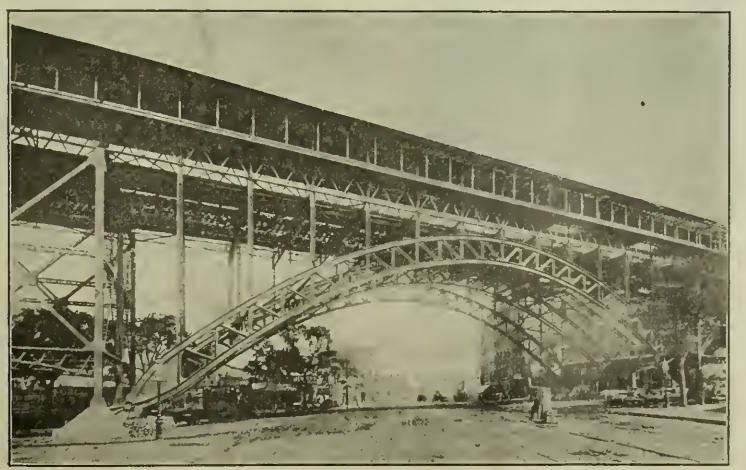
### Traffic Features of the Subway.

At the present time, instruction trains are being run through the New York Rapid Transit Subway from 145th street as far south as the present terminus at City Hall. There remains still to be done some work at the stations and a considerable amount of harmonizing and adjusting of all the parts of the transportation machine, and October 1st is the earliest date at which the subway is likely to be open for general public use. There is still much uncertainty with regard to many of the operating details. It is not known how many cars will ultimately be required to maintain the desired local and express services, although it is proposed to start with about 600, and there is a similar uncertainty with regard to the make-up of the trains. Eight cars will probably be the maximum.

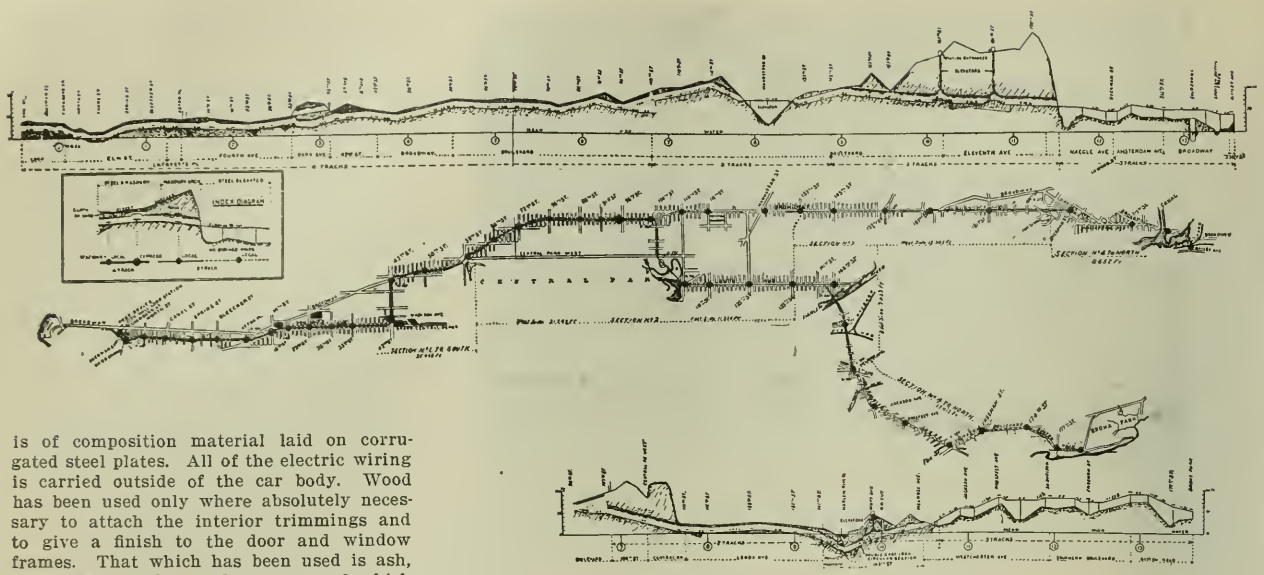
At the start, it is probable that about 40 local and 25 express trains will be run north as far as 145th street on both the east and the west sides. The cars will be more fully described and illustrated in a subsequent article. It is sufficient here to say that they are as nearly fireproof as it is possible to make them. All of the body, roof and underframing is steel and the sides and roof are sheathed with thin steel plates. The floor



Interior View, Cut-and-Cover Section.



Manhattan Valley Viaduct, Broadway and 129th Street.

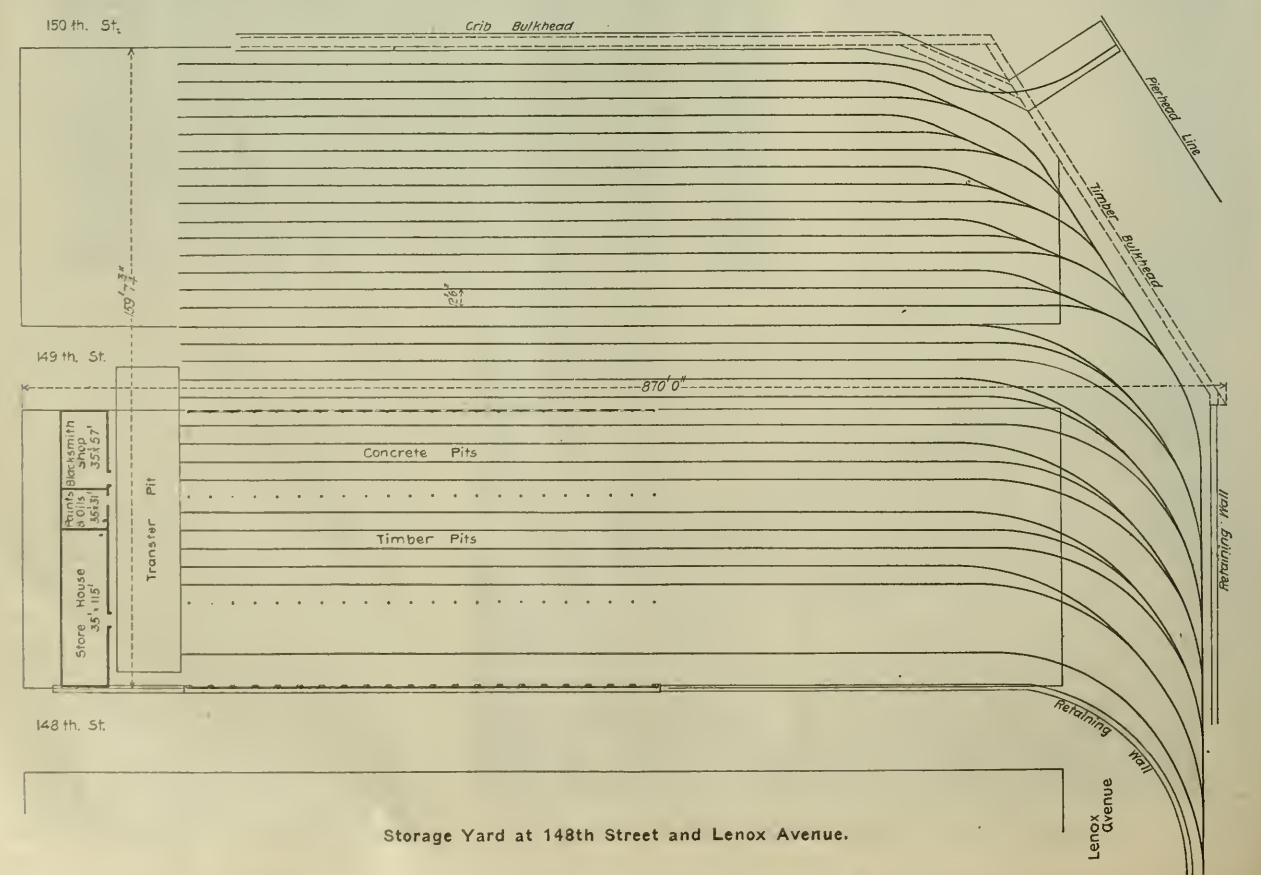


Plan and Profile, Rapid Transit Subway.

is of composition material laid on corrugated steel plates. All of the electric wiring is carried outside of the car body. Wood has been used only where absolutely necessary to attach the interior trimmings and to give a finish to the door and window frames. That which has been used is ash, treated with a fireproofing compound which makes it practically incombustible. The seats are rattan and are arranged part longitudinally and part across the car in the same way as in the cars now used on the elevated railroad. The platforms are enclosed but the entrance doors on each side are 10 in. wider than the entrance gates of the elevated cars, so that passengers can be handled at stations quicker and with less crowding. The car bodies alone cost about $3,600. For the present these steel cars will be supplemented by a large number of copper-sheathed wooden cars which were originally bought with the intention of running them in the subway but which have been supplanted as the standard design by the more substantial steel cars. About 600 of these cars are owned by the Interborough, and for the past year some of them have been running on the elevated lines. They are interchangeable both with the older equipment of the elevated lines and the steel cars of the subway, and can be used on either line. When the large outstanding orders for steel cars are completed, however, these copper-sheathed cars will probably be withdrawn from service in the tunnels.

Slightly larger than the cars now in use on the New York elevated lines, the seating capacity of these subway cars will be about 52, and the loaded capacity, with the aisles and platforms filled with standing passengers, is supposed to be 110, although it has never been apparent that there was any particular limit to the number of passengers that could get on a train on the elevated road during rush hours.

Details as to the time-table and running time are not yet available, but it is expected that the express trains, making three intervening stops, will run in about 14 minutes from City Hall to Ninety-sixth street, a distance of approximately seven miles. The station arrangements will, in general, be the




Storage Yard at 148th Street and Lenox Avenue.

same as at present on the elevated road, with two men, one ticket seller and one collector, at each station. There will be about 18 train despatchers and assistant train despatchers, and the despatching will be done entirely by telephone. The duties of despatchers are chiefly those of a yardmaster or trainmaster, orders for the movement of trains on the time of other trains being, of course, unnecessary on a road of this character. The storage yards, where the trains will stand when not in service, will be located at 148th street and Lenox avenue and at 133d street and Broadway. The accompanying plan shows the arrangement of the 148th street yard.

Exits Distinguished From Entrances by Style of Roof.

One of the most interesting features of the subway work is the excellence of the stations, especially in comparison with those of the old London underground road, and the Paris Metropolitan. The covered cut style of excavation which prevails for most of the distance permits the stations to be quite perfectly lighted and ventilated, and the electric lights for the stations are entirely independent of the main power as well as of the circuits which operate the signals. In case of accident, the main power can be shut off on a signal given by pressing a button; and there are buttons for this purpose at the stations and also at intermediate points along the route. These can be used at any time without affecting either the block signal circuit or that of the station lamps. Care was also taken to make the individual stations distinctive, to serve more fully as landmarks, and considerable ingenuity has been shown in the scheme of decoration, as will be seen in the accompanying photographs. There was a fine opportunity here for good decorative work and the architects fully availed themselves of it. The photograph of the tablet and decorations marking the Astor Place station is characteristic, and the flat-tailed beavers on either side of the name of the station, and, indeed, appearing wherever there seemed to be a good place for a tablet, will prevent New Yorkers from forgetting that the Astor family made their money in the fur trade of the Northwest. Besides their excellent artistic effect the shields with the beavers are perfectly distinctive, occurring nowhere else in the subway decorations, so that if you see a beaver out of your car window you may know that you are at Astor Place. Similarly, the station at Columbus Circle is decorated with little caravels under full sail, and at the station near Columbia College the seal of the college is made use of. Practical New York has seen very little of this kind of suggestive decorating of such purely businesslike and unsentimental structures as the stations in the Subway, and the citizens are to be congratulated on having this every-day aid to esthetic education.

### Signaling in the Subway.

The system of automatic block and interlocking signals in the subway is one of the most complete installations which has ever been made. Between 96th street and the City Hall, there are four tracks, two of which will be used for local trains stopping at all stations, and the other two, which are in the middle, will be used for through express train service in both directions. Between 96th street and 145th street, there are three tracks, two of which will be used for local trains and the third track, which is in the middle, will be used for express trains which will run in one direction only, going down in the morning and up at night. Beyond 145th street, on the West Side division, there are but two tracks, which will be used only for local trains. These tracks run on the surface or on an elevated structure for the entire distance to Kingsbridge. The train service on the express tracks will be very similar to that on steam railroads in that the trains will run at speeds of from 35 to 45 miles an hour, making no stops for long distances. These express tracks will be block signaled for their entire length and the local tracks will be block signaled at stations and at curves where the motorman's view ahead is obstructed. On the local tracks the conditions are very similar to those found on the elevated railroads. Trains are supposed to be under control at all times so that there is little necessity for putting in a block-signal system on these tracks. Such a system has never been thought necessary or advisable on the elevated lines and the same reasons which have prevented its use there, hold good in the subway. In addition to the automatic block signals, all of the junction points and crossovers from one track to another are protected by interlocking signals and switches similar to those used on steam railroads.

The distinguishing feature of the block-signal installation is the use of alternating current track circuits for actuating the signal relays. The rails act as return feeders for a 500-volt power circuit and also carry a 10-volt alternating current connected through the insulated blocks and the signals which control train movements on those blocks. On account of the limited clearances and the conditions of night which prevail in the tunnel the signals indicate by color at all times and not by position. The movement of the colored glasses which show the indications is accomplished by air cylinders operated through electro-pneumatic valves connected with the signal relays, this portion of the apparatus being practically a duplicate of that used in the Westinghouse electro-pneumatic system on steam railroads. The signal lamps are lighted by electricity taken from a separate circuit. On the elevated and surface portions of the line the signals have semaphore blades for use by day and the usual colored glasses for indicating the position of the signal by night. The operating mechanism for the signals in the tunnel and on the surface is the same.

All of the interlocking signals and switches are operated by the Westinghouse electro-pneumatic system with only very slight modifications from standard steam railroad practice. At the more important junction points, interlocking machines are placed in cabins set between the tracks and having an operator constantly on duty; but at other points on the line, where there is but a single crossover requiring not more than five or six levers, the machines are mounted on the station platform. Power for operating all of the block signals and interlocking signals is obtained from motor-driven air compressors mounted in six sub-

Natural Lighting, Twenty-third Street Station.

stations located at distances of about two miles apart.

Every block signal has, as an auxiliary, an automatic stop so arranged that if a motorman overruns a home signal the train is stopped before reaching the *next* home signal, the overlap principle being used to give this distance to stop in.

The entire installation was designed and built by the Union Switch & Signal Company under the direction of Mr. George Gibbs, Consulting Engineer for the Interborough Rapid Transit Company.

## The Power Equipment of the New York Subway.

All the power for operating the New York rapid transit subway will be generated at a central power station, which occupies the block between Eleventh and Twelfth avenues and Fifty-eighth and Fifty-ninth streets. The power-house is 609 ft. x 201 ft., and there is room for future extensions. The power plant is divided into six sections. The first five sections are alike with the exception of the fourth, which has steam turbines. The equipment of each of the other sections consists of two main engines with condenser sets, circulating pumps, two boiler feed pumps, two feed water heaters, two air pumps, 12 boilers and one stack, and provision is also made for the installation of four economizers. The turbine section contains one large engine and is also designed for accommodating four 1,250 kilowatt steam turbines. This section also contains two 250 kilowatt steam driven exciter units, three 250 kilowatt motor-driven exciter units, and other accessories. The equipment for the sixth section has not yet been decided upon. The 60 boilers are on one floor on both sides of a 20 foot passage-way. The boilers were built by the Babcock & Wilcox Company, and each contains 6,000 sq. ft. of heating surface and 100 sq. ft. of grate surface. Each battery is connected by means of four smoke uptakes to a horizontal flue, three batteries connecting to two such flues. The arrangement is such that the gases may be passed through economizers. Each section of six boilers is provided with two engine-driven mechanical-draft fans which deliver air under the grate.

The stacks are in the middle of the passage between the boilers and are supported on steel columns. The bases of the stacks are on a level with the bottom of the coal bunkers, and hence do not extend down into the boiler-room. This method of building stacks is new. Each stack is about 120 ft. high and 15 ft. in diameter at the top, and is the Alphons Custodis type. The coal bunkers are above the economizer floor and between the stacks. Seven bunkers are provided so that different grades of coal may be used if desirable. The maximum storage capacity of the bunkers is 16,000 tons. The coal supply is delivered from boats, which land alongside a pier built at the foot of Fifty-eighth street. Here the coal is unloaded, crushed and delivered to a small building near the pier, from which it is loaded on a belt conveyor, which carries it through a tunnel to the power house, from which point it is elevated by belt conveyors to the distributing conveyor which passes over the bunkers. The coal conveyors were built by the Robins Belt Conveyor Company. Most of the boilers will be fired by hand. Some of the boilers are fitted with superheaters. The ash cars under each row of boilers are hauled by electric storage battery locomotives to a conveyor at the water edge which elevates the ashes to a large pocket from which they are discharged into a scow.

The main engines have a rated capacity of 7,500 h.p. and are capable of developing 50 per cent. overload. The engines are twin compound type. The high-pressure cylinders are 42 in. in diameter and the low-pressure cylinders are 86 in. in diameter. The stroke is 60 in. and the speed is 75 r.p.m. The generators were built by the Westinghouse Electric & Manufacturing Company. They have a capacity of 5,000 kilowatts each and furnish three-phase alternating current at 11,000 volts and 25 cycles per second. The steam turbines are the Westinghouse-Parsons type and are direct connected to 11,000 volt, 1,250 kilowatt, three-phase, 60 cycle generators. All motors and generators are connected to the switchboard, which is in a switching room on the Fifty-ninth street side of the building. The operation of all the electrical apparatus is controlled from this point. It is estimated that the cost of the power station will be $7,000,000 when fully equipped. When all the units have been installed and the station is working to its full capacity, the combined power will be 120,000 h.p.

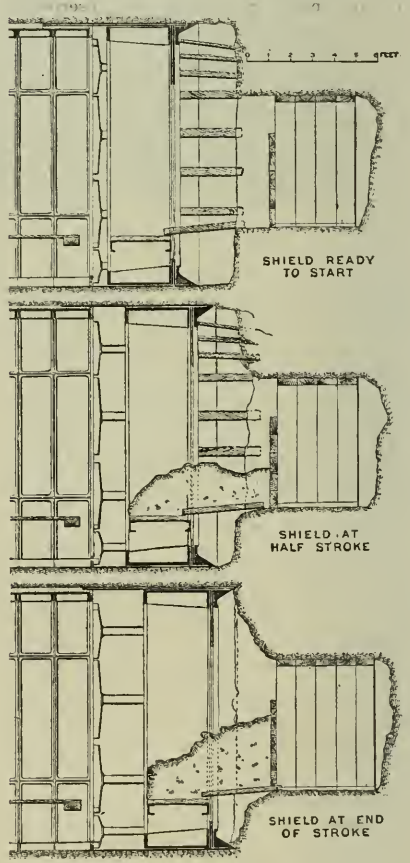
About 600 motor cars will be required for the opening of the line. The Westinghouse multiple control system will be used, three cars out of five, or five cars out of seven or eight in a train being motor cars. The cars for both local and express service will be similarly equipped. The motors were specially designed as it was necessary to have a great deal of power in a limited space. Each motor is rated to use 300 amperes at 570 volts, which is equivalent to 200 h.p. The motor will carry 500 amperes without injurious sparking. The motors are encased but are designed so that easy access can be gained to the interior for inspection and repairs.

## Tunneling With a Shield in London Clay.*

The underground electric railroads or "tube" railroads in London have nearly all been driven through the stiff clay which underlies the ground by the Greathead shield method without air pressure. The Greathead shield consists of three principal parts, the cutting edge, the skin and the cylindrical jack casting. The cutting edge is of cast steel made in three parts bolted together and is of slightly larger diameter than the skin of the shield in order to facilitate the progress of the shield through the clay. The skin consists of a cylinder 6 ft. long made up of ½-in. steel plates in three sections with butt-joints and ½-in. cover plates extending from the cutting edge, to which it is fastened with countersunk setscrews, to within about 2 ft. 9 in. back of the jack-castings, forming what is known as the tail of the shield. The object of the tail is to support the ground above and protect the miners while erecting the tunnel lining rings. The ring of jack-castings is made in six sections bolted together and also bolted to the skin and cutting-edge with hardwood packing inserted in the horizontal joints. Besides affording a firm foundation for the jacks these castings greatly strengthen the shield and are indeed its main support. Between the jack-castings and the cutting-edge is a steel diaphragm consisting of two ½-in. plates which give stiffness to the shield and assist in maintaining its circular shape.

The shield is driven forward by eight hydraulic rams or jacks, each 7 in. in diameter, the required pressure being obtained with an air intensifier which is fixed to the shield. This receives air at a pressure of 60 lbs. per sq. in. and intensifies the pressure, forcing water into the rams at a pressure of 2,200 lbs. per sq. in. A flexible pipe connects the compressed-air main in the tunnel with the shield and the intensifier draws its water from two tanks also fixed in the shield, one on either side. The shield is fitted with an oak grouting-rib made in sections, having strips of leather nailed to its outer edge and projecting about ½-in. beyond the oak rib all around. This ring is held in position by the rams and serves to keep the grout in and to distribute the pressure of the rams evenly over the segments of the tunnel-lining.

The shield is moved forward in the following cycle: A box-heading is driven in advance of the shield, being always kept about 6 ft. or 8 ft. ahead of it. The heading is 6 ft. high and from 5 ft. to 6 ft. wide and is timbered with 4-in. x 4-in. head and side-trees. Two miners and two laborers




Work Done by Shield in One Stroke.

work continuously in the heading even while the shield is being moved forward and they are able to just keep pace with it. Just before the shield is moved forward, the last lining ring is grouted up, the grouting ribs being held in place by the rams. The clay ahead of the shield is roughly trimmed to the shape of the cutting edge for a distance of about 20 in. in front. Piles or cutting boards, 6 in. x 1¾ in. x 3 ft. long, sharpened to a point and shod with iron at one end are then placed in front of the shield and projecting out into the bank of clay as shown in the illustration. The number of these piles which are used varies with the nature of the ground; their purpose is to bring down the greater part of the clay as the shield moves forward. Small pockets are formed in the clay, just large enough to support the pointed ends of the piles until the shield starts. The first two rows of the heading lining are knocked away and laid across the entrance of the

*Extract from a paper presented to the Institution of Civil Engineers, London, by H. A. Bartlett, and reprinted from the Proceedings, Vol. 156.

heading to keep the clay from falling into it as it is brought down by the piles. Planks are laid from the heading to the platform of the shield to keep the loose clay from falling into the invert. The shield is given its full stroke of 20 in. without stopping unless going around a sharp curve in which case it is stopped at half-stroke to check its position. The work done in one stroke is shown in the illustration.

The shield having reached the end of its stroke, the rams are drawn back, the grouting rib is removed and the invert of the tail of the shield is cleaned out ready to receive the segments of the tunnel lining. While the shield is going forward the cast-iron segments for the ring, with the necessary bolts and packings, are brought forward on trolleys. The two bottom segments are placed in position on the skin and are bolted to the last ring erected, packings having been inserted in the joints. The packings are creosoted deal and are cut to the shape of the segment flanges with holes bored for the joint bolts. They vary in thickness from ⅜ in. upwards, thicker packings being necessary when going around curves. The next two segments or "side plates" are then lifted into position on the bottom plates and are similarly bolted to the last ring. Meanwhile, two miners, using the heap of clay in front of the shield as a platform have trimmed off the clay around the upper half of the cutting edge for a distance of 20 in. ahead of it, and have placed the cutting piles in position ready for the next advance. A temporary staging about 4 ft. above the rail-level is erected just back of the shield and the top segments and the key are lifted into position and temporarily propped, being forced about 1 in. higher than their final position in order to give sufficient clearance for fixing the key in place. When the key is in position, the temporary props are removed, the packings are inserted and the whole ring is bolted up. The remaining sections of the grouting-rib are then placed in position and the rams are forced out to hold them. The ring is then thoroughly grouted with lime or cement under a pressure of 60 lbs. per sq. in. As soon as the ring is bolted up, the temporary stage is removed, and the clay brought down by the piles is loaded into skips and run back to the shaft. When all the loose clay has been removed, the miners trim off the clay in the invert ahead of the shield, and the first two settings of the box-heading are knocked away preparatory to the next stroke of the shield.

Two sets of apparatus are used for guiding a shield, in order to control its movement, in respect to (1) line, and (2) level.

(1) Its movement in respect to line is controlled as follows: Two plumb-lines are suspended from the top of the tunnel, about 30 ft. apart, the forward line being about 12 ft. from the shield. These two lines are hung exactly on the center line of the tunnel if on a straight stretch, or on the tangent-line if the tunnel is on a curve. The shield is fitted with a removable center-rod, which can be fixed in two brackets on the back of the shield. On this center-rod a saw-cut is made, exactly in the center. In order to test the shield for position in line, the two plumb-lines are allowed to hang in the tunnel, and the center-rod is placed in position in the shield. If the saw-cut on the center-rod is in exact alinement with the two plumb-lines, the shield is in its correct position as to line; if it is found to be out of line, it must be brought right again by using more rams on one side than on the other. When going round a curve, a table of offsets for every foot of length is compiled. A mark is made on the center-rod, at a distance from the center saw-cut equal to the offset for the particular point as given in the table, and this mark is brought into alinement with the plumb-lines.

(2) For checking the position of the shield in respect of level, two adjustable boning-rods are bolted to the roof of the tunnel, about 30 ft. apart, the forward rod being about 10 ft. from the shield. The cross-pieces on these rods are adjusted to the required height by means of a level, and a fixed mark is made on the shield. If the shield is at its correct level this mark should be exactly in alinement with the tops of the two cross-pieces in the tunnel. If it is not, the level of the shield must be adjusted by putting more power on the top or bottom rams as required.

In a method of guiding the shield introduced by Mr. H. H. Dalrymple-Hay, two guide rods, each about 25 ft. long, are fixed to the shield on its horizontal diameter, one at each side. These guide-rods are graduated in feet and inches and are drawn forward by the shield past two "zero-pieces" or indexes fixed to the sides of the tunnel. As the shield advances in a straight line, the readings on both rods should of course be the same. If they differ, one side of the shield is gaining on the other and the shield is going "off line." For going around curves, a special shrunk scale is calculated for the inner side of the curve and marked on the inner guide rod so that the shield is guided on the curve by keeping the scale readings the same on both rods. With methods such as these it is fairly easy to keep the shield within 1 in. of its correct position.

The force required to drive a shield depends, of course, on the nature of the soil through which the tunnel is being driven. The following table shows the force required to drive a shield through the London clay. The figures have been taken from actual observations and under varying conditions. The first three sets of observations apply to a shield 13 ft. 5¾ in. in diameter and the remainder to a shield 22 ft. 10 in. in diameter. In the case of the larger shield, the back pressure exerted by the six table-rams, each 7 in. in diameter, has to be deducted.

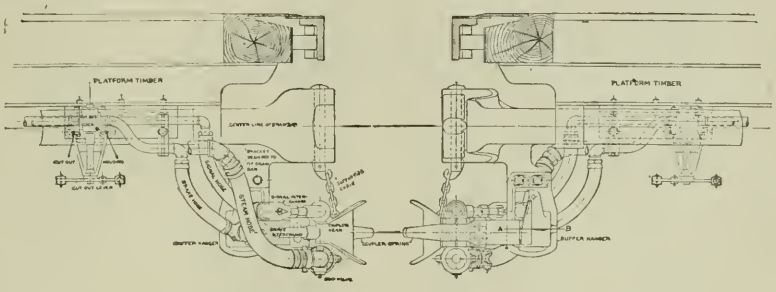
*Force Required to Drive a Shield in Tunneling Through London Clay.*

| Shield Diameter. Ft. | Shield Diameter. Ins. | Shield Circumference, Feet. | Rams. No. | Rams. Diameter. Inches. | Rams. Pressure, Lbs. per sq.in. | Pressure. Total Forward, Tons. | Pressure. Total Back. Tons. | Pressure. Resultant Forward. Tons. | Pressure per Foot-Run of Cutting-edge. Tons. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 5¾ | 42.3 | 8 | 7 | 2,240 | 307.8 | .... | 307.8 | 7.3 | Maximum obtainable. |
| .. | .. | .... | 6 | 7 | 1,680 | 173.1 | .... | 173.1 | 4.1 | Piles used. |
| .. | .. | .... | 8 | 7 | 1,800 | 247.4 | .... | 247.4 | 5.8 | Piles used. |
| 22 | 10 | 71.75 | 22 | 7 | 2,240 | 847.0 | .... | 847.0 | 11.8 | Maximum obtainable. |
| .. | .. | .... | 15 | 7 | 1,176 | 303.0 | 91.8 | 211.2 | 2.9 | No piles used. |
| .. | .. | .... | 16 | 7 | 1,170 | 321.6 | 91.8 | 229.8 | 3.1 | Piles used. |
| .. | .. | .... | 18 | 7 | 1,150 | 356.4 | 91.8 | 264.6 | 3.7 | |
| .. | .. | .... | 19 | 7 | 1,100 | 359.1 | 91.8 | 267.3 | 3.7 | |
| .. | .. | .... | 19 | 7 | 1,145 | 374.3 | 91.8 | 282.5 | 3.9 | |
| .. | .. | .... | 20 | 7 | 1,000 | 344.0 | 91.8 | 252.2 | 3.5 | |
| .. | .. | .... | 20 | 7 | 1,160 | 400.0 | 91.8 | 308.2 | 4.3 | |

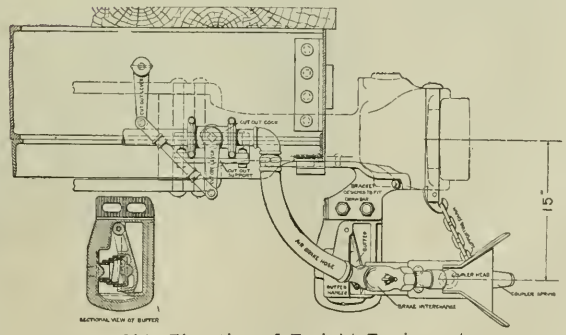
NOTE.—Pressures are given in long tons of 2,240 lbs.

## The Westinghouse Automatic Air and Steam Coupler.

The Westinghouse Automatic Air & Steam Coupler Company has an interesting exhibit in the Transportation Building at the World's Fair, St. Louis. It consists of an arrangement of two short car platforms modeled to represent the ends of passenger and freight cars, and also a locomotive pilot. One car platform is so mounted as to permit of a variation of four inches in its height, and it can be moved with considerable momentum toward either the locomotive pilot at one end or the other car platform at the other end. On these platforms and on the pilot are mounted full size models of the Westinghouse automatic air and steam coupler, and the device is shown under conditions closely approximating actual service conditions. The car platforms are so arranged that they may be coupled at an angle to each other, representing the case of an extreme curve and the movable platform is operated by compressed air, with an arrangement of an air cylinder and a slide valve connection. Both the 3-hose passenger equipment and the single-hose freight equipment are shown. Besides this exhibit there is a small model of two complete car trucks and frames fitted with air, steam and signal hose couplings which supplements the larger exhibit, and both are in more or less constant operation.




Side Elevation of Passenger Equipment.




Side Elevation of Freight Equipment.

The freight and passenger equipments are shown in the accompanying illustrations. The coupling head, which is of malleable iron having V and wedge-shaped guides projecting toward the front and an outwardly bent spring firmly riveted to the back, is supported by the coupling spring resting in the slotted buffer hanger, the hanger being bolted to a cast-steel bracket riveted to the drawbar. It is held in proper position by a chain attached to the draw-bar knuckle pin, and will adapt itself in coupling to differences in height of cars or angles of contact which do not permit the operation of the automatic car coupler itself. The slotted buffer hanger consists of a malleable iron frame embodying a spring seat and a cup-shaped buffing piece riveted from the upper part of the hanger. A volute spring holds the buffing piece forward to furnish a yielding resistance for the head during the coupling, and the car coupler itself checks the impact before the buffer spring of the automatic hose coupling has been fully compressed. The coupling heads, which are alike for passenger and freight service except in the number of gasket openings in the face, are so modeled that the positive engagement of the connections is effected without friction or wear on the gaskets, the gaskets being placed in holes in the coupling face connected to the pipe terminals by short hose.

The couplings are perfectly interchangeable and there are no rights or lefts. Proper provision has, of course, been made to allow connection with the automatic coupling and the old hand coupling. Coupling up the train lines between cars equipped with hand couplings and automatic couplings is effected in but little more time than that necessary for making the usual hand connections with the old method.

A convenient feature of the steam connection to the automatic head is that the parts may readily be removed in summer. The automatic drip valve which is a part of the steam attachment hangs down always at the lowest point in the steam connection, never failing to permit the condensation to escape at a pressure of four pounds or less, or at higher pressure when properly set, so that freezing, which is a common annoyance with hand hose couplings, is entirely avoided.

The device may be supplemented, if desired, by a cut-out mechanism for either passenger or freight service, which consists of a system of extension stems combined with proper link connections, by means of which the brake and signal cocks may be operated by a single handle from either side of the car. Provision is made by the various systems of steam heating for the operation of the steam valve without going between cars, usually by means of an extension rod secured to the step and connected to the valve by universal joints.

Besides this exhibit the automatic coupling is shown attached to an automatic dump car exhibited by the Goodwin Car Company. The Goodwin car requires three air connections; one for brakes and two for dumping. As these cars are usually used in railroad construction work, where they are operated over temporary tracks, the conditions are exceptionally severe, but the automatic coupling has given perfect satisfaction on all cars to which it has been applied. The special exhibition train of the Missouri Pacific, consisting of six cars and a locomotive, is also fitted throughout with the automatic passenger coupling equipment.

The automatic air and steam coupler has a number of apparent advantages. It does away with the danger to employees engaged in coupling hose between cars. Instances of scalding as a result of the unexpected uncoupling of the hand-steam connection are not infrequent, and a hot steam connection is also a dangerous thing to handle. The economy in time used in coupling and uncoupling cars is an important advantage, especially in the case of roads doing a large suburban business where a large number of trains must be handled in and out of the terminal within a short space of time. The New York Central has equipped all of its trains on the Putnam division with this automatic hose coupling and has found a great saving in time as a result. The Missouri Pacific has also adopted the automatic coupling for all the cars used in its suburban service out of St. Louis, and the Long Island has equipped its entire passenger rolling stock, consisting of 565 cars and 170 locomotives. This road has found that the congestion at its terminal station in Long Island City has been greatly relieved since the adoption of this device.

The material saving in the use of coupling hose is one which can be immediately reduced to a basis of dollars and cents. The New York Central has estimated that the cost of hose when using hand couplings is 230 per cent. of the cost of maintenance of the automatic couplings. It has been pointed out that by far the greater part of air hose removed from cars has been damaged by being cut, chafed, strained or torn at the nipple as a result of carelessness in uncoupling or pulling the hose apart before the connection has been uncoupled. The automatic coupling eliminates these losses entirely.

Inasmuch as the coupling forms an absolutely tight joint, the losses in the air brake and steam lines through the train are greatly reduced. Where the automatic coupling has been applied, a considerable saving in the amount of steam required to heat the train and the amount of air required to operate the brakes has been found. As yet the automatic coupling has been applied to passenger equipment only, but it has quite as many advantages for freight service as it has for passenger service. The congestion in yards where trains are made up and sorted would be relieved to a considerable extent if the time now consumed in coupling up and uncoupling air brakes was saved. It is almost impossible to enforce any rule calling for the coupling up of all brake connections throughout a long freight train, and as a rule only a few cars in the head of the train are coupled. As has been pointed out in these columns before, the dependence upon a few cars in the head end of a long train is probably the cause of a good proportion of the wheel failures due to excessive brake action and a good part of the damage done to draft gear and couplers. A device which would encourage the connection of all the cars in a train is to be commended for that reason if for no other.

## Railroad Shop Tools.

*(Continued.)*

### BORING MACHINES.

The horizontal boring machine shown in Figs. 1 and 2, is made by the Betts Machine Company, Wilmington, Del. This machine is known as No. 3. It is double back geared, which gives 15 changes of speed on the spindle. The spindle is cast steel 5 in. in diameter and has an adjustment of 30 in., with provision for 60 in. when required. The spindle can be driven in either direction and has a full bearing through the cast iron sleeve at all times. It has a quick hand movement by rack and pinion. It has an automatic variable feed from $^{1}/_{100}$ in. to $^{35}/_{100}$ in. and the spindle can be fed in either direction without reversing its motion. The table is 10 ft. long and is elevated by two screws, worm wheels and worms, which are driven by power. The table carries a saddle which has a movement parallel to the main spindle; on this saddle is a cross table 48 in. x 60 in. which has a horizontal movement at right

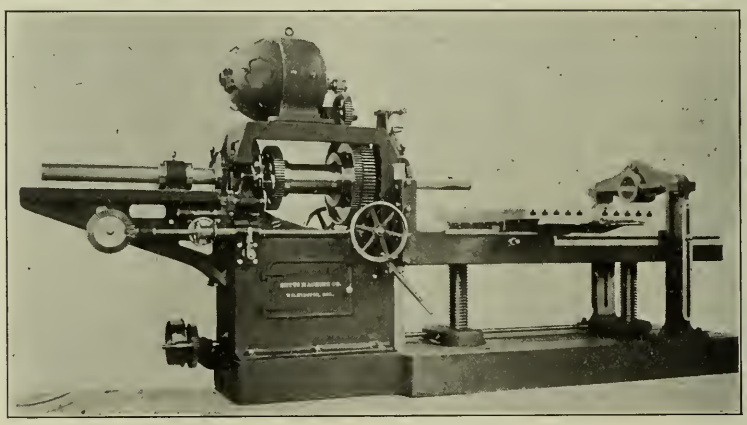


Fig. 1—The Betts No. 3 Horizontal Boring Machine.

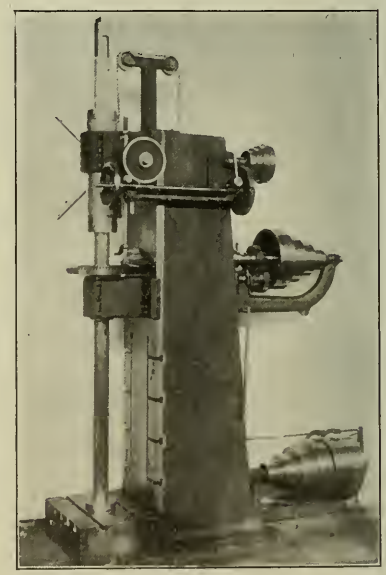


Fig. 3—Hoefer Vertical Boring Machine.

angles to the spindle. These tables can be lowered until the top table is 35 in. from the center of the spindle. By removing the upper tables, which are 6½ in. thick, the maximum distance from center of the spindle to the bed can be increased to 41½ in. The approximate weight of this machine is 30,000 lbs.

The vertical boring and drilling machine shown in the accompanying illustrations, Fig. 3, is made by the Hoefer Manufacturing Company, Freeport, Ill. It is especially designed for boring engine cylinders. One of the advantages of this type of machine is that the chips fall away from the cutters, thus preventing any chance of the chips wedging under the cutters and crowding up the boring bar. The spindle is of crucible steel 3⅜ in. in diameter and has an automatic feed of 16 in. in one setting and a vertical movement of 60 in. The spindle is supplied with both hand and power feed. The power feed can be stopped automatically at any desired point. The driving gears have a ratio of 4:1 and the machine is also supplied with back gears. The spindle is supported at its lower end by both a stationary and a revolving sleeve. The outer or revolving sleeve is supplied with a cap to prevent the borings from entering the bearings. The maximum distance from the face of the column to the center of the spindle is 8½ in. The machine occupies a floor space of 24 in. x 78 in. and the net weight of the machine is 5,500 lbs.

The accompanying illustration, Fig. 4, shows the new No. 1 "Precision" horizontal boring, drilling and milling machine made by the Lucas Machine Tool Company, Cleveland, Ohio. The principle of this machine is the raising and the lowering of the spindle and simultaneously with it, the outer support for the boring bar, instead of the conventional way of raising and lowering the table. This construction also makes possible the use of an exceedingly deep box bed, resting on three points, thus eliminating the necessity (and expense) of a foundation for the machine, and incidentally making it a matter of small expense to set the machine in a new location if desired.

The yoke carrying the outer support for the boring bar is fitted to the bed and is adjustable by a wrench to any point desired along the bed. Pieces of work longer than the nominal range of the machine may be drilled and milled. When holes are of such a length that the outer support for the boring bar is not needed they may be bored, by removing the upper portion of the yoke, which in this form of machine leaves the table as stiff, strong and efficient as before.

This machine will handle automobile engine work and the cross motion of the platen is such that cylinders and similar work may be bored and faced on the front and back portions of the platen alternately, thus making it easy to set one piece of work in position while the machine is at work on another. The platen has a milling feed. The vertical milling feed to the head, which is a regular feature of the larger machine, No. 2, may be easily and inexpensively applied to the machine shown.

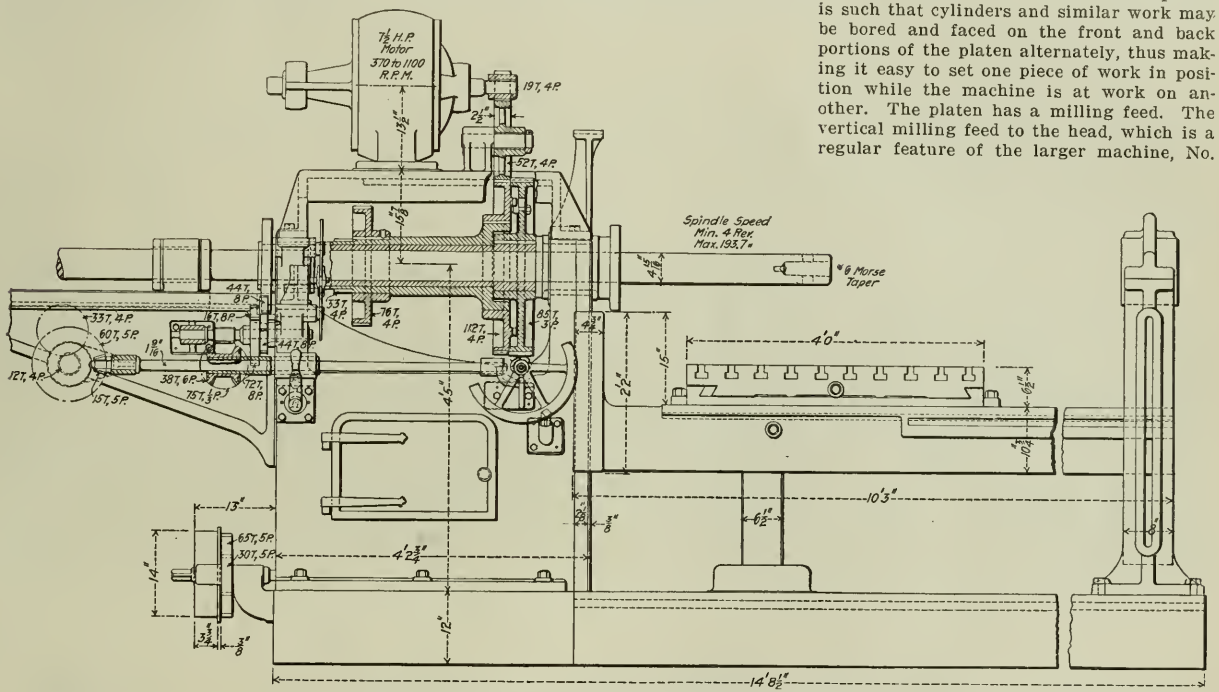



Fig. 2—The Betts No. 3 Horizontal Boring Machine.

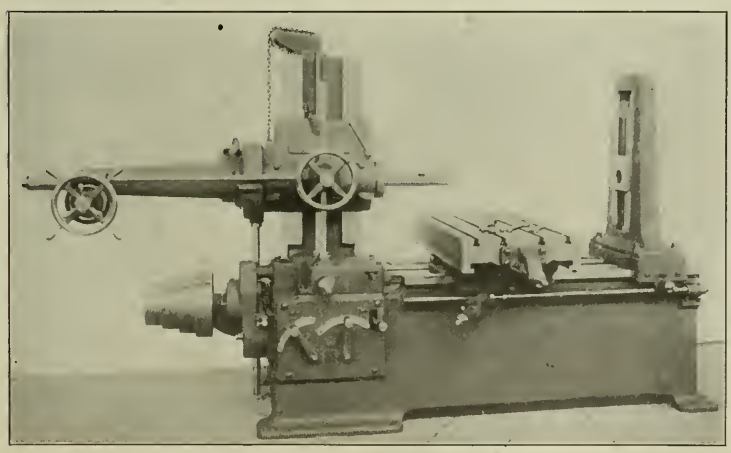


Fig. 4—The Lucas Horizontal Boring Machine.

The screws are all precision screws, cut from special hard steel and have adjustable dials graduated to thousandths of an inch, so that holes may be bored or surfaces milled an exact distance apart without jigs. The spindle is crucible steel and all working parts are ground or scraped. The machine is supplied with quick power moving devices, geared feeds, friction safety devices, etc., and it is adapted to receive single speed belt or electric drive when desired.

*(To be continued.)*

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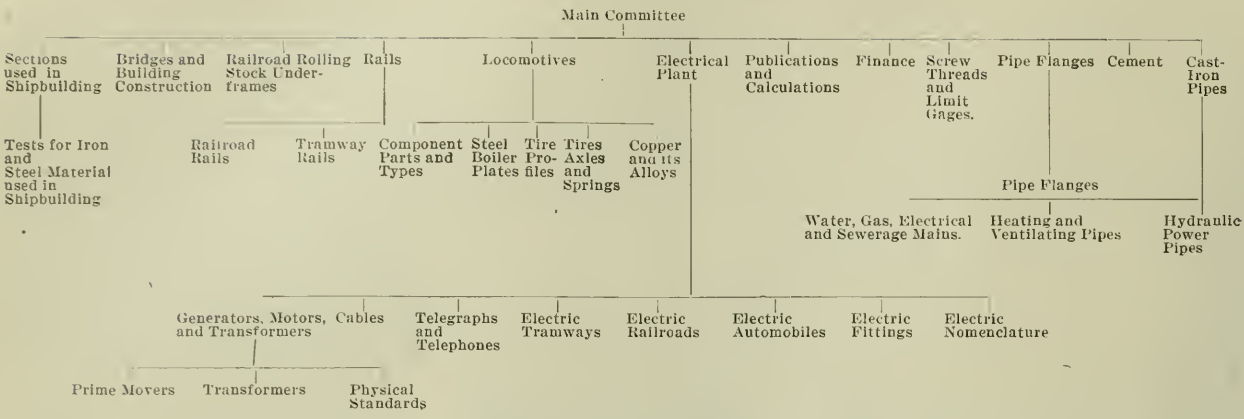
The New York *Tribune* of Aug. 18 announced in a leader that the first construction train had passed through the Simplon Tunnel and gave some account of that great undertaking. The *Tribune* is too previous. At the end of July there remained 1,393 ft. to be excavated to let daylight through. All work of extension at the north end has been suspended, on account of the difficulty of draining away the hot water springs, and with work going on at the south end only it was not expected to open through till October, and no construction train is likely to get through for months after that. The Milan Railroad exhibition, to celebrate the opening of the road, has been postponed till 1906. What has misled the *Tribune*, perhaps, is the passing of a construction train July 14 through a cork-screw tunnel, itself the trifle of about two miles long, on the railroad which is to connect the Italian system of railroads with the Simplon Tunnel; unless it may be the opening of the Austrian Wachein Tunnel May 31, less than four miles long.

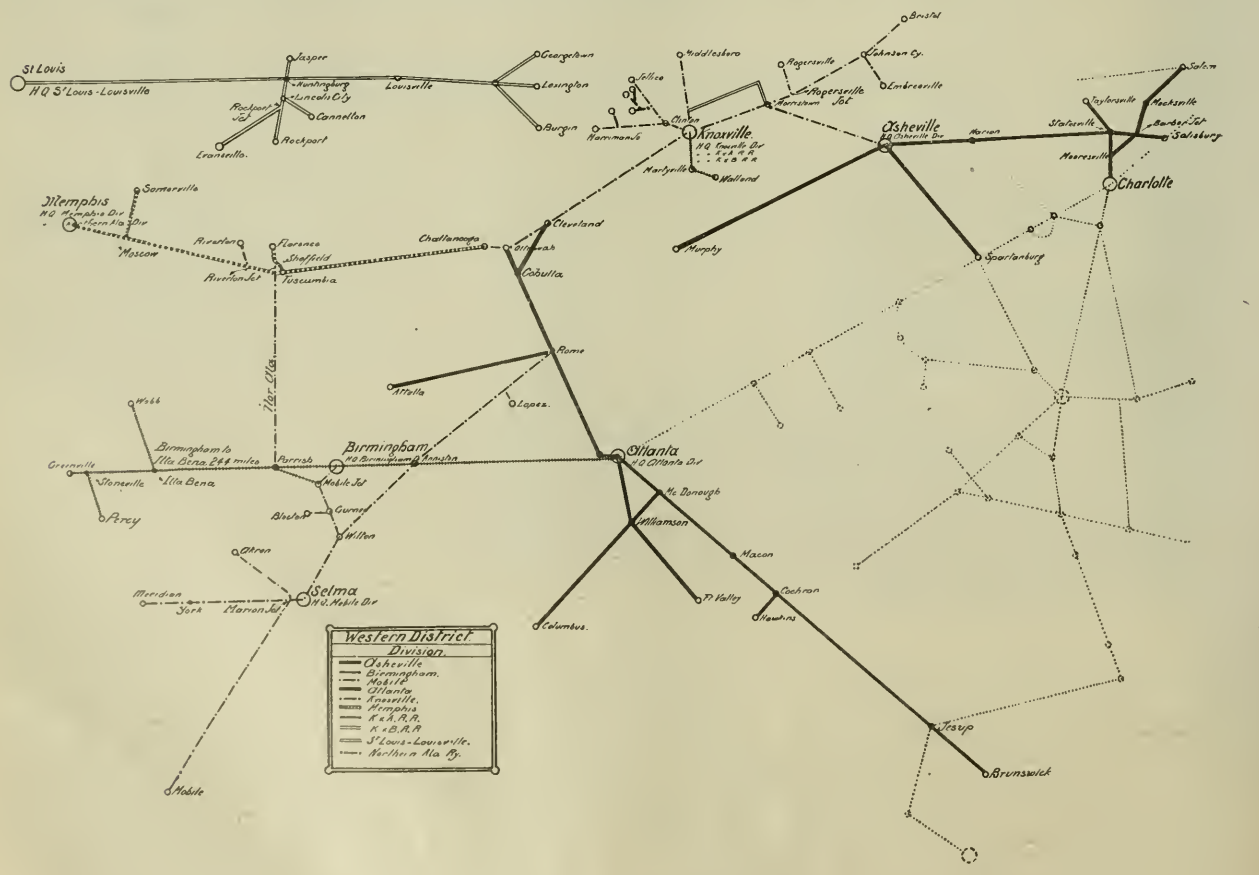
*THE ENGINEERING STANDARDS COMMITTEE.*




## The Divisions of the Southern Railway.

In looking over the list of officers of the Southern Railway in the *Official Guide* recently, it was noticed that there had been an increase of over a third in the number of superintendents and assistant superintendents in one year, while there had been only a trifling increase in mileage. As more thorough supervision of the operating department is one of the improvements in railroad service which, we believe, ought to be widely copied, this looked like a significant fact; and to illustrate the situation on the Southern Railway we have procured a map showing the territories managed by each of the 15 division superintendents of the company. The map is shown herewith in two parts, the whole being too large for a single page. The lines of the company are divided, for purposes of administration, into what are called the Eastern district and the Western district, though they are not so strictly separated, geographically, as might be implied by these words. The Southern is an aggregation of a large number of railroads which until quite recently were independent, and the geographical simplification of the respective territories of the superintendents necessarily is a slow process.

The map on the left-hand page represents the western district, the easternmost point in which is Salem (and also contains the St. Louis-Louisville lines). Those lines belonging to the Eastern district, which extend into the territory embraced in this map, are shown in light dotted lines. The map on the right-hand page shows the eastern district, which extends as far west as Atlanta. On this map the lines of the western district are shown in the same mahner as those of the eastern on the other map. The towns and cities at which there are division headquarters are shown on both maps in large letters. The other features of the maps




Western District of the Southern Railway.

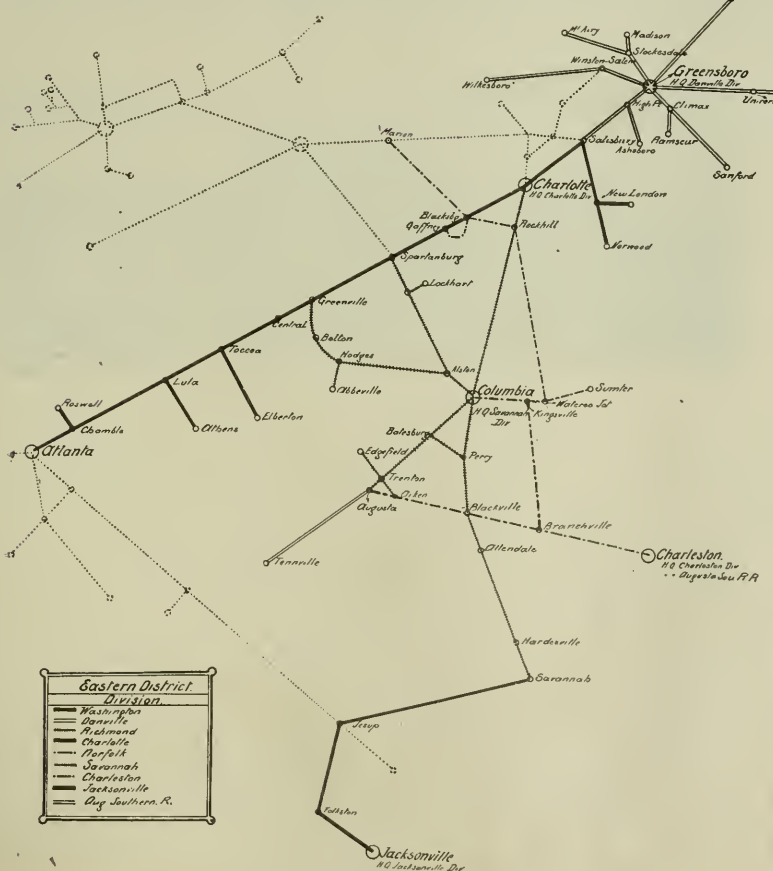
are self-explanatory. The reader will bear in mind that the St. Louis-Louisville lines, shown in the upper part of the left-hand map, are far removed geographically from the western district proper, the connection being by the Cincinnati, New Orleans & Texas Pacific, in which the Southern controls an interest. The St. Louis-Louisville lines, and the line from Birmingham to Greenville, are shortened to bring the map within the space available. With these two exceptions the maps are approximately correct as regards distances between principal towns.

Each division has a superintendent, and each superintendent is assisted by one or more subordinate officers, as follows:

| Division and Officers. | Miles. |
|---|---|
| Washington (2 assistant superintendents) | 344 |
| Danville (1 assistant superintendent and 2 trainmasters) | 639 |
| Charlotte (2 trainmasters) | 455 |
| Richmond | 283 |
| Norfolk (1 trainmaster) | 437 |
| Savannah (1 trainmaster) | 643 |
| Charleston (1 trainmaster) | 439 |
| Jacksonville | 145 |
| Asheville (2 trainmasters) | 449 |
| Birmingham (1 assistant superintendent and 2 trainmasters) | 576 |
| Mobile (2 trainmasters) | 572 |
| Atlanta (2 trainmasters) | 710 |
| Knoxville (3 trainmasters) | 552 |
| Memphis (1 trainmaster) | 332 |
| Knoxville & Augusta and Knoxville & Bristol Railroads | 66 |
| Total Eastern District | 3,385 |
| Total Western District | 3,257 |
| Total miles | 6,642 |
| St. Louis-Louisville | 505 |
| Total Southern Railway | 7,147 |
| Independent roads: Northern Alabama | 110 |
| Augusta Southern | 83 |
| | 193 |
| Grand total | 7,340 |

The General Manager of the Southern is at Washington, D. C.; the General Superintendent at Greensboro, N. C.; the Assistant General Superintendent in charge of the Eastern District, also at Greensboro, and the Assistant General Superintendent in charge of the Western district is at Birmingham.

The St. Louis-Lonisville lines have a separate general manager, whose office is at St. Louis. The Northern Alabama is under the management of the superintendent of the Memphis division, and the Augusta Southern under that of the superintendent of the Charleston division.




Eastern District of the Southern Railway.

## The Great Western Motor-Coach Services.

BY W. B. PALEY.

The Great Western has already added six services of steam to the two described in the *Railroad Gazette* of June 10. Two of these are partly over the same ground as the Westbourne Park and Southall service. One of them is between Park Royal and Acton, via West Ealing, and brings the great population about Ealing into direct communication with the beautiful Brent valley traversed by the new Greenford line. Ten trips are made in one direction and nine in the other, on week-days; eight and seven respectively on Sundays, on which day the service is not put on till the afternoon. The coach only remains at Acton two minutes before starting back, but stays at Park Royal on the average 21 minutes. The trips fit in between those of the other service so as to equalize the intervals between trains (that is, motors) so far as possible. Keeping the main line clear is the chief reason for the short stay at Acton, and the same applies to the Westbourne Park stop on the original service, also but two minutes.

On Sundays only, beginning August 7, motor-coaches have been run at intervals of about 35 minutes between Kensington (Addison Road Station) on the West London Railway, and West Ealing, over the above line. Not many people join at Addison Road but the next station, Uxbridge Road, adjoins the Shepherd's Bush terminus of the Central London or "Two-penny Tube," and taps the enormous traffic brought by that line. The new service is intended as a counter attraction to the London United Tramways, which end at the same place and do a prodigious business on fine Sundays. About a mile further north the motors turn off the West London (which the Great Western and London & North Western companies own jointly) at North Pole junction and cross the main fast roads at West London Junction on to the slow line, from which in a short distance the Greenford section diverges.

Low fares being absolutely necessary, sixpence only is charged to any of the stations or "haltes" on the new line, including return. The tickets are available at any of these places on either journey, which, though it seems a small thing, is quite a new departure. The furthest point, Castle Bar Park halte, to which the ticket takes you, is fully seven miles from Addison Road. So far the venture appears to have been successful, considering the short time it has been in operation, but the mode of working the traffic is somewhat peculiar and not apparently very economical. Two trains are used, each consisting of two motor-coaches with a six-wheeled saloon, third-class, placed between them. Smoking is allowed in the saloon, a term which here means a coach without compartments, entered by one door on each side and having the seats ranged round the sides and ends. Usually there are two tables in the middle. Both motors put on steam at starting, but the rear one shuts off after a time. Both take in water on the up journey, the leading one at Park Royal and the other at Addison Road before going back. On the Brentford branch the motor service was soon increased to every half-hour each way on Sunday afternoons and evenings, instead of once an hour. An intermediate "halte" has been opened, called Trumper's Crossing, the fare to it from either end being one penny. All the motor-coaches running in the London district are

kept at Southall, where they look rather odd, standing outside the running shed amongst goods and tank engines. Three are in use on week-days, each service employing only one, but on Sundays there are seven owing to the peculiar arrangement just described.

A motor service has also been started in the Plymouth district between Plympton, five miles east of the town, and Saltash, as much to the west. The distance between the two places direct is 9½ miles, but the cars run into Plymouth (Millbay) terminus, which lies at the end of a short branch, and out again, so that the whole trip is about 11 miles. Three additional stations, of a temporary character, have been constructed for the purpose of this service. The cars cross the Tamar over the celebrated Albert Bridge, built by Brunel in 1859, which immediately adjoins Saltash station. Slight variations exist in the service, some journeys ending short of Plympton, but the general effect is an addition of about a dozen extra communications per week day in each direction between the outlying extremities of the district and between these and the center of it. Eight such trips are given on Sundays, the whole being in addition to the ordinary train services. A motor coach also makes three trips each way between Plymouth and Yealmpton, half an hour's run with eight stops, part of it being over the Plympton route. Of the great advantage to the neighborhood of these new services no one who knows it can have a doubt.

Seventy miles further down, in Cornwall, a partial service of motor-coaches has been put on the branch, nearly nine miles long, that extends from Gwincar Road to Helston. It makes only four trips each way out of the total of eleven, most of them in the evening; but fills up its time with running three trips along the main line between Redruth and Hayle, 9½ miles, one between Hayle and Carnborne, six miles, and back to Gwincar Road. The total mileage it thus puts in is about 135½. On Sundays it merely performs the small service on the Helston branch, two trips each way, making 35 miles in all.

Two motor-coaches are now stationed at Wrexham, in Denbighshire, North Wales. One starts out at 9.55 a.m. and runs up the main line (Birkenhead section) to Gobowen, 12¼ miles. It soon comes back as far as Ruabon, 7½ miles, and sets forth on a trip of 45 miles of hilly and tortuous single line, amongst very grand mountain scenery, to Dolgelley, in Merionethshire. Staying there half an hour, it returns direct to Wrexham, finishing a day's work of 114½ miles at 4 p.m. The second coach leaves at 1.50 p.m. and goes via Ruabon along the Dolgelley line, but only so far as Bala, 27¼ miles out of the 45. At 2.53, at Corwen, it passes the other coach. Another double trip is made between Ruabon and Bala, after the last of which it makes two double trips of six miles between Ruabon and Llangollen, on the same line. Finally it gets home to Wrexham at 10.20 p.m., having done 142½ miles. One of the Bala journeys occupies only 67 minutes, with 10 stops. The Lambourn Valley Railway, only 12½ miles long, extending from near Newbury, on the Berks and Hants section of the Great Western to the small town of Lambourn, on the Wittshire downs, is now worked by a motor-coach. Hitherto it has provided its own rolling stock, of a light and somewhat peculiar kind. The line is single, laid with rails of the American type of only about 60 lbs. per yard, and has in places gradients as steep as 1 in 60. There are seven intermediate stations, several of them mere platforms quite as primitive as the "haltes" just constructed on the London & Greenford line. The motor makes five trips each way, equal to a day's work of 125 miles, 42 minutes being the usual time taken.

The figures given will afford a good idea of the working capacity of these vehicles. They are being tried under very different conditions of traffic, and on journeys varying from the nine minutes of the Brentford branch to the two hours of the Ruabon and Dolgelley run. The writer doubts if passengers who have booked through, first or second class, to stations served by motor-coaches which are third class only, will quite like the new system, and thinks the smoking question will probably cause friction sometimes. On the other hand, the spaciousness and airiness of the motors, the immensely improved view from the windows, and the saving of trouble in not having to pick out a compartment from amongst first, second and third-class smoking and non-smoking ones, will please a great many travelers.

## Santa Fe Station in Oakland.

The Santa Fe has recently completed a new station at its Pacific Coast terminus at Oakland, California. The building is in the typical California style of Spanish mission architecture, which the Santa Fe has already introduced in the Stockton, Fresno and Berkeley passenger stations. In fact, this style of architecture has been closely followed in the building of all the stations on the San Joaquin Valley division of the Santa Fe. Both the Fresno and Oakland stations are built of steel lath covered with concrete and with red tile roofs. The one at Oakland is 204 ft. long, including arcades and baggage room, and 54 ft. wide, including the arcades. It is a two-story structure, 30 ft. high from the ground to the top of the towers. The station is extremely artistic and has arcades 12 ft. wide running entirely around it, and extending out from the ladies' waiting-room a distance of 75 ft. The cost was about $12,000. The first floor contains two waiting-rooms, each 24 ft. 9 in. by 27 ft., and connected by a hallway 22 ft. long and 7 ft. wide. The ticket office is 22 ft. by 15 ft. with the window opening into the hall between the two waiting-rooms. The interior finish of the waiting-room is in green wainscoting, with electric light fixtures. The office wainscoting and furniture is of oak, and the benches and seats are cut in the old Spanish style. Maple wood floors are used throughout. The second floor is devoted to the drafting room and private office of the assistant engineer. The station is located at 40th street and San Pueblo avenue, and extensive grounds have been laid out with flower beds, lawns and palm trees.

We are indebted to H. K. Gregory, assistant general passenger agent of the Santa Fe, for the photographs shown.

Santa Fe Station at Oakland, California.

Santa Fe Station at Fresno, California.

## An Explanation of Form F.*

BY H. W. FORMAN.

Instead of regarding Form F as unimportant and merely a matter of point of view, the general and consistent theory upon which the Standard Code is constructed must be kept in mind while delving to get at its true meaning and application. It is hardly deserving of the opprobrium that is heaped upon it. The reason why it is more

*FORM F. FOR SECTIONS.

.....will display signals.....to.....for.....

EXAMPLES.

*Eng 20 will display signals and run as 1st No 1 London to Paris.*

*No 1 will display signals London to Dover for Eng 85.*

*2d No 1 will display signals London to Dover for Eng 90.*

This form may be modified as follows:

*Engs 70 85 and 90 will run as 1st 2d and 3d No. 1.*

*Engs 70 85 and 90 will run as 1st 2d and 3d No 1 London to Dover.*

Under these examples the engine last named will not display signals.

For annulling a section:

*Eng 85 is annulled as 2d No 1 from Chatham.*

If there are other sections following add:

*Following sections will change numbers accordingly.*

The character of a train for which signals are displayed may be stated. Each section affected by the order must have copies, and must arrange signals accordingly.

City Hall Station.

The As

Relation of Covered Trench to Street Surface.

Subdivision of Ga

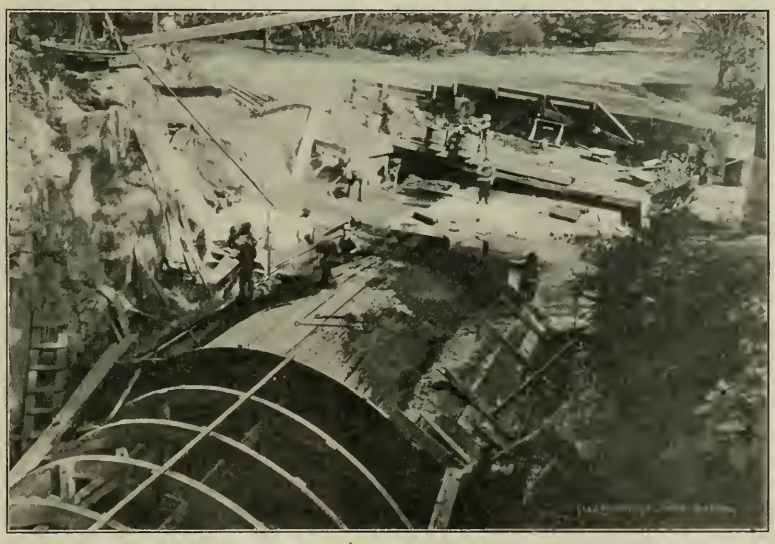
North End of Manhattan Valley Viaduct.

Skew-Backs of

rs.

Twenty-eighth Street Station.

y-sixth Street.



Cut-and-Cover Construction for the Tube Tunnel under Central Park.

129th Street.

Viaduct North of Fort George.

generally misunderstood than any other form is largely due to carelessness of examiners who jump at conclusions, instead of taking pains to learn just what the Train Rule Committee of the American Railway Association meant; and because of an unwillingness to concede that the rules have provided two ways for annulling trains—by their train numbers (Form K), and by their engine numbers (Form F). It appears to be difficult for many railroad men to accustom themselves to the simple proposition that a section of a train can be annulled by its engine number as effectually as a regular train can be discontinued by its train number, and that the same principle declared in Form K, to the effect that when a regular train is annulled it must not be restored, also applies to Form F. That is, when a section of a train is annulled by its engine number it must not be restored within that territory on that date. A perusal of Form F will convince anyone that the committee intended it to be used whenever sections were to be changed or annulled and that the movement must be made by the employment of engine numbers. Form K has an entirely different mission; it was never intended that an order should be given reading, "2d No. 1 of Feb. 29th is annulled Alaska to Halifax."

To fully understand Form F it is only necessary to keep these Code principles in mind and give due thought to what actually constitutes the annulment of a section and what simply authorizes the changing of sections or engines on sections. It is all-important that the address and wording of signal orders be in strict accordance with the rules.

The word "annulled" seems to be the stumbling block in this form, it being contended that it does not always mean what it says; that it purports to in some cases annul a section without doing so, while in others it does annul sections by mention of their engine numbers instead of only their train numbers. Granting that there may be ground for such criticism, I cannot see that those who have substituted the word "discontinued" for "annulled" have bettered the situation any, as there is no practical difference in the meaning of the two words. If everyone who has practically the same idea were allowed to give it a new dress and inject it into the Code, all the years devoted to securing uniform rules and getting them generally introduced would be wasted. It is to the interest of every railroader to uphold the present rules, making, if need be, personal sacrifice of opinion to maintain uniformity throughout the United States. It is, however, to be regretted that the committee framing Form F did not go into the matter a little deeper and give a few more examples which would enable anyone to fully understand the form without having to sometimes seek an explanation.

Suppose a district extends from A to Z, and that No. 1 runs from A to Z. When the despatcher issues an order for 1st and 2d No. 1 at C reading, "Eng. 85 is annulled as 2d No. 1 from C," 2d No. 1 of that date is annulled from C to Z and another 2d No. 1 must not be run anywhere between C and Z. He must not give a later order worded, "Eng. 85 (or any other) will run as 2d No. 1 C to Z," even if 1st No. 1 has not been given a copy of the first order and has not taken down signals, for the reason that this last order is an attempt to restore a section which has been properly annulled; any interested train may, upon receipt of the first order, proceed against 2d No. 1 anywhere between C and Z, because it has received the annulment of that section. Despatchers have been known to issue an order similar to the first example quoted (I have committed the same error), and afterward instruct No. 1 to display signals, say from G to Z, for a second section. It will be seen that this should not have been done. If it is desired to annul 2d No. 1 from C, and at the same time allow for a future 2d No. 1 from some station beyond C, the order annulling 2d No. 1 from C should indicate limits, thus, "Eng. 85 is annulled as 2d No. 1 C to G," then the despatcher may at any time thereafter authorize No. 1 to display signals for a second section between G and Z. Cases are on record where two orders were given to get the signals displayed by 1st No. 1 taken down and to annul the second section, thus, "1st No. 1 will take down signals at C," and "2d No. 1 of Feb. 29th is annulled C to Z," because trainmen and enginemen had never been instructed that an order reading, "Eng. 85 is annulled as 2d No. 1 from C" was not only authority for 1st No. 1 to take down its signals, but also was the annulment of 2d No. 1. The annulment of 2d No. 1 renders the signals displayed by the first section void and they must come down at C, or as soon thereafter as the order is received. If No. 2 was at G, holding an order to meet 1st and 2d No. 1 at that station, and, after 1st No. 1 had passed, it were to receive an order reading, "Eng. 85 is annulled as 2d No. 1 from C" it could proceed, as this order renders the meeting order void. A train that does not exist cannot be met.

So much for the annulment of a section. Now when is a section *not* annulled; that is, when is one simply displaced or dropped out, without in any way affecting the schedule or the signals that are displayed by sections in advance? An order addressed to 1st, 2d and 3d No. 1 reading, "Eng. 90 is annulled as 2d No. 1 from C following section will change number accordingly" does not annul 2d No. 1; it drops out the second section upon its arrival at C, but the same order further provides that a following section shall move up and take its place, therefore, under an order of this kind, 1st No. 1 must not take down its signals even if through error the order be addressed only to the first section, or it be found necessary to give it to 1st No. 1 after passing C. Another train receiving a copy of this order would not be justified in disregarding 2d No. 1, because it is clearly shown that a following section will assume that number. Nor is 2d No. 1 annulled when an order is issued reading, "Eng. 90 is annulled as 2d No. 1 from C. Eng. 70 will run as 2d No. 1 C to Z"; but if the order were to read "Eng. 90 is annulled as 2d No. 1 from C," *and stopped there*, without instructing following section or sections to change number or numbers accordingly, or without stating that some other engine would run as 2d No. 1 from C, then 2d No. 1 is annulled from C to the terminus of its run on that district. Thus it will be seen that when an engine is instructed to vacate a section, provision must always be made in the *same order* for keeping the section or train alive, or it is annulled. An order for 1st and 2d No. 1, worded, "Eng. 85 is annulled as 1st No. 1 from C following section will change number accordingly" accomplishes two ends: it takes down the signals on 1st No. 1 without annulling the schedule, but does annul the second section. Hence, the advantage in making use of the word "annulled" in this form, qualifying it when necessary, and the need of fully comprehending the theory upon which Form F is based.

Considerable condemnatory expression developed several years ago when the Train Rule Committee rendered a decision that it was necessary to advise the first section when the third was annulled. They did not say that it must always be done, only when the order creating the sections was worded as shown by the fourth Code example. It is not necessary that it be done in all cases, but often it is, to pave the way for a future order when the first section will be directly affected. To illustrate: If engines 70, 85 and 90 were instructed to run as 1st, 2d and 3d No. 1 A to Z and the despatcher desired to annul 3d from C and 2d from G, the order annulling 3d from C must also be addressed to 1st No. 1 at C or G, because if 1st No. 1 only receives the annulment of 2d No. 1 at G it would be doing wrong if it were to take down its signals, since notice was given to it in the order at A that the train would be run in three sections. The first section has the right, in such cases, to know that all following sections are annulled before removing its signals.

If there are five sections of a train and the despatcher desires to annul the 1st and 5th from C, only one order is required to make the movement if worded as follows: "Engs. 20 and 95 are annulled as 1st and 5th No. 1 from C following sections will change numbers accordingly." Under this order the first and fifth sections drop out and the remaining sections run as 1st, 2d and 3d No. 1 from C. The fourth section would, upon arrival at C, take down its signals and run as 3d No. 1 from that point.

When one section is run around another, some despatchers are under the impression that it is necessary to add to the order that the engine following will pass the one in advance, thus, "Engs. 70 and 85 are annulled as 1st and 2d No. 1 from C. Engs. 85 and 70 will run as 1st and 2d No. 1 C to Z. Eng. 85 will pass Eng. 70 at C," while others sometimes issue two orders, modeled (a) "Engs. 70 and 85 are annulled as 1st and 2d No. 1 from C." (b) "Engs. 85 and 70 will run as 1st and 2d No. 1 C to Z." Order *a* annuls both sections while *b* is an attempt to revive a schedule which has been ordered out of existence. If an order has been issued reading, "Engs. 70 and 85 are annulled as 1st and 2d No. 1 from C. Engs. 85 and 70 will run as 1st and 2d No. 1 C to Z," the second section would have been directed to pass, display signals and run as 1st, and the first section arriving at C would have allowed the following section to go by it and left there as 2d No. 1 without signals.

Sometimes the engine hauling No. 1 breaks down at C and is returned to A for repairs and perhaps another engine is sent to take No. 1 forward. In such event, orders have been issued annulling the original engine as No. 1, and when the relief engine arrived at C another order was given recreating No. 1. After studying the theory upon which the Code is made it will be seen that the first order, at least in effect, annulled No. 1 and that the later order restored a train which had been abolished. A message instructing the engines to be changed is all that is necessary, unless, in some rare contingency, it is deemed advisable to issue a train order to provide for some other movement, then the same order should also instruct some other engine to run as No. 1, otherwise, the schedule has seemingly been annulled. If the despatcher can find no other way out of a difficulty he should remember that he is always allowed to take away from sections all of their authority to proceed by annulling the order creating them without in any way affecting the schedule or so hampering himself that he cannot afterward legally create as many sections as he desires.

Form F, as here interpreted, may appear complicated, but it is hoped that the reverse may be found to be true and it is firmly be-

lieved that it will be if the examiner will prepare a series of train orders in chart form to exhibit to his class. When this practice has been followed it has been found that the men grasp the theory very quickly, and once they understand the form there should be no further misunderstanding or risk of accident.*

At the seventh annual convention of the Train Despatchers' Association of America, it was decided to petition the American Railway Association to change Form K to read "For Annulling a Schedule," and in other ways so modify the Revised Code that there would be a clear and sharp distinction between "train" and "schedule." The despatchers argue that often when the rules mean schedule the word train is erroneously used; that an engine displaying markers and running as an extra is a train, but has no schedule, and that time-table schedules, not trains, should be annulled. In some respects this alteration would improve the rules, but I cannot see that, even if this were done, a section could be annulled in one order and revived in another, even though the subheading of Form F be changed to read "for changing sections." There is a cardinal tenet that must always govern, namely, that when a regular train, or a section, is annulled (call it discontinued if the word annulled grates harshly upon the senses) it shall remain so, and it must not be restored by another later order. This reasoning is in harmony with Rule 82, which says that when a regular train loses right and class, by becoming 12 hours late, it ceases to exist for that date and no one must try to resurrect it by train order.

It would be unsafe to so refine the language of the Code that the average conductor or engineman could not readily and correctly interpret it.

*Further explanation of Form F by charts and questions and answers, will be found in "Rights of Trains on Single Track," a book by Mr. Forman, published by *The Railroad Gazette*.

## Kitchen Cars on the New York Central.

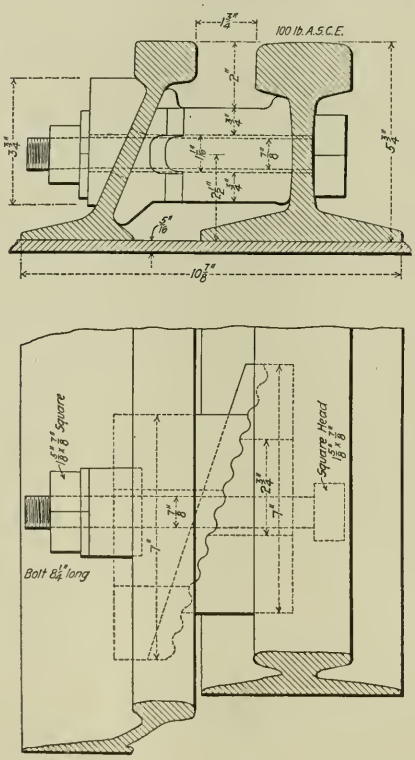
The New York Central has recently built at its West Albany shops, a kitchen car or cafe coach for use in trains on which the travel is not heavy enough to justify hauling a dining car. The floor plan of this new car is shown in the accompanying drawing. It is 61 ft. long over end sills and is divided into three compartments, a seat compartment in one end for passengers, a dining compartment 18 ft. 1 in. long in the middle and a kitchen and pantry 17 ft. 8 in. long at the other end. The seat compartment is finished inside as a standard passenger coach with high-back seats upholstered in green plush, and will accommodate 24 persons. Lavatories for men and women and a wash stand and linen locker occupy part of the space in the end of the car. In the dining compartment 18 persons can be seated at the tables, which are arranged as in the ordinary dining car. The kitchen has every facility for serving the most elaborate meals. The interior finish of the whole car is light mahogany and no attempt has been made to have any elaborate ornamentation.

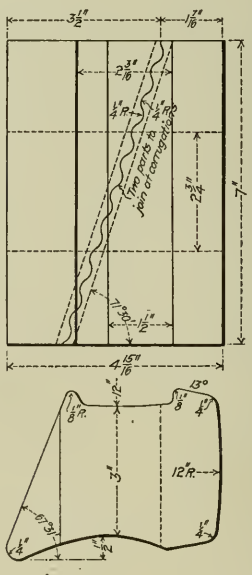
The Monon has a number of quite similar cars in use and the service which they give is said to be quite satisfactory. Much better meals can be served than from a buffet parlor or sleeping car and more persons can be accommodated at one time. Such a car also has an earning power as a passenger coach which a dining car has not. The service is *a la carte*, and extra waiters can be employed when necessary to serve meals to passengers in other cars in the train who may not wish to leave their seats.

We are indebted to Mr. F. W. Brazier, Assistant Superintendent of Rolling Stock, for the drawing.

## An Adjustable Filler Block for Guard Rails.

The accompanying illustrations show an adjustable filler block designed by M. C. Hamilton, Eng. Main. of Way, Rapid Transit Subway Construction Company. This device consists of three parts, two wedge shaped pieces and one beveled washer. The wedges are pierced with an oblong hole, and have corrugated faces, as shown. These faces fit into each other, and pressure applied to them by means of the bolt which passes through the rails prevents them from slipping. With this device the guard rail can be adjusted any distance to from 1¾ in. up to 2½ in. The normal distance is 2 in.



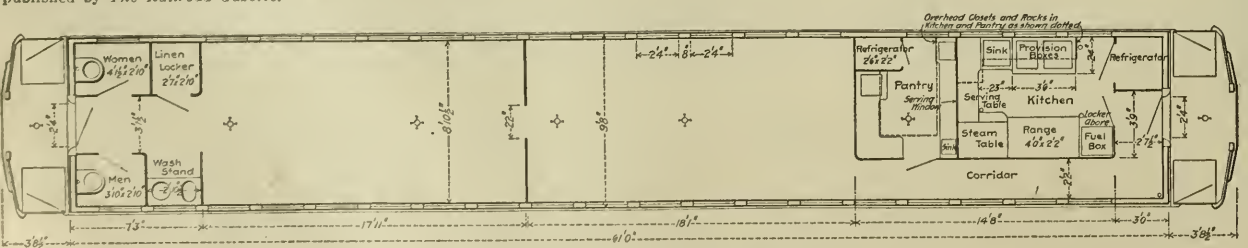



Adjustable Filler Block for Guard Rail.

## Foreign Railroad Notes.

To a committee of the Bavarian Legislature the Minister of Transportation declared that on the State Railroads the question of temperance was a very serious one; and that he was determined to oppose beer drinking among enginemen and trainmen. This in the country where nearly everyone drinks beer, and very many large quantities of it, is especially significant. The means adopted to oppose beer drinking are chiefly the provision of hot tea and coffee and soup in winter, and aerated waters and other cool drinks in summer, at a fraction of the cost of beer.

Russian journals express alarm lest the petroleum production on the Caspian shore should fail, or decrease seriously, based on the fact that many wells now yield salt water instead of oil. The exhaustion of wells and oil districts in the course of time is in the nature of things, but there seems to have been no recent great change in Russia. It would be a serious matter to have a great decline there, because it has become almost indispensable as fuel. Nearly two-fifths of the locomotives in all Russia use petroleum, and nearly all steamboats on the Caspian and the Volga.




Floor Plan of Cafe Coach for the New York Central.

RAILROAD GAZETTE

## LUBRICATION AND LOST WORK IN LOCOMOTIVES.

All motion between machine parts in contact, is opposed by frictional resistance. The movement of a journal in its bearing is the result of an expenditure of energy. It is only when the lubrication is bad that there is wear of the metal parts and it may be assumed in considering the general case that the energy expended in wearing away the material of the journal and its box may be wholly neglected. Accepting this view, it follows that all of the energy employed in overcoming the friction of a journal is expended in giving motion to the film of lubricant which is interposed between it and its box and that ultimately all of the energy appears in the form of heat. The process, while commonplace enough, is interesting in the relations it presents. For example, a journal resting in its bearings is set in motion. The resistance to be overcome is represented by the viscosity of the lubricant. As energy is absorbed, the temperature of the lubricant increases and gradually, heat passes outward from the lubricant to the metallic parts surrounding it until finally it is dissipated into the surrounding atmosphere. After a considerable period of running under constant conditions of load and speed, the journal and all parts in its immediate neighborhood assume a fixed condition of temperature. Those exposed surfaces which are nearest the lubricant becoming most highly heated, while more remote have lower temperatures. Under these conditions, there is a constant flow of heat from the lubricant, outward through the metallic parts of the machine and from these to the atmosphere. Moreover, the amount of heat flowing into the atmosphere is directly proportional to the work done in overcoming friction. It follows that the temperature of the metallic parts adjacent to a journal may be accepted as a direct indication of the energy which is being absorbed by the frictional resistance of the journal. The lost work increases when the temperature rises and diminishes when the temperature falls. It follows also that the metallic parts about a journal, when warmed to their work, must always have a higher temperature than the air about them.

The friction of any large machine such, for example, as a locomotive running at speed represents many horse-power, the heat equivalent of which must be radiated from its machine surfaces. A modern locomotive lubricated with oil may run for a long time in an atmosphere of 60 degrees F. without any of its bearings becoming sufficiently heated to feel warm to the touch, notwithstanding which fact they may be radiating the heat equivalent of from 50 to 75 horse-power. This condition may be accepted as evidence of low frictional losses. All this is of especial interest in view of a practice fast becoming common whereby axle-boxes and pins of locomotives are lubricated with grease instead of oil. It is admitted that greased journals run at higher temperature than those which are oiled, and this admission is equivalent to charging the greased journal with greater frictional loss. But the practice is justified because it gives the better protection against delays arising from deficient or defective lubrication. Grease lubricated locomotives not uncommonly come in, with journals so hot that they fry grease at every pore, and in such cases it is evident that their operation throughout the run has been attended by a very high frictional loss. From an operating point of view, grease appears to be a success, but from a purely academic point of view, the arguments are not all favorable to its use. In all this no wholesale condemnation of grease is intended. It is serving to keep locomotives on the road when many other things have failed, but its use is nevertheless a make-shift made necessary by conditions which the locomotive designer has not yet succeeded in overcoming by means which are more logical.

While grease appears to give great relief to those who have been troubled by flowing babbitt and scored box, it may not be the only means available. It is apparent first of all that there should be a better proportion of parts, the adoption of which would make unnecessary the present unusual means of lubrication. So long as this cannot be accomplished there yet remains the possibility of using graphite mixed in oil which, if it can be supplied the journal with regularity and certainty, will not only insure the safety of the rubbing surfaces but effect a decided reduction in friction even as compared with that obtained from oil. It is impossible to score a journal in the presence of good flake graphite. Again, there is always the possibility of substituting ball-bearings for smooth-surface ones. We understand that at least one manufacturer is prepared to apply ball-bearings both to the axles and crank-pins of locomotives, observing limitations as to the pressure imposed upon individual balls which in other service have given perfect satisfaction. But whether it is to be overcome by better designing, by the use of graphite, by the adoption of ball-bearing or what means soever, it is to be hoped that the reign of grease will be short.

## THE ST. LOUIS WORLD'S FAIR.

The Transportation Building at the World's Fair contains a fine exhibit of our best engines and cars, and thus affords an opportunity to mark, by comparison with the fair of 1893, the progress that has been made in the past eleven years. The railroad man who reads railroad literature knows pretty accurately about this progress already, and to him the educational value of the exhibit at the Fair is chiefly in its effect in impressing on his mind those salient facts which he knows but does not know well enough. This is by no means a useless process, and every railroad man who can conveniently go to the Fair should go, though it is proper to say that if he were nothing more than a railroad man, and took no interest in architecture and the arts and crafts, in beauty and ingenious inventions and human progress generally, he would find a somewhat narrow lesson. Of course, it is highly important to take your boy of 16 to the Fair if you can afford the time to do so.

The Machinery Building and that devoted to electricity are, of course, of interest to mechanical officers, and some of the improvements shown in them call for more study than do the cars and engines; because, unlike cars and engines, a machine is not constantly advertising itself by traveling up and down in the land. In shop tools, as in locomotives, the progress made during the past 11 years has been in perfecting speed and power rather than in changing principles or fundamental processes, and here as well as with engines it is useful to supplement descriptions and pictures and narrow experience by visible object lessons covering wide experience. In electricity great progress has been made, but here, also, the magnitude of the industry is at least as striking as its triumphs of ingenuity and skill. The General Electric Company bewilders the observer with the number and variety of its productions; and the Westinghouse companies are so numerous as to require a big directory and two information bureaus.

In the broad field of transportation, the automobiles, of course, show the most numerous elements of novelty. Of these there is a good display of all kinds in the buildings, and there is another important exhibit outdoors; the sightseeing omnibuses (electric). These, of which there are dozens constantly traversing the grounds in all directions, are as useful and popular a feature of life at the Fair as they are with strangers in the cities of New York, Washington and Denver; though the guides' jokes are not so cunning. As the magnificent distances in the St. Louis grounds materially intensify the feeling of "lead in the shoes" that afflicts most people at all great fairs, this ideal adaptation of a force of nature for the use of man is, therefore, nothing less than a triumph. It would seem as though the 'mobile 'bus might be made to add still another important convenience by being used for regular lines, direct from one point to another, within the grounds, without making stops to see things. The Intramural railroad is too roundabout (made so for a proper purpose) to afford quick transportation in the busiest parts of the grounds, except to and from a few places.

The automobile as a freight carrier is also coming to the front, and there are examples on exhibition. The auto truck appears to be increasingly appreciated in cities, and it may be that where freight houses now keep miles of streets blocked every day with waiting teams for half an afternoon, we shall some day be able to turn the horses out to grass and see a reduction of the nuisance to half-miles.

On the ocean, as on our railroads, the most notable improvement of the past 10 years has been in bigness, and the models of steamships do not attract by any salient novelty. The turbine steamer is yet too new to be prominent. The electric launches on the lagoon seem to be duplicates of those which were seen at Chicago in 1893 and at Buffalo in 1901.

In automobiles the exhibit of utility is found in the omnibuses just mentioned, while the exhibit of variety and newest designs is to be found in the beautifully finished vehicles in the Transportation Building; but in electric cars to run on rails, the outdoor working exhibit (the Intramural railroad) is in itself a good example both of the utilitarian features and of beauty and simplicity

of design. This railroad, seven miles long, with its western terminus brought around to within a few rods of the eastern, will give to foreigners a good idea of the characteristic American "trolley road." It is on the surface nearly all the way, trestles (wooden) being used only for a short distance at one end, and to cross ravines in what may be called the unimproved portion of the park. For a short distance on the north side it is what may be called a street railroad; but practically all of the rest of the line is sufficiently fenced in to bring it within the class of private-right-of-way railroads. There are several places where may be seen the characteristic American "deadly grade crossing"; though the speed of the cars is uniformly so moderate that it is perhaps ungracious to suggest the thought of crossing-dangers. This moderation in speed is, indeed, one of the attractive features of the road, affording a refreshing relief from the strenuous conditions of city street transit. The quick starting and the high speeds on curves that prevail now in all our cities, and that have perforce made even our grandmothers agile athletes (if they ever ride in street cars) are unquestionably an evil, even though we complacently accept them as a necessary evil; and it will be nothing amiss for a few thousands of us to try "going slow" for once. Opportunity for sightseeing is, of course, one reason for moderate speed; possibly there are others.

The cars are about 20 feet long (not "open"), with transverse seats and a central longitudinal aisle, and they are run in trains of two, with a fare collector in each. The St. Louis Car Company is the builder, and they are good examples, without freaks or exaggerations. At each of the 17 stopping places there are platforms, with enclosures and gates, but the gates are not now in use, and fares (10 cents each) are collected on the cars. Thus we have as one "exhibit," for the edification of the world, the unbusinesslike but almost universal American custom of collecting fares in such a way that the conductor who does not steal is looked upon as an impossible paragon. The unpleasant feature of the Intramural railroad is the ever present cheap-grade lunch counter, every station being given up largely to baked beans, coffee cups and untidy attendants.

In all of the foregoing, as the reader will have noticed, it is an American fair that we have been considering. Foreign nations are not absent, but they do not tell us much that is new and striking. The two most prominet foreign nations are Germany and Japan. Japan has nothing which is likely to instruct Americans about transportation, and Germany chiefly, as has Japan largely, devotes her exhibits to other fields of science and industry and to art. One German exhibit, however, is prominent, and is noticed by everybody, the big Henschel three-cylinder compound locomotive, of which more will be said in a later issue. Aside from these there are a multitude of books and records and pictures, affording to the visitor with some leisure interesting studies of methods and habits in the several countries; but none possessing salient features susceptible of easy comparison with American ways of doing things.

That the advertising motives, which used to be thought sufficient warrant for sending all kinds of exhibits all over the world, has now largely died out, is not to be wondered at, for the photographer and the technical journal have become so expert and enterprising that different nations know each other and are able to see each other pretty well without actually touching hands. Indeed, Germany and Japan appear to have made their great exhibits at St. Louis not to instruct the world, or even, so much as formerly, to sell goods; but from a "human" motive—to show their friendly feeling towards America. On a gigantic scale they are copying the tactics of the merchant who is as careful to take buyers to the theater and to make dinner parties for them as to show them meritorious wares.

Some notes on the locomotives and cars will be given in another issue.

## CONCRETE AND METAL TIES.

Another new design of reinforced concrete cross-tie is illustrated and described elsewhere in this issue, together with a brief statement of the result of a year's trial in the track of the Ulster & Delaware. Like nearly all the other experiments made with metal and concrete ties during the last 15 years, the first few months of service have been highly encouraging as regards resistance to exposure and low cost of maintenance. But a good sound white oak tie also gives excellent service for the first year or two in the track. Five years, even ten years, is hardly long enough to positively determine the ultimate saving by the use of some such material as steel or concrete, and also the average life of ties made of one or the other. The life of a wooden tie is about six years, and the present cost of such ties laid in the track is between 30 cents and 75 cents, rarely more than that. The cost of manufacture alone of the many designs of steel or concrete ties varies from 50 cents to $3.50 apiece, being usually more than $1.50 rather than less. By a rough calculation, allowing for decreased cost of maintenance, which is a debatable point in favor of the metal tie, it must have a life of at least ten years in order that it may stand on an even basis of cost with the wooden tie. So far as we have been able to ascertain, every experiment made in the United States with ties of other material than wood has proved to be a failure before the end of ten years, and but one or two have lasted that long. Some of the forms of ties designed three and four years ago are still in use, apparently giving hopeful and instructive results, but they cannot be classed as unqualified successes. An engineer of maintenance of way summed up the situation not long ago by saying that when oak ties cost a dollar apiece he would begin to consider the use of some substitute. In his eyes there was no real advantage in using any of the proposed metal or concrete ties other than that they might cost less in the long run than wooden ties when wooden ties had a prohibitive first cost laid upon them. Undoubtedly the time will come in this country, as it has done in some parts of Europe, when the supply of timber suitable for cross-ties will have become so limited that some other material more permanent and lasting will have to be used, even at a high first cost. The claims of European engineers about the good qualities of metal cross-ties other than their longer life have never been fully substantiated in this country, and there is little positive information even about that essential point. The use of tie-plates, spike plugs, and, above all, preserving processes, will do much to put off the day when the wooden tie can no longer be used economically, and will give so much the more time for the patient investigators to thoroughly test their new designs of some other materials. Innumerable failures must accompany the development of any entirely new departure from the old way, and it is well not to be too sanguine as to the success of the experiments in their present condition. Let us wait and see.

The meeting held in New York September 8, by the committee selected to arrange for an exhibit of railroad appliances in connection with the International Railway Congress, at Washington, next May, marked the beginning of a very interesting enterprise. The chairman, Mr. George A. Post, in his address to the committee of thirty-three representative railroad supply men whom he had gathered about him, told of the scope and functions of the Congress, and pointed out that a unique opportunity would be afforded to show the ablest and most influential railroad men of all countries what had been accomplished here in developing appliances. The difficulty in effectively presenting a new device at most expositions lies partly in the fact that only an exceedingly small proportion of the visitors are interested, while the number of prospective buyers is smaller yet, and partly in the confusing array of articles tending to distract the attention even of those most concerned. But the audience at the Railway Congress will be made up of men who are not only trained experts in the different branches of the service, but who are the authoritative heads of the buying department. These foreign railroad men, moreover, will have no Pike, with its side shows, to divert them from the appliances which are to be exhibited. The exposition will be designed for a trained audience only, and for an audience able to buy. Even to those manufacturers who are not interested in a foreign market for their goods, the appliance exhibit will be of the greatest value because it will be seen and studied by the great gathering of American railroad officers, who will come from all parts of the country to attend the Congress. A chance, better than ever before, seems to be presented to give the fullest publicity, both in this country and abroad, to the American railroad appliances that represent the result of the ingenuity and perseverance of generations. The committee considers it essential to the success of the proposed exhibition that permission be obtained to use the White Lot, in Washington, and a bill will be presented in Congress to authorize such use.

### American Locomotive Company.

In 1903-1904 the American Locomotive Company enjoyed a remarkable year, for which the report is now at hand, in that with gross earnings $36,974 less than during the year ended June 30, 1903, manufacturing, maintenance and administrative expenses decreased $647,329, leaving net earnings $610,355 greater than last year. The total gross earnings amounted to $33,068,750. A smaller sum than last year was also charged against net earnings for interest on bonds of constituent companies, bills payable, etc., so that

the profit available for dividends was $5,425,539, as against $4,805,253 last year. After a 7 per cent. dividend had been paid on the preferred stock, as previously, costing $1,750,000, there remained a surplus from the year's operations of $3,675,539 as compared with $3,055,253 last year. From the current surplus $1,000,000 was appropriated as an extraordinary improvement and betterment fund, and a current balance of $2,675,539 was carried forward to profit and loss.

The company's gross earnings in addition to the revenue from the sale of new locomotives and extra parts, included the sale of steam shovels, dredging machinery, trucks for electric service, and rotary snow plows, and also repairs. The expenses included direct manufacturing cost, both of labor and of material, and all indirect charges against production, such as maintenance and renewal of buildings, machinery and tools and shop expenses and supplies, etc. Besides this, 20 per cent. depreciation was charged off, during the current year, from the book value of patterns, drawings, templets, iron flasks, formers, and dies. The item of expenses also included a charge of $1,101,299 for additions to property. The work of rearranging old shops with a view to greater economy in the manufacturing processes has been actively continued during the year, and there have also been heavy outlays for the replacement and betterment of existing property, which the company believes will make it possible, in connection with similar disbursements in previous years, for the property to be fully maintained and renewed in the near future at a small average annual cost. During the past year, the mechanical and electrical engineers of the company have kept in mind the problem of the possible future application of electric power to steam service railroads, and have also consulted with regard to the specific proposition for an electric locomotive suitable for use in the suburban traffic of the New York Central. Agreements have been entered into with the General Electric Company for the manufacture of 30 electric locomotives, to be delivered by 1906, the American Locomotive Company to construct the mechanical parts and the General Electric Company to supply all the electrical apparatus.

The report says frankly that the company does not expect to maintain during the next year or so the exceptional volume of business which it has received during the past three years, and this decrease is doubtless already being felt. It is believed that the improvements in organization and in the efficiency of plants have now progressed far enough so that the company will be in good shape to weather a period of dull business and to reduce operating expenses and cost of production when gross earnings fall off.

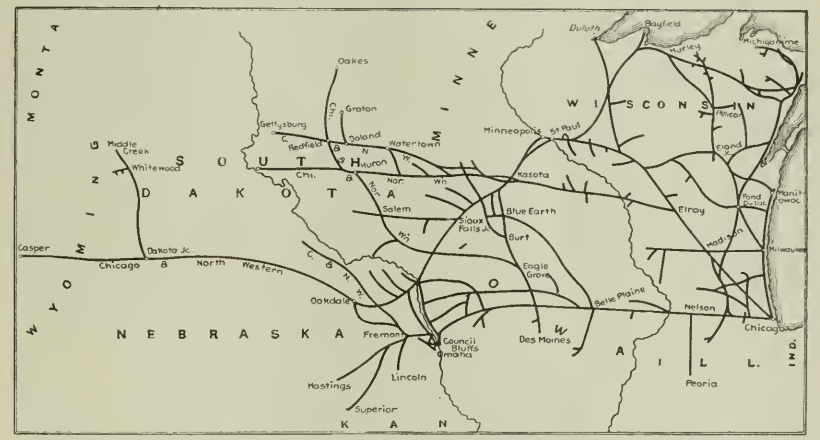
At the directors meeting held June 6, 1904, Mr. Robert J. Pitkin was elected President of the company, succeeding Mr. Callaway. Mr. James Sague was elected Vice-President and Mr. Leigh Best, Third Vice-President, while retaining his position as Secretary. Mr. William M. Barnum was at the same time made a director.

## Chicago & North Western.

The fiscal year of this company has now been changed to end on June 30 instead of on May 31st, as previously, so that the reports are uniform in period of time covered with those published by the majority of railroad companies. The figures for the present year instead of being compared with the previous fiscal period are compared with the 12 months ending June 30, 1903, and a separate income account is made up for the intervening month. Gross earnings for the 12 months aggregated $53,334,633 as compared with $50,639,142 for the preceding 12 months, but as these earnings were from 7,404 miles in 1904 as compared with 6,457 in 1903 the earnings per mile of road decreased from $7,842 to $7,203. Passenger earnings increased somewhat faster than freight earnings during the year and amounted to the high total of 17.42 per cent. of the entire earnings. Like most of the roads reporting thus far, operating expenses, including taxes, increased faster than gross earnings, aggregating $37,227,109, as against $33,851,672, an increase of $3,375,437, where earnings increased but $2,695,492. A considerable part of this increase, however, is chargeable to expenditures for maintenance of way and structures, which were made on a very liberal scale during the year. The two items—renewals of ties and repairs of roadway and track—alone added over $700,000 to the expenditure in excess of that for the year ending June 30, 1903. New steel rails aggregating 53,530 tons were included in this expenditure, the greater portion of which was laid in replacement of rails of lighter weight in 446 miles of track. The maintenance of equipment charge of $5,509,734, an amount $307,227 in excess of that charged last year, included the cost of 1,675 new freight cars charged entirely to operating expenses at a cost of $1,061,484. It is therefore evident that, had it been deemed essential, operating expenses could have been considerably cut down.

The total charge for conducting transportation was $21,654,456, an increase of over $2,000,000, in which by far the greatest single item was locomotive fuel. Although the tonnage of freight carried decreased from 30,498,440 tons in 1903 to 28,128,810 tons in 1904, locomotive fuel cost nearly a million dollars more. This is in part to be accounted for by the longer average haul, which amounted to 144½ miles as against 132½ miles last year, bringing up freight ton miles to an amount approximately one-half of one per cent. greater than in the year preceding, and necessitating a freight train mileage of 18,106,231 miles as against 17,531,086 miles last year. The average revenue tons per train mile decreased accordingly from 230.6 tons to 224.6 tons. An increased cost was charged against practically all forms of service, the chief items being the wages of engineers and firemen, freight conductors and freight brakemen, which increased in the aggregate $344,517. The only important decrease in the detail statement of the cost of conducting transportation was the interline freight car service balance, which decreased $155,635, or about 39 per cent.

The company has never equaled the gross earnings per mile of line for 1902, which in that year were $8,097. In 1903 they were $7,843 and for the current year $7,203. The increase in mileage of the lines of the western lines of relatively thin traffic is undoubtedly responsible for this. The Chicago & North Western has been continually increasing its mileage and the figures of traffic density are naturally affected somewhat unfavorably by the presence of undeveloped new lines; but the average approximate earnings per mile run by freight trains this year were $2.07, which is a high record for the company. The average approximate earnings for the preceding 12 months were $2.05; for the year ending May 31, 1902, they were $2.02; in 1901, $1.98, and in 1900, $1.96. In fact, the increase in this respect has been continuous and substantially uniform for many years, except that the gains between 1895 and 1899 were more rapid. Of course this, in view of the smaller total tonnage and the longer haul indicates a higher rate, and, as a matter of fact, the rate per ton increased from $1.17 to $1.32. It is to be regretted that the report does not classify by percentages the chief commodities carried, and that it is hence impossible to say whether or not the increased rate was chiefly due to a higher grade of freight or whether it was occasioned by a flat increase.




Chicago & North Western.

## NEW PUBLICATIONS.

*Air-Brake Tests.* Compiled and published by the Westinghouse Air-Brake Company, Wilmerding, Pa. 1904. Leather, 325 pages. There has been gathered together in this book the principal data of all of the most

Principal operating expenses for the year are summarized below:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked. | 7,404 | 6,457 |
| Revenue trainload ..... | 224.5 | 230.6 |
| Gross earnings ..... | $53,334,634 | $50,639,142 |
| Passenger earnings ... | 13,027,708 | 12,161,997 |
| Freight earnings ..... | 37,254,539 | 35,811,008 |
| Operating expenses ..... | 35,389,304 | 32,015,178 |
| Conducting transport'n. | 21,654,456 | 19,639,435 |
| Main. way and struc... | 7,166,308 | 6,297,166 |
| Main. equipment ..... | 5,509,734 | 5,202,507 |
| Net earnings ..... | 16,107,525 | 16,787,470 |
| Net income ..... ..... | *5,096,185 | 5,537,248 |
| Extraordinary charges against net income.. | 4,000,000 | 5,013,418 |

*Includes net income for month of June, 1903.

important brake trials which have been made in this country and in Europe since the inception of power train braking. The results of many of these trials have been presented in papers and reports presented to the various engineering societies, and for the most part the subject matter in this compilation consists of reprints of the whole or liberal extracts from these papers. The tests are arranged in chronological order beginning with the famous Galton-Westinghouse experiments made in England in 1878-1879, and include, besides a full report of these, the Burlington trials, Paris & Lyons Railway tests, Westinghouse freight train trials made in 1887 which marked the beginning of the successful application of the quick-action air-brake, the Karner trials on the New York Central, the tests of the Pennsylvania at Sang Hollow, Shiproad and Absecon, and the hitherto unpublished tests made at Atison, N. J., on the Central Railroad of New Jersey. As a whole the book forms the most complete history of the air-brake and its development that has yet been published.

## TRADE CATALOGUES.

*St. Louis Expanded Metal Fireproofing Co.*, St. Louis, has prepared a two-leaf folder showing the results of tests of reinforced concrete beams made by Prof. Talbot at the University of Illinois and described in a paper read before the American Society for Testing Materials, June, 1904. On one page the results, recorded in tabular form, give the amount and kind of reinforcement, area of metal in square inches, maximum load in pounds, stress in steel in pounds per square inch and the age of the concrete, which was 60 days in all cases. The beams were all 12 in. wide, 13½ in. deep, and were tested on a 14-ft. span loaded at two points 4 ft. 6 in. apart. On the opposite page to the table the results are shown graphically. Four kinds of reinforcement were tested, one being with plain bars and the others with patent bars. One of the latter is, of course, the Johnson corrugated design. With the plain bars as unity, the efficiency of Johnson bars is given at 164 per cent., the highest obtained.

The gas department of the *Pyle-National Electric Headlight Company*, Chicago, issues a pamphlet devoted to the Commercial Acetylene Co.'s safety storage system, for which it is general agent. A description of the system is given, with figures on the cost to make and compress the gas, and also its comparative cost and lighting power. Car and station lighting are then taken up, and interior views of a number of cars on different roads, equipped with the system, are shown, also passenger stations, semaphore bridges and locomotive headlights. A large number of yachts have this system, a view of one being shown and a list of 61 others given. Automobile and carriage owners are also extensive users of the system.

*The Joseph Dixon Crucible Company*, Jersey City, N. J., are distributing its September issue of "Graphite." It is an extremely interesting issue inasmuch as it shows a number of illustrations of important modern structures such as: the St. Regis Hotel, New York; the Wabash Railroad terminal, Pittsburg; the new North German Lloyd terminal, Hoboken; and the framework of the Fifth Regiment Armory building in Baltimore.

*The Northern Engineering Works*, Detroit, Mich., are distributing its bulletin No. 17. This is issued as a supplement to its crane catalogue and illustrates several types of overhead electric trolley hoists. This firm also build a number of types of pneumatic hoists, and a complete line of overhead tracks, switches, and turn-tables.

The September list of *J. A. Fay & Egan Co.*, Cincinnati, contains 12 pages and offers the usual diversified lot of second-hand tools. They are principally wood-working machinery, with some iron-working tools included.

# CONTRIBUTIONS

## Good Principles of the B. L. E.

New York, Sept. 14, 1904.

To the Editor of the Railroad Gazette:

It was indeed a pleasure to read the two articles which appeared in last week's issue (the 9th) entitled, "The Difficulty of Getting Promoted," one signed G. S. M., and the other commenting on the same by the editor. Among the many sensible articles which have been published in the *Railroad Gazette* from time to time on this subject none have appealed to me as these have done. They were certainly brainy masterpieces, bold and fearless.

There is nothing "vicious" inculcated in the teachings of the principles of the Brotherhood of Locomotive Engineers. Their aim is to follow out as near as they can the motto, "Do unto others as you would that they should do unto you." Neither is there any authorized "brotherhood bully," delegated with authority to act as such. While it is true that jealous and vicious dispositioned persons are sometimes among the members of the Brotherhood, and their actions might lead one to look upon them as bullies, this is the individual, not the Brotherhood as a whole. We find such characters in all organizations. Such men as these are the obstacles in the way for promotion of intelligent men who are ambitious, striving to prove themselves worthy and capable. The Brotherhood does indeed endeavor to make a close bargain for its members in the matter of wages—a fair day's work for a fair day's pay—and to regulate so far as possible, all things being equal, the promotion of its enginemen, according to their rank in seniority in service, from one train to another. I cannot conceive what the question of seniority has to do with the promotion of an engineer from his rank to that of an official position. I can hardly believe that an operating officer, with any backbone, would tolerate the seniority argument, if in his judgment he found an engineman qualified for promotion to an official position.

J. PUFFENBERGER,
Ex-President Joint Municipal Board of the B. L. E. of Greater New York.

## Handling Fast Freight on the Canadian Pacific.

The Canadian Pacific on Sept. 12 put into operation a new system of handling fast freight on its through trains between St. John, West St. John, Newport, Montreal, Toronto, Owen Sound, and Windsor; and between North Bay, Sault Ste. Marie, Fort William, Winnipeg, North Portal, Kootenay Landing and Vancouver. It is known as the "Red Card" system and has been designed to reduce telegraphing of car reports, to give prompt record of the movement of cars containing freight which is included in the general classification, and to ensure shipments going through to destination in the same train with proper connections at junction points.

All cars containing freight, excepting salt, iron and heavy material, to and from steamers lying at St. John, West St. John, Montreal and Vancouver; all cars containing perishable freight; all loaded refrigerator cars iced or heated; and all cars containing mixed lots of general merchandise whether in car load lots or less, are classified as "red card" cars and are forwarded with a red card 4¼ in. x 6½ in., printed as in Fig. 1, and properly filled out,

**CANADIAN PACIFIC RAILWAY**

**THIS CAR CONTAINS**

**RED CARD FREIGHT**

**AND MUST NOT BE DELAYED**

***Carding Station*** _____

***Initial*** _____

***Number*** _____

***Date Carded*** _____

***Kind Contents*** _____

***Destination*** _____

***This card must be removed immediately car is unloaded at destination.***

(WRITE PLAINLY IN BLUE PENCIL)

Fig. 1—Red Card.

FORM C. S. 10
4-8-04-38371

**CANADIAN PACIFIC RAILWAY**

***Loaded at*** _____

***Date*** _____

***Initial*** _____

***Number*** _____

***Destination*** _____

***Kind Contents*** _____

***This card must be removed immediately car is unloaded at destination.***

(WRITE PLAINLY IN BLUE PENCIL)

Fig. 2—White Card.

tacked on each side. The general list of commodities included under this classification includes, agricultural implements (new), bullion, copper and copper matte, household goods, live stock, nursery stock, seeds, settlers effects, etc., besides the commodities usually classed as merchandise. All other bulky freight, such as grain, lumber, coal and ore is shipped in cars to which white cards 4¼ in. x 6½ in., printed

as in Fig. 2 and properly filled out, are attached on each side.

Certain of the most important stations and junction points on the company's lines, 51 in all, have been designated as "red card" stations, and to each one, a symbol letter or letters has been assigned together with a series of numbers beginning with 1 and running up to from 50 to 1,000, depending upon the average number of loaded cars originating and forwarded from each point. These numbers and the station's symbol letter are used in numbering the envelopes in which the way-bills for cars loaded with "red card" freight are enclosed and forwarded. When the end of the series has been reached the envelopes are numbered beginning with 1 again and so on indefinitely. The envelope containing the way-bill for each car is made of red paper and measures 13 in. x 5¾ in. The front is printed as in Fig. 3 and the back as in Fig. 4. On the front of the envelope at the top are blanks for filling in an identification of the car and contents and instructions for routing to destination. Below these are blank spaces for inserting the number and symbol of the forwarding station and the train in which the car is to travel. Blanks are also left for recording the weight of the car and a reference to the regular way-bill. At the bottom are printed a few simple instructions for agents and conductors, and along one edge space is left for any special instructions following the car such as stopping for icing, etc. On the back there is printed a key to the symbols used for indicating the date of departure of the car and also blank spaces for entering a record of the car's movement. Each conductor, when the car is turned over to him at the forwarding point or division point, must enter in the space provided, the number of the train and train symbol, station car was taken from, and station at which car was left, date and signature.

When all of the cars containing "red card" freight which are to go forward from any station in a particular train, are ready, the agent gives the lowest symbol number to the red envelope covering the car for nearest destination, and envelopes covering cars for succeeding points beyond are given successive symbol numbers in their proper order, the car going the greatest distance having the highest number. For example, Toronto forwards "red card" freight in a train as follows: One car for Smith Falls, three cars for Ottawa, and five cars for Montreal. The envelopes for these cars would all bear the Toronto symbol letter R Y, and if the series of numbers was beginning with 1, with the number 1 would be given to the car for Smith Falls; 2, 3 and 4 would be given to the cars for Ottawa; 5, 6, 7, 8 and 9 would be given to cars for Montreal. The opening number for the next envelope for "red card" freight from Toronto, regardless of destination, would be 10.

The trains shown in the list below are known as "red card trains" and are given a symbol letter showing the date of departure from the terminal. Trains leaving on the first day of the month have the symbol A added to the train number, those leaving on the second day, the symbol B, and so on, and this symbol identifies each train all the way through to its final destination. In making all reports, trains are referred to

CANADIAN PACIFIC RAILWAY COMPANY

## RED CARD FREIGHT

INITIALS ..... CAR NO. .....
(INITIALS)

TRANSFERRED TO ..... CAR NO. .....

AT ..... DATE ..... 190

FROM .....

TO .....

FINAL DESTINATION .....

ROUTING ..... R. R.

CONTENTS .....

CONSIGNEE .....

FREIGHT OUT OF SS. .....
(SHOW HERE NAME OF BOAT FREIGHT TAKEN FROM)

CONSIGNOR ..... WEIGH AT .....

STOP CAR AT ..... FOR .....

TRAIN NO. ..... SYMBOL LETTER .....

FORWARDING STATION SYMBOL LETTERS .....

" " " NUMBER .....

| WEIGHT | REFERENCE TO REGULAR WAY-BILL |
|---|---|
| WEIGHED AT ..... | DATE 190... NO. |
| GROSS. ..... | STATION FROM |
| TARE .. ..... | ..... |
| NET .... ..... | |

INSTRUCTIONS

IMPORTANT READ CAREFULLY

**This envelope will be used exclusively for cars containing Red Card Freight.**

**When cars loaded with Red Card Freight are accompanied by the regular Way Bills, all of the Way Bills for the car must be enclosed in one of these envelopes.**

**Each of these envelopes must bear the Symbol Letter of the train, in which it was first handled. Each envelope must also bear the proper car symbol and number from forwarding station.**

THE FREIGHT COVERED BY THIS RED CARD ENVELOPE MUST NOT BE DELAYED. IF CAR IS SET OUT ON ACCOUNT OF BAD ORDER OR OTHER UNAVOIDABLE CAUSE, CONDUCTOR OR YARDMASTER MUST SECURELY AFFIX HERETO A "SET OUT CAR" REPORT FROM C. S. 3; AND EVERY CARE MUST BE TAKEN BY ALL CONCERNED TO AVOID FURTHER DETENTION.

ALL MOVEMENTS MUST BE SHOWN BY CONDUCTOR ON BACK OF THIS ENVELOPE.

AGENT WILL ENTER ON BLANK LINE BELOW, ANY SPECIAL INSTRUCTIONS FOLLOWING CAR

Fig. 3—Front of Red Envelope.

ALL TRAINS HANDLING RED CARD FREIGHT FROM RED CARD STATIONS, WILL BE GIVEN A SYMBOL ACCORDING TO DATE OF DEPARTURE AS PER KEY GIVEN BELOW.

| KEY | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| SYMBOL | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | Y | Z | A A | B A | C A | D A | B B | C B |

## RECORD OF MOVEMENT

| No. OF TRAIN | TRAIN SYMBOL | STATION NO. TAKEN FROM | STATION NO. LEFT AT | DATE | | CONDUCTOR |
|---|---|---|---|---|---|---|
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CONDUCTORS MUST ENTER IN SPACE PROVIDED, NUMBER OF TRAIN AND TRAIN SYMBOL, STATION TAKEN FROM AND LEFT AT, DATE AND SIGNATURE.

INSTRUCTIONS

IF TRACK SCALE WEIGHT IS OBTAINED IN TRANSIT AND IS SHOWN HEREON, AGENT AT DESTINATION, OR AT JUNCTION, IF WAY-BILL IS MADE TO A POINT BEYOND, MUST TRANSFER THE WEIGHT TO REGULAR WAY-BILL.

AGENTS MUST POSITIVELY SEE THAT ALL CARS OF RED CARD FREIGHT ARE PROPERLY CARDED, AND THAT WAY-BILLS ARE COVERED BY RED CARD ENVELOPE.

Fig. 4—Back of Red Envelope.

## CANADIAN PACIFIC RAILWAY COMPANY.

CONSIST "R. A." REPORT.

| SENDING OPERATOR | RECEIVING OPERATOR | TIME FILED | TIME SENT |
|---|---|---|---|
| A. | | B. | |

FROM STATION _____ DATE _____ 190__

TO CAR SERVICE OFFICE, _____

Following Cars Red Card Freight Left this Station on

Train No "D" _____ Train Symbol "F" _____ Engine No. "G" _____ Departed at "H" _____ M.

| SYMBOL LETTER AND NUMBER | CAR Initials. | CAR No. | CONTENTS | Received from Connections or Received for Red Carding DATE | Received from Connections or Received for Red Carding TIME | SHIPPING POINT | DESTINATION | REMARKS |
|---|---|---|---|---|---|---|---|---|
| J. | K. | M. | N. | Q. | R | S. | U. | V. |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

This CONSIST REPORT is to be made up from information shown on face of Red Envelope before each train handling Red Card Freight leaves the Station; and is to show only such cars as are handled as RED CARD FREIGHT

Agents at Red Carding stations, other than junction points with foreign lines will show in columns Q. and R. the date and time cars are received by them for Red Carding.

**Operators must telegraph this Report within one hour after train leaves Station.**

Fig. 5—Consist Report.

by their numbers and their date symbols.

*Red Card Freight Trains.*

| Train No. | Between |
|---|---|
| 85 and 86 | Montreal and St. John. |
| 19 and 20 | Montreal and Newport. |
| 51-55-57-50-52-56 | Montreal, Toronto, London and Detroit. |
| 115 and 116 | Prescott and Sault Ste. Marie. |
| 117 and 118 | North Bay and Vancouver. |
| 31 and 32 | Medicine Hat and Kootenay Lodge. |
| 105 and 106 | North Portal, Moose Jaw and Vancouver. |

CANADIAN PACIFIC RAILWAY COMPANY

## SET OUT CAR

### "R.C." REPORT

CAR SERVICE OFFICE "A"_____ FROM "B"_____

SUPERINTENDENT "AA"_____ DATE "C"_____ 19

(GIVE HERE SYMBOL LETTER AND NUMBER SHOWN ON RED ENVELOPE)

CAR BEARING SYMBOL "D"_____

SET OUT AT "F"_____

BY TRAIN No. "G"_____ TRAIN SYMBOL "H"_____

TIME SET OUT "J"_____ ON ACCOUNT OF "K"

_____

_____

_____

_____ POSITION

INSTRUCTIONS—Read Carefully

IF FOR ANY CAUSE A CAR LOADED WITH RED CARD FREIGHT IS SET OUT, ONE OF THESE "SET OUT CAR" FORMS MUST BE PROPERLY FILLED OUT BY THE CONDUCTOR WHEN CAR IS SET OUT BETWEEN TERMINALS AND ATTACHED SECURELY TO THE FACE OF THE ENVELOPE CONTAINING THE WAY-BILLS FOR THIS CAR. THIS FORM MUST REMAIN WITH PROPER ENVELOPE UNTIL IT REACHES DESTINATION.

CONDUCTORS MUST LEAVE THESE "SET OUT CAR" FORMS WITH TELEGRAPH OPERATOR, WHO WILL TELEGRAPH THEM TO THE CAR SERVICE OFFICE AS DIRECTED, AND DISTRICT SUPERINTENDENT, AND THEN TURN THIS FORM ATTACHED TO ENVELOPE OVER TO PROPER PARTY.

THIS CAR MUST NOT AGAIN BE DELAYED EXCEPT ACCOUNT BAD ORDER. YARDMASTERS AND CONDUCTORS MUST SEE THAT THIS RULE IS ABSOLUTELY ENFORCED

THE SYMBOL IS SHEWN ON FACE OF RED ENVELOPE.

YARDMASTERS WHO TAKE CARS OF RED CARD FREIGHT OUT OF TRAIN FOR ANY CAUSE, AND HOLD THEM FOR ANOTHER TRAIN, MUST ATTACH ONE OF THESE "SET OUT CAR" REPORTS PROPERLY FILLED OUT TO THE ENVELOPE FOR EACH CAR SO DELAYED AND MAKE PROPER REPORT OF IT TO CAR SERVICE OFFICE AS DIRECTED, ON FORM C. S. 4.

OPERATORS WILL USE SYMBOL LETTERS SHEWN HEREON IN TRANSMITTING REPORT

**Fig. 6—Set Out Car Report.**

CANADIAN PACIFIC RAILWAY COMPANY

## DELAYED CARS FORWARDED

THIS FORM TO BE USED TO REPORT FORWARDING OF ANY CARS LOADED WITH RED CARD FREIGHT WHICH HAVE BEEN DELAYED FROM ANY CAUSE

| SENDING OPERATOR | RECEIVING OPERATOR | TIME FILED | TIME SENT |
|---|---|---|---|
| | | _____ M. | _____ M |

### "R.F." REPORT

CAR SERVICE OFFICE "A"_____ FROM "B"_____

SUPERINTENDENT "AA"_____ DATE "C"_____ 190

THE FOLLOWING CARS LOADED WITH RED CARD FREIGHT, WHICH HAVE BEEN DELAYED AT THIS STATION WENT FORWARD THIS DATE.

TRAIN "D"_____ ENGINE "F"_____

TIME FORWARDED "G"_____ M

SIGNATURE "J"_____

POSITION "K"_____

| SYMBOL LETTER AND NUMBER | | SYMBOL LETTER AND NUMBER | |
|---|---|---|---|
| FROM | TO | FROM | TO |
| "M" | "N" | "Q" | "R" |
| | | | |
| | | | |
| | | | |

INSTRUCTIONS

THIS FORM WILL BE USED BY AGENTS AND YARD MASTERS TO REPORT THE FORWARDING OF CARS LOADED WITH RED CARD FREIGHT WHICH HAVE BEEN DELAYED AT ANY STATION ON ANY ACCOUNT OPERATORS MUST SEE THAT THIS REPORT IS WIRED WITHIN ONE HOUR AFTER CARS LEAVE. USE SYMBOLS GIVEN IN TRANSMITTING.

**Fig. 8—Delayed Cars Forwarded Report.**

If necessary to run any of these "red card" trains in two or more sections the extra sections are designated as 2nd 52 or 3rd 52 with the corresponding date symbol, the same as for the regular train. Where there is import, export, perishable or other "red card" freight to be forwarded in excess of load for the regular "red card" trains, extra trains are to be run to accommodate it, filling out with dead freight if necessary in order to make up the tonnage rating. These trains are identified as to class and are reported by the following designating symbols:

| From | Kind of freight. | Designating symbol. |
|---|---|---|
| West St. John | Import. | MP |
| Montreal (west) | Import. | ML |
| Montreal (east) | Export. | MJ |
| Windsor | Provision. | PV |
| Owen Sound (east) | Boat Freight. | BF |
| Toronto to Owen Sound | Boat Freight. | BO |
| Fort William (west) | Boat Freight. | BF |
| Winnipeg (east) | Live Stock. | SK |
| Winnipeg (west) | Coast. | CF |
| Vancouver | Tea. | TA |
| Vancouver | Silk. | SI |

For example, sufficient import freight is at West St. John on the 25th day of the month to load regular "red card" trains 86 and three extras. The regular train would be designated 86Z, the symbol Z representing the 25th day, and three extras would be designated as MPZ, MP2Z and MP3Z respectively. These extras and sections of regular trains are given the same care in quick despatching as the regular trains.

When a train of cars loaded with "red card" freight is made up and is ready to be sent out the agent or yardmaster turns over to the conductor of the train all of the envelopes containing the way-bills of the cars to be sent, but before doing so he is required to make out the "consist report" shown in Fig. 5, the entries being taken from the envelopes. This report is telegraphed in to the Superintendent of Car Service within an hour after the train leaves the station. Each item and column heading, as will be seen, has a letter symbol for convenience in telegraphing the reports. The Superintendent of Car Service is thus informed immediately of the departure of all "red card" cars, their contents, initial and number and destination.

CANADIAN PACIFIC RAILWAY COMPANY

## PASSING "R.B." REPORT

| SENDING OPERATOR | RECEIVING OPERATOR | TIME FILED | TIME SENT |
|---|---|---|---|
| | | _____ M | _____ M |

TO CAR SERVICE OFFICE FROM "B"_____

"A"_____ DATE "C"_____ 190

RED CARD FREIGHT CARRYING FOLLOWING SYMBOL LETTERS AND NUMBERS PASSED THIS STATION AS SHEWN BELOW

| SYMBOL LETTERS AND NUMBERS | | MOVEMENT | | | | | |
|---|---|---|---|---|---|---|---|
| | | ARRIVED | | | LEFT | | |
| LOWEST No. | HIGHEST No. | TRAIN No. | TRAIN SYMBOL | TIME J | TRAIN No. | TRAIN SYMBOL | TIME N |
| D | F | G | H | | K | M | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

CAUSE OF DELAY "M"_____

_____

_____

_____ AGENT OR YARDMASTER

INSTRUCTIONS

THIS REPORT MUST BE MADE BY AGENTS OR YARDMASTERS AT DESIGNATED STATIONS, AND TELEGRAPHED TO CAR SERVICE OFFICES, AS DIRECTED, IMMEDIATELY AFTER CARS HAVE DEPARTED. IN MAKING UP THIS REPORT, USE THE HIGHEST AND LOWEST SYMBOL NUMBERS WITH LETTERS SHEWN ON RED CARD ENVELOPE. MAKE SEPARATE ENTRIES WHEN BREAKS OCCUR IN CONSECUTIVE NUMBERS.

**Fig. 9—Passing Report.**

The "set out car" report, Fig. 6, is printed on pink paper and is mucilaged on the back at the top. Whenever a car containing "red card" freight is set out of its proper train for any reason, one of these forms is made out by the conductor or yardmaster and pasted on the envelope accommpanying that car. The report, with the envelope, is left with the agent at the station where the car was set out, and the information contained thereon is telegraphed at once to the car service office. In case a car is set out at a siding where there is no agent the report

CANADIAN PACIFIC RAILWAY COMPANY

## SET OUT REPORT

### "R. D." REPORT

THIS REPORT TO BE USED AT POINTS WHERE MORE THAN ONE CAR OF RED CARD FREIGHT IS SET OUT.

| SENDING OPERATOR | RECEIVING OPERATOR | TIME FILED | TIME SENT |
|---|---|---|---|
| | | _____ M | _____ M |

CAR SERVICE OFFICE "A"_____ FROM "B"_____

SUPERINTENDENT "AA"_____ DATE "C"_____ 190

THE FOLLOWING CARS WITH RED CARD FREIGHT HAVE BEEN SET OUT AT THIS STATION

| SYMBOL LETTER AND NUMBER SHOWN ON RED CARD ENVELOPE | | BY TRAIN | | | ON ACCOUNT OF (GIVE HERE EXACT CAUSE FOR EACH CAR SET OUT) |
|---|---|---|---|---|---|
| LOWEST NO. | HIGHEST NO. | NO | Symbol | TIME | |
| "D" | "P" | "G" | "H" | "J" | "K" |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

SIGNED_____ POSITION_____

THIS FORM WILL BE USED TO REPORT SET OUT CARS CONTAINING RED CARD FREIGHT WHEN MORE THAN ONE CAR IS SET OUT. WHEN ONE CAR IS SET OUT, USE REGULAR SET OUT FORM C. S. 3. GIVE SYMBOL LETTER AND NUMBER ONLY WHEN REFERRING TO SUCH CARS ON THIS REPORT.

TRAIN SYMBOL IS SHEWN ON FACE OF RED ENVELOPE.

**Fig. 7—Set Out Report.**

CANADIAN PACIFIC RAILWAY COMPANY

## REPORT OF ARRIVAL-DESTINATION

### "R. G." REPORT

| SENDING OPERATOR | RECEIVING OPERATOR | TIME FILED | TIME SENT |
|---|---|---|---|
| | | _____ M | _____ M |

TO CAR SERVICE OFFICE FROM "B"_____

"A"_____ DATE "C"_____ 19

FREIGHT WITH WAY BILLS CARRYING FOLLOWING SYMBOL LETTERS AND NUMBERS, ARRIVED THIS STATION AT TIME AND DATE GIVEN BELOW

| SYMBOL LETTERS AND NUMBERS | | ARRIVAL THIS STATION | | | |
|---|---|---|---|---|---|
| | | TRAIN | | TIME | DATE |
| LOWEST No. | HIGHEST No | No. | SYMBOL | | |
| "D" | "F" | "C" | "J" | "K" | "M" |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

_____ AGENT OR YARDMASTER

INSTRUCTIONS

AGENT OR YARDMASTER AT DESTINATION OF CARS WILL MAKE OUT THIS REPORT IMMEDIATELY ON ARRIVAL OF CARS OF RED CARD FREIGHT TRAVELLING UNDER SYMBOL LETTERS AND NUMBERS AND TELEGRAPH IT TO CAR SERVICE OFFICE AS DIRECTED. AGENTS AT JUNCTION POINTS WHERE CARS LEAVE THE COMPANY'S RAILS, WILL MAKE OUT THIS REPORT, SHEWING ARRIVAL OF ALL SUCH CARS AT THEIR STATIONS.

IN MAKING UP THIS REPORT USE THE HIGHEST AND LOWEST SYMBOL NUMBER WITH LETTERS SHEWN ON THE RED CARD FREIGHT ENVELOPE.

MAKE SEPARATE ENTRIES WHEN BREAK OCCURS IN CONSECUTIVE NUMBERS

TRAIN SYMBOL FOR TRAIN ON WHICH CAR ARRIVES IS SHEWN BY CONDUCTOR ON THE BACK OF THE RED ENVELOPE.

**Fig. 10—Arrival at Destination Report.**

and envelope is left with the agent at the next telegraph station beyond, and the agent there forwards the report and attends to the disposition of the car. If it is necessary to transfer the contents of a "red card" car to another car, the required information is entered on the envelope and red cards attached to the sides of the car to which the load was transferred. No change is made in the symbol letter and numbers which identify the shipment through to destination.

When more than one car is set out at a station for any cause, one of the pink slips, Fig. 6, is attached to the envelope accompanying each car and the set out report, Fig. 7, filled in and telegraphed to the Superintendent of Car Service. The pink slip attached to the envelope accompanying a car shows that it has been set out once and must not again be delayed unless on account of bad order.

The "delayed cars forwarded" report, Fig. 8, is used to report the forwarding of cars loaded with "red card" freight which have been delayed at a station for any cause. It is entirely separate from the consist report, Fig. 5, which gives information of cars originating from a station only and should not be confused with it.

The form shown in Fig. 9 is known as the "passing report" and is used to report the arrival and departure of all "red card" freight from certain specified stations and junction points along the line. These reports advise the car service office of the movement of all such freight between point of loading and destination. This information is telegraphed in immediately after the departure of trains and is a very essential part of the system.

When a car or cars arrive at their destination the agent makes out a report of arrival at destination, Fig. 10, which gives the time of arrival and identification of each car. If a car is consigned to a point on a foreign road, the agent at the connecting point makes out one of these reports, but if the car leaves the main line at a junction with one of the company's branch lines the agent reports its arrival and departure on the branch line train on the passing report, Fig. 9.

If freight entitled to "red card" classification originates at some intermediate station, that is a station not designated as a "red card" station, it is forwarded by the first train to the nearest "red card" station and the agent at that station is instructed to card it and forward it in the proper train the same as for cars originating at that "red card" station.

Local merchandise cars traveling as "red card" freight are forwarded as such to the last district terminal reached before distribution of the freight begins, and from that point are forwarded in the first local train out. For example, Montreal may load a car with "red card" local freight for points between Smith Falls and Havelock. The car would be "red carded" to Smith Falls, where it would be set out and travel in a way freight from Smith Falls to Havelock. Such cars are reported from the point where they leave the "red card" train on the passing report, Fig. 9.

While the system is apparently rather complicated, yet it is, in actual working, extremely simple and efficient. The Superintendent of Car Service has in his office at all times a complete record of the movement of all cars of high class freight and can determine at once the cause of any delays to shipments en route. Freight is handled with much less confusion and loss of time, and the claims for damages for delayed shipments of perishable goods are greatly reduced. One of the most essential features of the system is the great saving in telegraphing which on a large road is a heavy expense. The Atchison, Topeka & Santa Fe has a system very similar to the one just described, which has been in use since 1900 with very satisfactory results. The Canadian Pacific will no doubt have the same good results after the system is once in smooth working order.

We are indebted to Mr. C. W. Spencer, General Superintendent of Transportation, for the information and copies of the blank forms used.

## The Roadmasters' Convention.

The twenty-second annual convention of the Roadmasters' and Maintenance of Way Association was held in the reading room of the Transportation Building at the St. Louis Exposition, September 13th and 14th. Mr. J. A. Kerwin (M., K. & T.), President of the association, called the meeting to order and delivered a brief address, after which Mr. Willard A. Smith, Chief of Transportation of the Exposition, made an address, welcoming the association to St. Louis and the fair.

The Secretary reported 22 new members elected. After disposing of one or two matters of business the discussion of the committee reports was taken up. There were six reports and individual papers and the discussion of each was brief and brought out little in addition to what the report or paper contained. Extracts from these papers will be printed as separate articles. The convention adjourned at the end of the second day. The officers for the ensuing year are: President, C. F. Blue (M. & O.); First Vice-President, J. L. Single (L. I. R. R.); Second Vice-President, C. B. Teller (C. & W. I.); Secretary and Treasurer, C. E. Jones (C., B. & Q.), re-elected; Members Executive Committee, W. A. Brandt, J. A. Lahey, C. H. Cornell and C. Buhrer. Next year's meeting will be held at Niagara Falls, September 12.

## Extension of Block System.

On September 15 the telegraph block system was put in force on the Pennsylvania lines between Crestline and Chicago, 280 miles. The company began installing the apparatus for this improvement about a year ago.

The telegraph block system is in force on the Vandalia throughout its main line from Indianapolis to East St. Louis, the system having been put in operation in May last; and it is now announced that it has been adopted on that portion of the Pittsburg, Cincinnati, Chicago & St. Louis between Columbus, Ohio, and Indianapolis, Ind., completing the establishment of the space-interval system from Jersey City to St. Louis.

## New York Terminal Station of the Pennsylvania.

Part of the exhibit of the Pennsylvania Railroad Company in the Transportation Building at the World's Fair, St. Louis, consists of a large sectional plaster model of the new terminal station which is to be built in New York City in connection with the tremendous undertaking of driving tunnels under the North and East rivers and the Island of Manhattan. The accompanying illustrations from photographs of this model give some slight idea of the appearance of the station when it is completed. For a complete description of the tunnel work the reader is referred to the *Railroad Gazette*, Oct. 9 and 16, 1903.

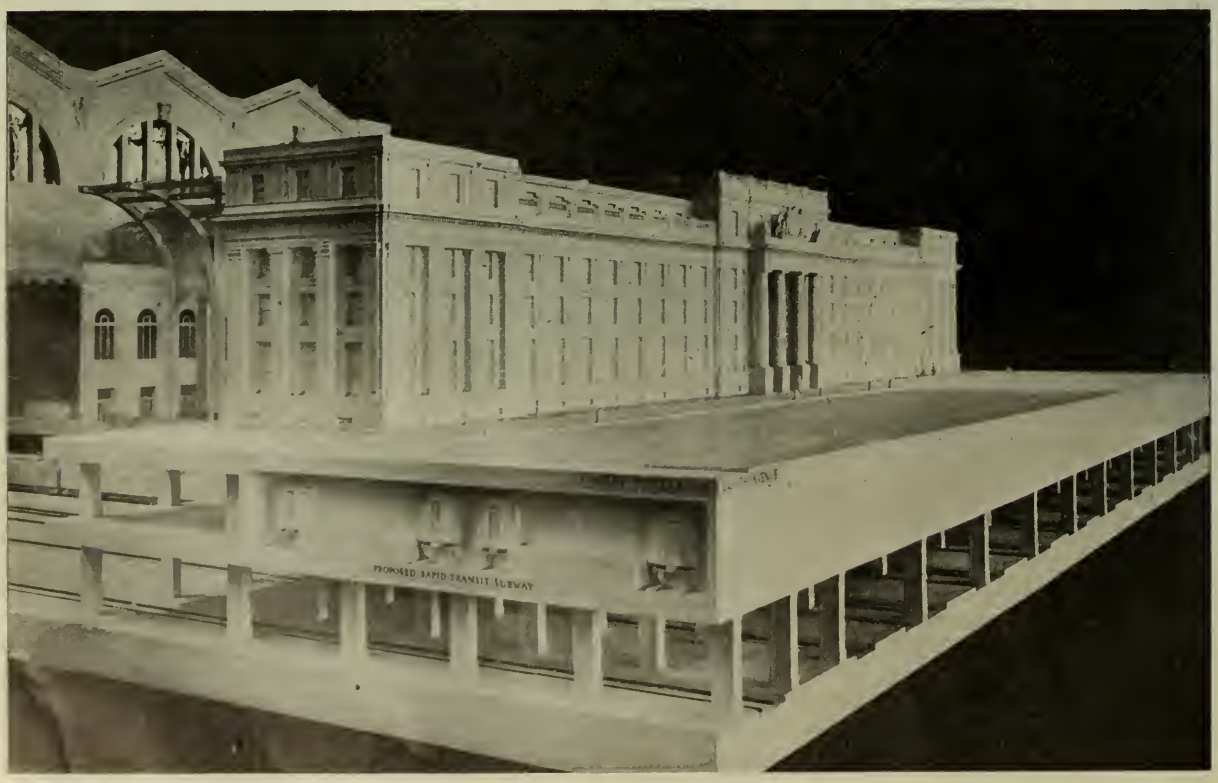
The site of the new station is the ground lying between Seventh and Ninth avenues and 31st and 33rd streets. The station building above ground occupies the two blocks enclosed by Seventh and Eighth avenues and 31st and 33rd streets, but the tracks in the station will extend as far west as Ninth avenue before converging to the four-track tunnel which begins at that point. Part of the ground above will be occupied by the new Post Office building and the remainder will be occupied by dwellings and stores or possibly converted into a public park. The tracks will be about 50 ft. below the level of the street in the terminal and will be reached from the main entrance floor by numerous flights of broad stairways and elevators. There will be 21 tracks in the station, all on one level.

The main entrance to the building will be from Seventh avenue and the carriage

Carriage Entrance from Seventh Avenue.

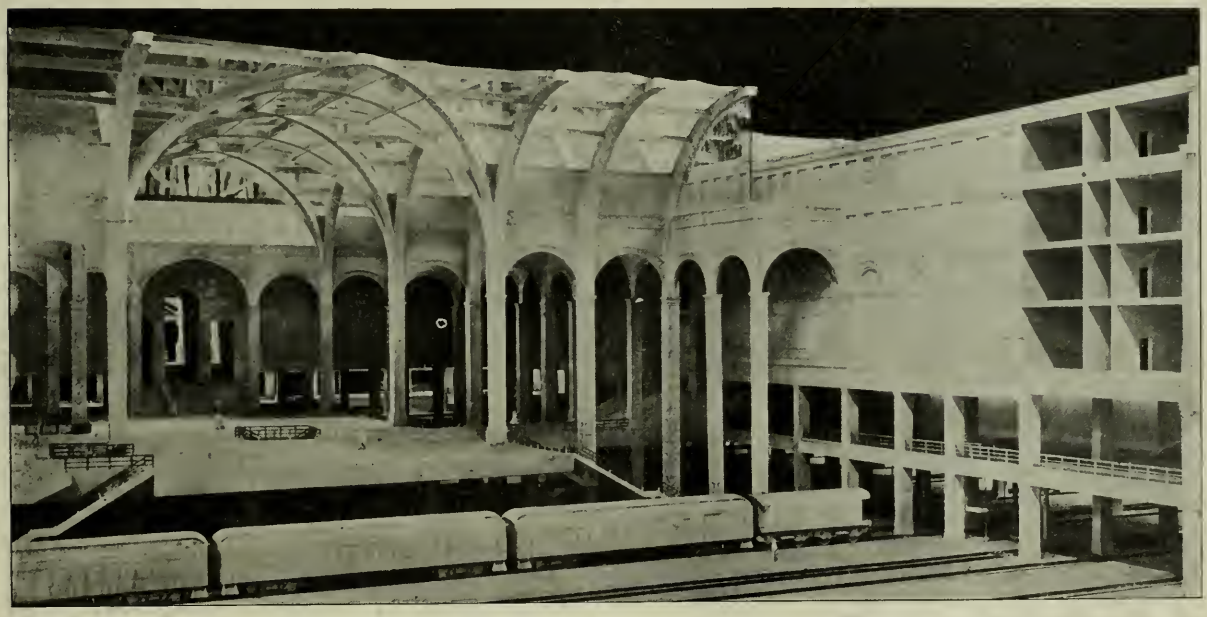
Interior of General Waiting Room.

Entrance to Concourse from Eighth Avenue.




General View of Eighth Avenue Elevation Showing Tracks Beneath.

Thirty-first Street Elevation Looking Towards Seventh Avenue.



Section Through Model Showing Concourse and Train Platforms Below.

General View of Seventh Avenue Elevation.

entrances will also be on that side, flanking the main entrance. A broad arcade supported by massive Doric columns runs along the entire front of the building. There are to be entrances in the center of the 31st street and 33rd street sides and another on Eighth avenue. Architecturally, the exterior has been treated simply, almost severely, but the huge proportions of the building require such a style.

Inside, the station forms a hollow square with clear openings from the train floor up to the arched roof. The waiting rooms, ticket offices, baggage rooms and restaurant are large in proportion with the exterior of the building. A large concourse is formed on the first floor below the street level and entrances lead from this directly to the train platforms below. The illustrations show the arrangement of floors and give a suggestion of the size of the rooms.

We are indebted to Mr. Theo. N. Ely, Chief of Motive Power of the Pennsylvania, for the photographs.

## Flange Wear and Side Bearing Trucks.*

BY GUSTAV LINDENTHAL.

The flange wear of rail and wheel is nearly absent on tangents and is greatest on sharp curves. A great lateral pressure is exerted on curves through the wheels bearing against the outside rail, for which three causes may be assigned: Centrifugal force, the force required for deflecting the direction of the wheels fixed on axles from a straight line, and, third, the frictional resistance of the center and side bearings on the truck.

Centrifugal force is so small that it may be neglected. The usual super-elevation of the outside rail on curves is adjusted for average speeds, at which the resultant of load and centrifugal force passes through the center of the track. In that case there is no lateral pressure against the rails, because the track is inclined at a right angle to the resultant, as shown in Fig. 1. There is of course a lateral pressure from the inclined tie transmitted to the ballast foundation, but it does not affect the rails. If the speed is greater or smaller than the average, then the resultant will move nearer the outside or the inside rail, exerting then a relatively small direct lateral pressure against one or the other. But inasmuch as

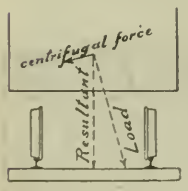



Fig. 1.

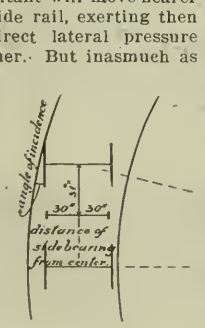



Fig. 2.

the lurching and swaying of the car brings pressure upon the side bearings of the truck, the friction in this case will hinder the truck from turning freely, and in that way an excess or deficiency of centrifugal force may be the cause of considerable flange pressure.

The lateral pressure upon the rail resulting from changing the direction from a straight line into and around a curve is more important. The truck of a heavy freight car can be taken as typical. It is a well established fact, first discussed by A. M. Wellington, in his book on Railway Location, that the front outside wheel of a truck is the only one in lateral contact with the rail. The flanges of the three other wheels do not touch the rails. Fig. 2 shows the normal position of the truck on a curve, in which the rear axle assumes the radial position. A truck with rigid frame and with the wheels rigidly fastened on the axles has a tendency to run in a straight line. On a curve it requires a large lateral force to move the wheels sideways from a straight line. If the wheels were loose on the axles, and if further the axles could assume a radial position, then the truck would exert no more lateral pressure upon a curve than it does on the tangent. Flange wear of wheels and rails would then be unknown. The construction of trucks and locomotives with radially swivelled axles, however, is impracticable.

With the four-wheel truck, the work of turning the car from a tangent into and around a curve is done by the outside front wheel, through which the entire lateral pressure of the truck against the rail is exerted. The front wheel pushes the three other wheels of the truck sideways from a straight line, in which they otherwise would

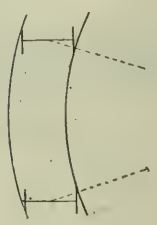


Fig. 3.

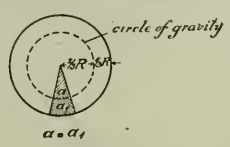



Fig. 4.

continue to roll. The slippage of the wheels by reason of their inability to turn on the axles has no appreciable influence upon lateral pressure. Assuming a heavy coal car, uniformly loaded, and with total weight of 160,000 lbs., we have on each wheel 20,000 lbs. With a coefficient of sliding friction of 0.25, the flange pressure on the front outer wheel of each truck will therefore be $3 \times 20{,}000 \times 0.25 = 15{,}000$ lbs. (or 30,000 lbs. per car). This lateral pressure is independent of the degree of curvature, but it is in direct proportion to the weight and load of the car.

If the outer front wheel were normal to the radius of the curve, there would be little flange wear, because the resultant of the vertical and lateral pressure would pass obliquely through the corner of the rail, and through the neck of the wheel flange. The flange itself would not be pressed against the side of the rail, and there would be only rolling friction along the inner edge of the rail. With new rails and new wheels, that is actually the case. Flange friction and train resistance on curves is very much less with new rails than with old, worn rails. But as the outer front wheel is not normal to the radius, its flange forms an angle with the rail (the angle of incidence). There is then side contact between flange and rail and consequent rubbing friction. It increases with the angle of incidence, that is with the degree of curvature, although the lateral pressure against the outside rail is the same on sharp curves as on light curves. The only way in which, for the usual center bearing truck, the lateral pressure from that cause (continuous change of direction on curve) could be reduced would be by lubricating the top of the rails on curves, reducing the coefficient of sliding friction from .25 to less than .03. That, however, is impracticable. The wheel treads would of course become greasy, and the tractive power of the locomotives and the holding power of the brakes would be greatly reduced. It is a choice of evils, and flange wear is the smaller of the two.

The length of wheel base has an important bearing upon flange pressure. If the base be long, as in a European car, without trucks, then the work of turning the car is performed by the front outer wheel and the rear inner wheel. The car or truck assumes then a position normal to the radius of the curve, as shown in Fig. 3. Both these wheels have flange pressures, which for each wheel is less than the flange pressure upon the front outer wheel of a shorter wheel base, as in the American truck. But the angle of incidence is greater, and both the outer and inner rail are subject to lateral pressure. Therefore, on European track, both rails on a curve show wear at the inside flange, while on American track the rail-flange wear is confined to the outer rail. It is clear that when the rear inner wheel participates in the work of turning the truck or car around the curve, the front outer wheel will be exposed to less lateral or flange pressure, and therefore to smaller flange wear. Therefore a longer wheel base than is usual for 4-wheel trucks (5 to 6 ft.) would have certain advantages in that respect. It is a fact that the wheels of the longer 6-wheel trucks show proportionately less flange wear.

Now considering by itself the friction of the center plate on the truck. Tests have been made on the friction of center plates by W. C. Squire, reported in the Proceedings of Western Railroad Club, 1898. From the tabulated results I select the pressure on center plate of 50,000 lbs. The power P required with a leverage of 31 in. varies from 3,044 lbs. for rough, unlubricated surfaces to 897 lbs. for rough, lubricated contact. Thirty-one inches is the distance given between center of plates and the horizontal axis of the axle. (See Fig. 2.) Assuming the diameter of center plate at 9 in., we can readily determine the coefficient of friction. The distance of the gravity line for a circular area is equal to ⅔ radius; (see Fig. 4) for a diameter of 9 in. it is equal to 3 in. from the center. The frictional resistance of the load L on the center bearing is $f L = \frac{31}{3} P$

or $f = \frac{31 P}{3 L}$

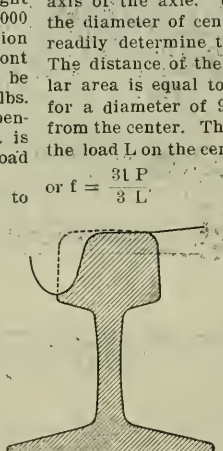


Fig. 5.

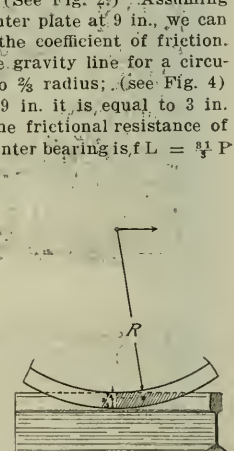



Fig. 6.

For unlubricated rough surfaces $f = \frac{31}{3} \times \frac{3044}{50{,}000} = 0.627$.

For lubricated rough surfaces $f = \frac{31}{3} \times \frac{897}{50{,}000} = 0.185$.

A fair mean value taken from Mr. Squire's table would be $f = \frac{31}{3} \times \frac{1625}{50{,}000} = 0.334$. The coefficient of friction may therefore vary from .62 to .18. A fair average value is .35, which agrees with observation and with the theoretical assumptions on center plate friction made heretofore.

Returning to the car with a total weight

*A paper read at the September meeting of the New York Railroad Club, September 16, 1904.

of 160,000 lbs., the load on each center plate may be assumed at 72,000 lbs. (without the weight of truck). For such a heavy car the center plate will be 12 in. in diameter. The distance of gravity circle from center will be 4 in. The distance from center to axle in a truck of 5-ft. 6-in. wheel base will be 33 in. Therefore the lateral pressure, p, on the outer front wheel due to friction of center bearing is, $p = \frac{4}{33}\ 72{,}000 \times 0.35 =$ 3,060 lbs., as an average, but taking the highest and lowest values, deducted from Squire's experiments, the lateral pressure against the rail may vary from 5,600 to 1,500 lbs., depending upon the condition of the contact surfaces of the center bearing.

The center plate never carries the entire load on the truck for any length of time, even with stout car and truck bolsters. The lurching of the car caused by uneven track and defective rail joints is quite noticeable on tangents and still more so on curves. It does no harm when on a tangent, but it adds very much to the curve resistance.

Let the speed be increased, or the center of gravity of the loaded car be higher than the assumed average, then a noticeable change results at once in the behavior of the center bearing car truck.

Assuming that, through unbalanced loading or through lurching, one or the other side bearing carries one-quarter and the center plate carries three-quarters of the load of 72,000 lbs. That is, 18,000 and 54,000 lbs. respectively. The side bearings are each 30 in. from the center. (See Fig. 2.) We have in this case a flange pressure, $p = \left(\frac{30}{33}\ 18{,}000 + \frac{4}{33}\ 54{,}000\right)\ 0.35 =$ 8,029 lbs., which is more than 2½ times the flange pressure when the load is carried on the center bearing alone. If, as frequently happens, with weak framed and overloaded cars, the side bearings carry one-half the load, the flange pressure may reach $\left(\frac{30}{33}\ 36{,}000 + \frac{4}{33}\ 36{,}000\right) \times .35 =$ 12,971 (or say 13,000) lbs. It is thus to be seen that the ordinary side bearings may increase the flange pressure more than four times the flange pressure due to center bearing alone.

It is usually assumed that the flange pressure due to friction of the center and side bearings occurs only on entering and leaving a curve. But this leaves out of consideration the elasticity of the truck. If the truck were perfectly rigid, then the motion of the center bearing would take place only on entering or leaving the curve; but the truck must pass through some elastic deformation before the friction of the center bearing is overcome. The result is that the lateral pressure against the rail, required to overcome the friction of the center bearing (or of the side bearings, if they are loaded), is more or less continuous throughout the curve. After leaving the curve the truck tends to turn back again into the normal position for the tangent, but here again the elasticity of the truck furnishes resistance and causes lateral pressure and flange wear for a certain distance on the tangent. This explains the observed flange wear on the inside rail of tangents, at the end of curves, which is puzzling to some trackmen.

Recapitulating the separate values of lateral pressure on curves, we have for the assumed loaded freight car, weighing 160,000 lbs., the following amounts per single truck:

From centrifugal force, nil.

From change of direction, with fixed wheels, 15,000 lbs.

From friction of center bearing, average 3,000 lbs., which may grow to 5,600 lbs., and, including side bearing friction, may reach 13,000 lbs.

That is, the outer front wheel of each truck in a modern heavy freight car may exert a lateral pressure against the rail varying from 18,000 to 28,000 lbs., when the vertical pressure upon the wheel is 20,000 lbs. under a car weighing 160,000 lbs., or, in other words, for each 100 lbs. vertical pressure there is from 90 to 140 lbs. lateral pressure under the front outer wheel, or, applying the relation to the whole car, the lateral pressure is from 22½ to 35 per cent. of the load of the car, be it light or heavy.

Several instructive conclusions can be drawn from this analysis. The outer rail on a curve is subject to a lateral pressure, which is from 45 to 70 per cent. of the vertical wheel pressures, assuming both pressures distributed upon a rail 30 ft. long.

Deducting friction of rail upon wooden

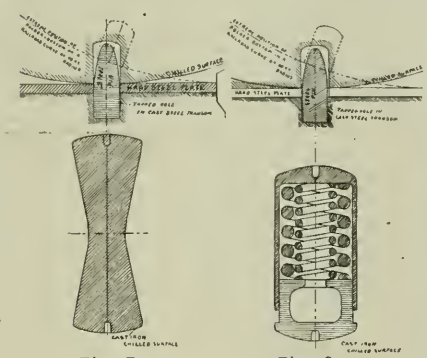


Fig. 7. Fig. 8.

ties amounting to 30 per cent., we have 15 to 40 per cent. of the lateral pressure left to be resisted by the rail spikes. It is no wonder that the spikes in hardwood ties are sawed off gradually, and that on soft wood ties the outside rail has a dangerous tendency to spread.

On new outside rails the resultant of vertical and lateral pressures from the outer front wheels has to overcome only rolling friction. But very soon the corner of the rail is abraided (see Fig. 5), and while the vertical pressure continues to cause only rolling friction, the lateral pressure against the side of the rail gradually causes rubbing or sliding friction, the coefficient for which is probably 100 times greater than that of rolling friction. The side of the rail head may therefore grind off faster from sliding friction than the top of the rail can wear from rolling friction. This sliding friction wears off also the wheel flange of the outer front wheel, but each wheel in a truck is at one time or another an outer front wheel so all wheels wear more or less alike. Assuming that the metal of the wheel tread and flange is twice as hard and tough as the ordinary steel rail, then for every ounce of metal ground off the flange of a wheel two ounces of steel are ground off the inner side of the outer rail of curves. As pointed out before, because of the angle of incidence the flange wear of outer rails is greater on sharp curves than on flat curves.

The rubbing or sliding friction due to flange pressure affects the tractive force required for hauling the car. For sharp worn flanges 1½ in. deep, in rubbing contact with the side of the rail, the frictional resistance may become quite large. The wheel flange fits tightly against the worn rail head, which has sometimes more than half its width ground off. The vertical contact area between rail and wheel flange is a triangle, as shown in Fig. 6. The center of gravity of that area will be ½ in. below the top of rail, which can be taken as the fulcrum with the radius of wheel, 15 in. as the lever arm. If the flange pressure under a 160,000-lb. car be taken as 2×18,000=36,000 lbs., then we have, for a coefficient of friction of 0.25, a resistance $R = 0.25\ \frac{0.5}{15} \times 36{,}000 = 300$ lbs., added to the ordinary tractional resistance of that car. It may occasionally reach 420 lbs. for 56,000 lbs. lateral pressure per car. For level grades and straight line, the tractional resistance is usually taken at 4 lbs. per ton, which would be 470 lbs. for the car weighing 160,000 lbs. The flange pressure would therefore nearly double that resistance, raising it to 8 lbs. per ton on a level grade, which closely accords with observed facts on worn curves.

The flange pressure reacts also upon the car axles, which are usually proportioned only for vertical loads and impact. A 6-in. axle has a moment of resistance $R$, which is very nearly $\frac{d^3}{10} = 21.6$. Taking the vertical load $P$ of 20,000 lbs., and the distance from center of journal bearing to center of hub as 8 in. we have an outer fiber stress of $\frac{8 \times 20{,}000}{21.6} = 7{,}400$ lbs. The outer fiber stress from lateral pressure will be $\frac{18{,}000 \times 15}{21.6} = 12{,}500$ lbs., and may reach $\frac{28{,}000 \times 15}{21.6} = 20{,}000$ lbs. per sq. in., showing that the axle may be strained higher from the lateral pressure on curves than from vertical pressures. And as both pressures are simultaneous, the outer fiber stress may reach (7,400 + 20,000) = 27,400 lbs., without torsional stress and without allowance for impact, which may double that stress. Therefore at times it may reach 55,000 lbs., alternating tension and compression, which is very near the elastic limit of axle steel.

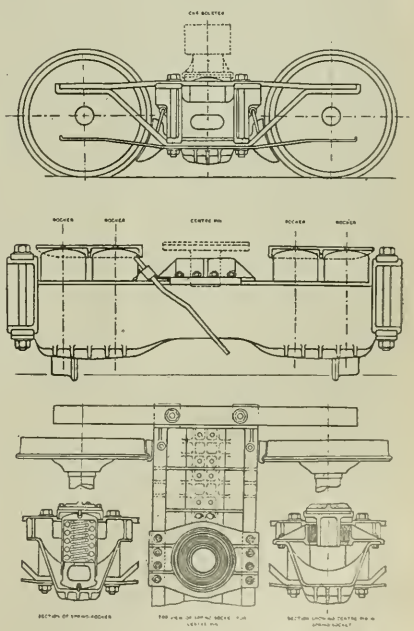


Fig. 9—Rocker Side-Bearing Truck.

As already pointed out car trucks are subject to severe diagonal stresses. The flange pressure from the outer front wheel must be transmitted indirectly to the other three wheels and to the center bearing through the diamond frame and through the truck

bolster, both subjected to bending moments tending to distort the truck, and bringing heavy secondary stresses upon its connections, which are, as a rule, much too weak to resist them. The lateral spring, or elastic resistance, mentioned above, is unavoidable, and the flange pressure from it is constantly present upon curves.

How then can the lateral pressure, so detrimental to truck and track on curves, be reduced? That portion (15,000 lbs. for the heavy car) due to the wheels being rigidly fixed upon the axles, which throws the work of deflecting them around the curve upon the outer front wheel, cannot be wholly eliminated, but it may be possible to reduce it. If the friction of the center plate could be lessened, then the rear outer wheel could come up closer to the rail and thus relieve the flange pressure upon the front outer wheel. The angle of incidence would then be also reduced. Each of these two outer wheels would exert a lateral pressure against the rail, although it might not be the same on both. A large part of the lateral pressure may still be left to the front outer wheel, but instead of the 15,000 lbs. in the case of the heavy car, there would perhaps be only 10,000 lbs., or even much less lateral pressure.

Any device that will reduce the friction of the center plate and side bearings will also reduce the flange pressure. One of the means used is greasing or lubricating the center plates on the trucks, and also the side bearings. A very considerable reduction of flange pressure and flange wear has been observed with it. But the inconvenience of lubrication and the difficulty of keeping it up have been found to be great impediments. Another plan is to do away entirely with center bearings and to rely upon nearly frictionless side bearings alone. A construction of this kind is shown in the illustration.

The side bearings consist in principle of large cast-iron balls (about 26 in. in diameter) on which the car body rests. Two such balls as a rule are used for each truck. The sides of the balls, being useless, are cut away, so that the form is that of columns or rockers, with spherical ends, which have hard chilled surfaces. In place of the center bearing there is a center pin or pivot, having a loose fit in a spring socket. It can take no vertical pressure, but the spring socket protects the pivot and so the truck frame against lateral shocks. The columns rest in pockets, one at each side of truck, and may have different forms. They may be rigid, or each column may consist of two telescopic parts containing inside spiral springs, giving it the action of a rubber ball. There is only rolling friction at top and bottom of these columns, the coefficient of which will hardly exceed .001, even with unmachined surfaces, liable to get gritty with cinder and dirt. Reverting again to the heavy freight cars, taking the weight on the rockers at each car end at 72,000 lbs., the rolling friction of both side bearings will be about 72 lbs. The lateral or flange pressure per truck from that cause alone will then be $\frac{30}{33}$ 72 lbs. $=$ 60 lbs. against 3,060 lbs. with the center bearing. This is in the proportion of 1:46. Moreover this small resistance from the rocker side bearings will only occur on entering and leaving the curve, whereas in a center bearing truck the friction of the center plate causes the flange resistance to continue throughout the curve.

If the flange pressure arising from fixed wheels can be reduced from 15,000 to 10,000 lbs., we would then have a total flange pressure of 10,000 + 60 = 10,066 lbs. against the total of 18,000 to 28,000 lbs. in the case of a center bearing truck, or from 40 to 65 per cent. less. As the flange wear is in direct proportion to flange pressure, there would be a saving of 40 to 65 per cent. in the wear of wheel flanges. The flange wear of rail heads would also decrease, but would not be noticeable, unless all trucks or a large proportion had rocker side bearings. The reduced curve resistance by reason of decreased flange pressure would also permit of hauling, with the same locomotive in any given train, more cars, when equipped with nearly frictionless side bearings.

### Tie-Plates on the Southern Pacific.

The Southern Pacific uses, perhaps, more tie-plates than any other railroad in the United States because of the fact that a large proportion of the ties in its tracks are California redwood, which is valuable because of its resistance to decay, but which is also very soft and is rapidly cut by the rail base. In 1890 this company designed the flat bottom tie-plate shown in Fig. 1, and large numbers of them have been used with excellent results, but on account of the heavy increase in wheel loads within the last few years it has been deemed advisable to increase the thickness from ⅜ in. to $^{7}/_{16}$ in., and to place the rail more nearly central on the plate. The new form of plate is shown in Fig. 2. It will be seen that the upper surface has been recessed and the rail base bears on three ribs. This lightens the weight and also allows particles of sand and grit which might cause serious wear between the plate and rail, to work out from under the bearing surface. The plates are made in two sizes, one 9 in. wide for 9-in. ties and the other 8 in. wide for 8-in. ties; the length is the same for both, 9 in. All of these new plates will be rolled in the railroad company's own rolling mill, which is operated as a part of the company's principal shops at Sacramento, Cal.

We are indebted to Mr. J. H. Wallace, Engineer of Maintenance of Way of the Southern Pacific, for the drawings and information.

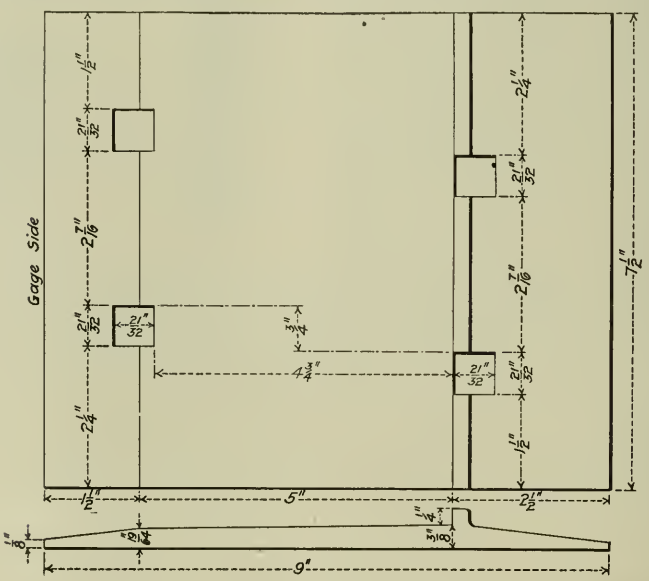



Fig. 1—Old Form of Tie-Plate, Southern Pacific.

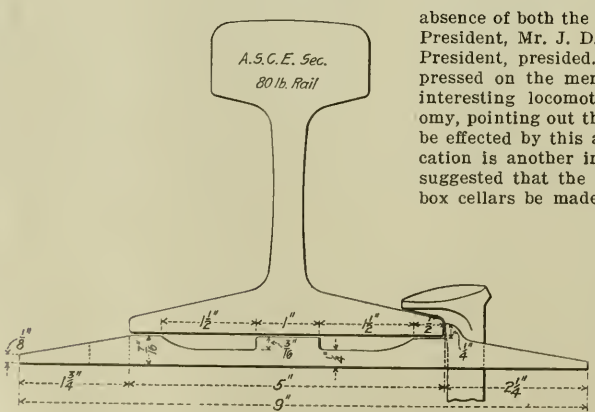



Fig. 2—New Tie-Plate for 80-lb. Rail.

### The Traveling Engineers' Convention.

The twelfth annual meeting of the Traveling Engineers' Association was held in the Lexington Hotel, Chicago, September 13th to 16th inclusive. In point of attendance it is the best convention the Association has had, 267 members having registered. In the absence of both the President and First Vice-President, Mr. J. D. Benjamin, Second Vice-President, presided. In his address he impressed on the members the importance of interesting locomotive crews in coal economy, pointing out the great saving that could be effected by this alone. The cost of lubrication is another important matter, and he suggested that the use of grease in driving box cellars be made the subject of a topical discussion. Electricity as a motive power was a matter members could not much longer neglect and he advised giving the matter attention.

The Secretary reported a total membership of 503, the net gain for the past year being 57, or 13 per cent. The Treasurer reported a cash balance of $400.

Mr. E. R. Webb's paper on "The Future Engineer—How Can Good Material be Obtained and Retained," was the first discussed. Mr. W. G. Wallace (C. & N. W.) thought all traveling engineers must en-

counter good material in their travels over the line—strong, intelligent young fellows without much education. The Delaware, Lackawanna & Western puts its prospective firemen on the ash tracks for a three months' term on the theory that a man who will stick to that work for the full time will make a good fireman. They have best success with farmer boys, section men and others from classes accustomed to heavy labor.

The matter was declared to be one that is giving the roads a good deal of trouble, as it is not easy to find firemen having the proper qualifications combined with the perseverance to become enginemen. One of the things to be observed in retaining good material is, not to load the engine down to the last ton. This practice, in conjunction with pooling, which keeps the average engine in poor condition, makes excessively hard the labor of the engine crew. Other points are not to give the men too long runs, and have the cabs comfortable for them, especially in winter.

Some interesting testimony in regard to the relative advantages of pooling and of single crews for locomotives was offered. In all cases it appeared that either where the pooling system had been lately abandoned, or where the two practices were respectively in force on adjoining divisions of a road, the engines with regular crews made noticeably better mileage and the interest of the firemen in their engines was much greater. The convention finally passed a resolution to the effect that the road foremen of engines should be permitted to employ all firemen and that they should endeavor to retain them by proper encouragement and instruction and should use their best efforts to make their surroundings as pleasant as possible.

Passing to the committee report on the "Progressive Examination of Firemen and New Men for Employment," the discussion turned on a suggestion that the association supply the answers to the questions prepared by the committee. Some were of the opinion that if this were done candidates would memorize answers without understanding their true meaning; whereas, if they were obliged to "dig up" the information they would be sure to have the required knowledge. Others suggested that the candidates' knowledge, where the answers are supplied, could be quickly tested by an oral test, following the written examination. The report of the committee was finally adopted as submitted, a motion to supply the answers to the questions having been rejected.

Discussion of the report on "The Water Tube" diverted to the brick arch, and little was said relative to the desirability of the tubes, or the reverse. This little was in line with the statements in the report in regard to difficulty of keeping clean, liability and danger of failure. In regard to the life of such tubes, Mr. C. B. Conger had run an engine with a set of these tubes for two years before removing them, although the rule on the road was for removal at the end of six months. This he attributed to the almost exclusive use of good water, the size of his tank and the service in which the engiue was engaged, enabling him to "run" bad water tanks. The final action was that circulating tubes are economical where conditions permit their use.

Mr. Ira C. Hubbell (K. C. M. & O.) read his paper on "Valve Motion—Its Relation to Steam Economy." Replying to a question, Mr. Hubbell said that Allfree-Hubbell locomotives could be equipped with larger exhaust tips than the corresponding locomotive having one of the usual valves. Asked how proper draft could be obtained with a lower terminal pressure and larger tip, he explained that the quick and full opening of the valve permitted the exhaust steam to rush out instantly, in full volume, filling the stack and giving the requisite draft. Furthermore, the lower release pressure does not tear the fire, permitting a lighter one to be carried than ordinarily, therefore less pressure is needed to create the requisite draft.

Mr. W. M. Boughton, of the Pere Marquette, said they have had three Allfree-Hubbell locomotives in service for nearly a year. They are moguls and are on fast merchandise runs. They are always ready to go out, the three not having lost to exceed two weeks altogether since they have been in service. They will run 20 per cent. further on a given amount of coal and water than any other engine on the division. Also, they are the liveliest engines he has ever ridden on.

The paper on "The High-Speed Brake" by Mr. L. M. Carlton (C. & N. W.) was next presented. Mr. F. M. Nellis thought that lubrication of the triple slide valves should be looked after more carefully than in the standard triples; that a better grade of oil should be used and applied oftener, as the higher pressure would tend to squeeze the oil out from under the valve. Also, moisture in the train pipe causes these triples to go into undesired emergency and greater care should be exercised to keep this moisture out.

Following this was some discussion relative to the functions of the reducing valve, Mr. J. P. Kelley (N. Y. A. B. Co.) asserting that its most important function was the production of uniform conditions throughout the train; that it is not a preventer of wheel sliding, and that high terminal cylinder pressures do not cause slid-flat wheels, although there will be sliding at the instant of stopping. Mr. Nellis disagreed with the assertion that it does not prevent wheel sliding, citing the experience of the Pennsylvania, which previous to the use of the reducing valve had a very considerable number of slid-flat wheels each month. Since then there have been few. In answer to a question as to how much further a train would require to come to a stop with all wheels locked by brakes, than under usual conditions, he said he knew of but one instance where this occurred under test, being in a trial on the Pennsylvania. The wheels locked at 45 m.p.h. and the train ran 33 per cent. further than it would otherwise have gone. On the other hand, on an experimental electric train on a New York elevated road, the stop was shortened 10 to 15 per cent. under similar conditions, due to the absorbing of the rotative energy of the revolving parts.

The final paper was "Headlights—Location, Type, Operation and Care," by A. L. Beardsley (A., T. & S. F.). There was considerable discussion in regard to the best place to set the turbo-generator and where to run its exhaust pipe. The paper advocated putting the machine just in front of the cab and running the exhaust pipe up over the top of the cab. A member from a road having tunnels on its line had trouble from sand and cinders, which worked into the machine, causing hot bearings. They were therefore moved up in front of the stacks. Introducing the exhaust pipe into the front-end gave trouble in all cases, and some overcame the trouble by running the pipe up inside of the stack to near, or above, its top. There was much favorable testimony in regard to the value and desirability of the electric headlight and a number of instances were cited where wrecks were averted by its use.

Mr. McManamy (P. M.) said they were using a double-carbon lamp in preference to having a copper negative, had speeded up the dynamo and were getting much better results than formerly.

There was some talk on the breakage of headlight glasses. One member said that an objection to strip glasses was that they permitted the reflector to get dirty quickly. The Santa Fe decreased breakage of solid glasses by substituting a wooden retaining rim for plaster of paris. Otherwise nothing new was offered.

Mr. W. J. McCarroll, of the Baldwin Locomotive Works, on Friday morning gave a lecture on Baldwin balanced compound locomotives, illustrated by stereopticon views. Starting with the one built for the Plant System in 1902,* a view of which was shown, the next was the Santa Fe design, and lastly that for the Burlington. Details of design and particularly of the revolving and reciprocating parts were dwelt upon, showing how the balancing is accomplished. In conclusion, the fine performance of No. 2,700 of the Burlington on two runs over its division from McCook, Neb., to Akron, Colo., was related. The division is 143 miles long and in that distance there is a total rise westbound of 2,044 ft. On the first run with a passenger train of 10 cars weighing 644 tons, 39½ minutes were made up. On the second run there were 12 cars weighing 719 tons and 13½ minutes were made up.

Following this Mr. S. M. Vauclain addressed the meeting on the same subject. He said that because American builders had only recently undertaken to build balanced compound designs was no indication that they had previously been oblivious to their advantages. But they could not ask Americans to accept the complicated foreign designs and a simplified American type had to be worked out that still was equivalent or superior to the foreign designs. He referred to the chief difficulty in the way of the adoption of the balanced compound in this country, which has been the deep-seated aversion to the crank axle. This was due to breakage in early times. Yet plain axles break, even nowadays when they are scientifically designed. There is little cause to wonder that crank axles broke in those days of unscientific design and poor material. He related some of the difficulties they encountered in trying to get crank axles when they built their first balanced compounds, of thoroughly investigating European practice and finding that they are still experimenting after 70 years, and of finding that their most successful design is a built-up one. The Baldwin Works can now produce an entirely satisfactory built-up crank axle and at a rate which will enable them to respond to almost any demand for locomotives.

A topical discussion on the subject of grease as a lubricant for locomotive driver and rod bearings brought out information on the experience of the D., L. & W., which is probably the pioneer in this practice. Mr. Talty said that on his division were 21 engines so equipped, and they were experiencing no trouble from hot bearings. On consolidation engines with 50-in. drivers, 21 in. x 26 in. cylinders, 1 lb. of grease for driving boxes and rods was good for 447 miles; on passenger engines, 465 miles; and on yard switching engines 7,500 miles. He thought any road could get rid of hot bearing troubles by the use of grease. Mr. Bickel said the Lake Shore has 40 engines on his division using grease. Mr. Talty spoke of a difficulty they formerly had, due to the "doper" when applying grease to the cellar of a new bearing or one just from the shop. He would smear some grease on the inside of the perforated plate, for initial lubrication until the grease in the cellar began to have effect. But this coating, when the bearing got hot, would burn hard and form a

*Railroad Gazette, Feb. 28, 1902.

ale, preventing the grease in the box from eing forced through the plate by the spring eneath. In response to a question as to hether the wedges could be adjusted as osely as with oil, he said not, but that they uld be kept close enough not to cause any jury.

Those who had tried grease for the trail- g truck wheels had not found it a success. olid brasses and also brasses with babbitt rips are used in the rods.

On motion, the committee on front-ends as allowed further time to prepare its re- rt, and it will be presented at the next nvention.

Section 3 of the By-Laws, relating to the lection of the place of meeting, was modi- d. The convention will vote on the places minated and from the five receiving the ghest number of votes the Executive Com- ittee will make a selection, preference ing given to the place receiving the high- t number. Should objections or obstacles velop, the next highest will be investigated, d so on.

The new subjects for the next convention e:

*Committee Reports.*

1. Grease as a lubricant for all bearings locomotives. 2. What system will enable e road foreman of engines to keep the best cord of tire wear? 3. What devices for. d arrangement of, engine and tender will ghten the work of engineman and fireman? Bell ringers, sanders, water scoops and her devices operated by compressed air; eir care and arrangement to get the best sults.

*Individual Papers.*

1. Electric motors, and instructing men to ndle them. 2. Injectors. Modern Prac- ce. 3. The latest makes of lubricators, eir operation and maintenance. 4. Mechan- al stokers.

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The Toledo Belt Railroad.

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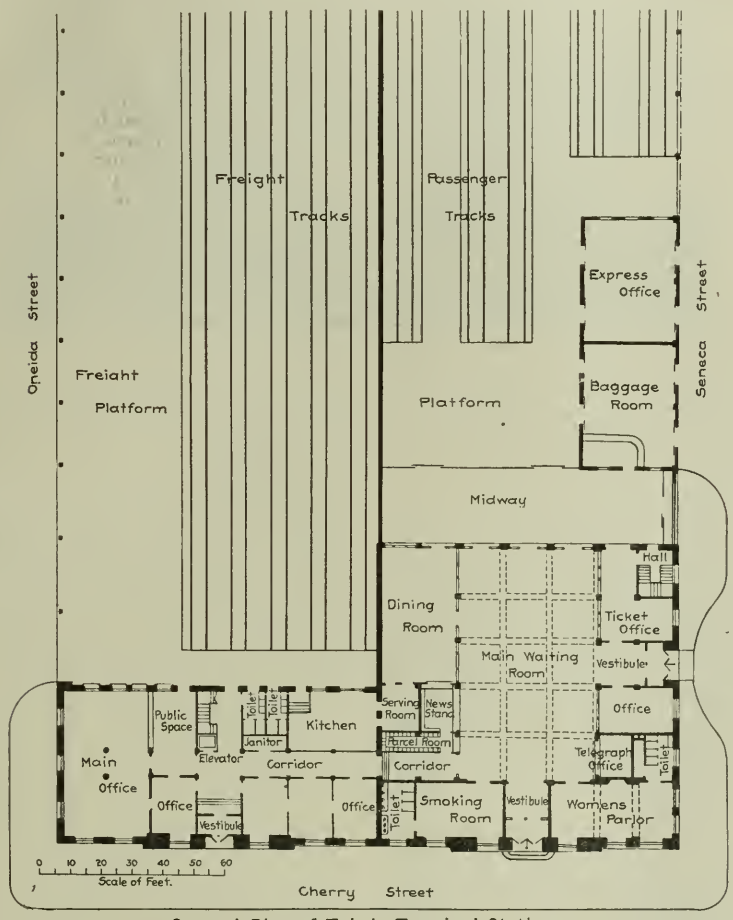
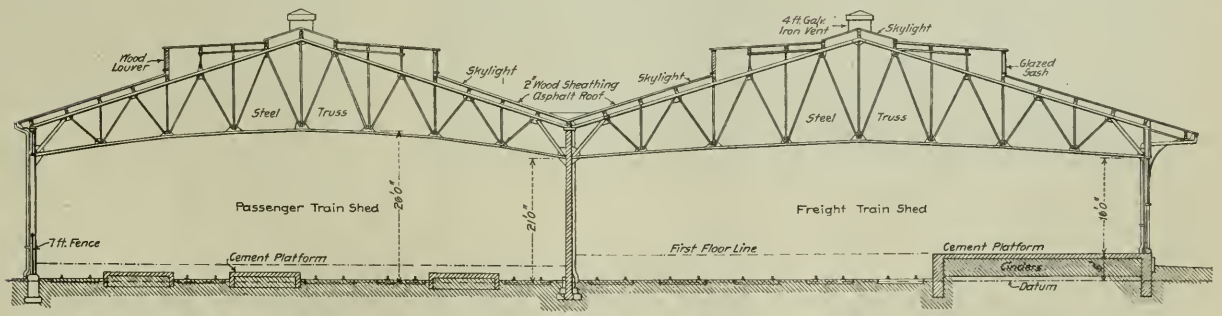



General Plan of Toledo Terminal Station.

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The smaller rooms and offices are grouped on three sides of the main waiting room, the men's smoking room and the women's parlor flanking the Cherry street entrance. The ticket office occupies the space between the

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The first floor of the freight section of the headhouse, except the part already referred to as containing the kitchen for the passenger section, contains the necessary offices for the transaction of freight business with the public. The second and third floors of the building are given up entirely to offices, with the exception of a room immediately above the ticket office and Seneca street vestibule. It will be observed that a stairway hall opens off of the midway. The stairway it contains leads to this second-floor room, which is a trainmen's room, and is provided with baths and other conveniences for their comfort.

Train sheds which are practically duplicates protect the freight and passenger tracks. The trusses for the former span 103 ft. while the span of the latter is 8 ft. less. A brick wall separates the two sets of tracks, and supports the trusses at their inner ends. Their outer ends rest on steel columns. The passenger tracks are separated from Seneca street by a 7-ft. iron fence with its panels between these columns.

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As the headhouse and sheds occupy only 425 of the 1,350 ft. between Cherry and La Grange streets, there is room to reproduce twice the present freight shed fronting on Oneida street, giving an outbound and an inbound house and also a storage house, if need be. Acknowledgments are due Mr. T. F. Whittelsey, General Manager of the Toledo Railway & Terminal Company, and Mr. George S. Mills, Architect, Toledo, for data courteously furnished.

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scale, preventing the grease in the box from being forced through the plate by the spring beneath. In response to a question as to whether the wedges could be adjusted as closely as with oil, he said not, but that they could be kept close enough not to cause any injury.

Those who had tried grease for the trailing truck wheels had not found it a success. Solid brasses and also brasses with babbitt strips are used in the rods.

On motion, the committee on front-ends was allowed further time to prepare its report, and it will be presented at the next convention.

Section 3 of the By-Laws, relating to the selection of the place of meeting, was modified. The convention will vote on the places nominated and from the five receiving the highest number of votes the Executive Committee will make a selection, preference being given to the place receiving the highest number. Should objections or obstacles develop, the next highest will be investigated, and so on.

The new subjects for the next convention are:

*Committee Reports.*

1. Grease as a lubricant for all bearings of locomotives. 2. What system will enable the road foreman of engines to keep the best record of tire wear? 3. What devices for, and arrangement of, engine and tender will lighten the work of engineman and fireman? 4. Bell ringers, sanders, water scoops and other devices operated by compressed air; their care and arrangement to get the best results.

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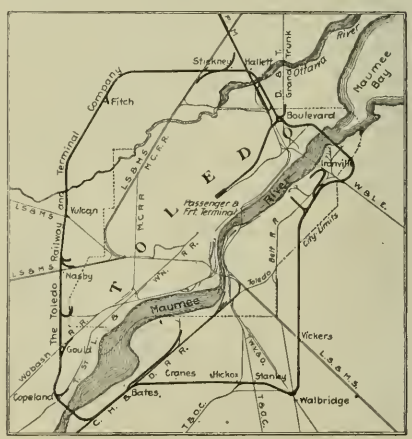


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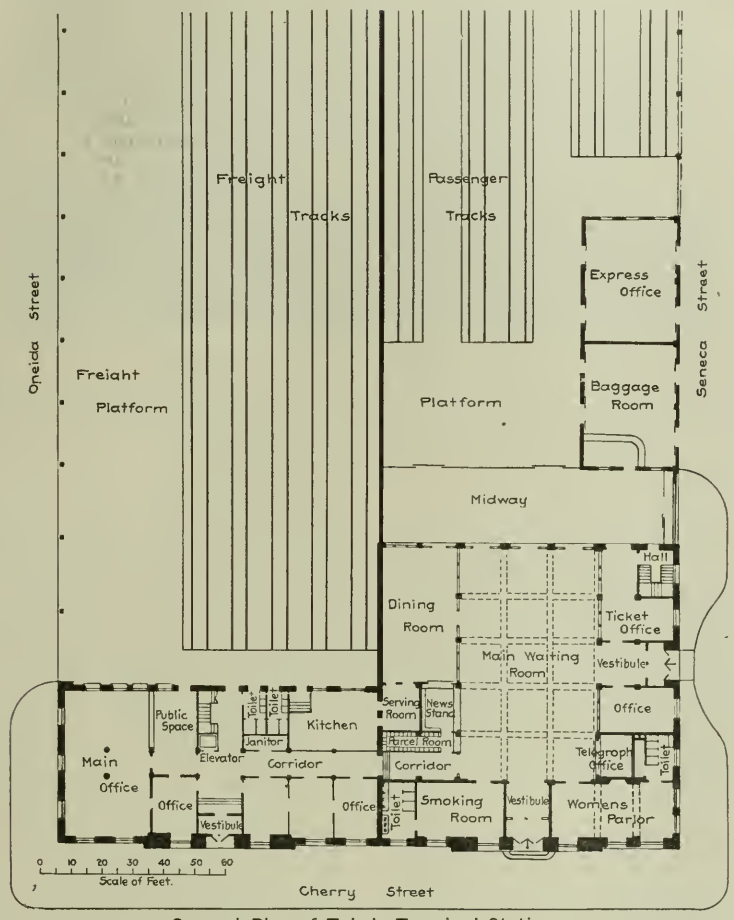


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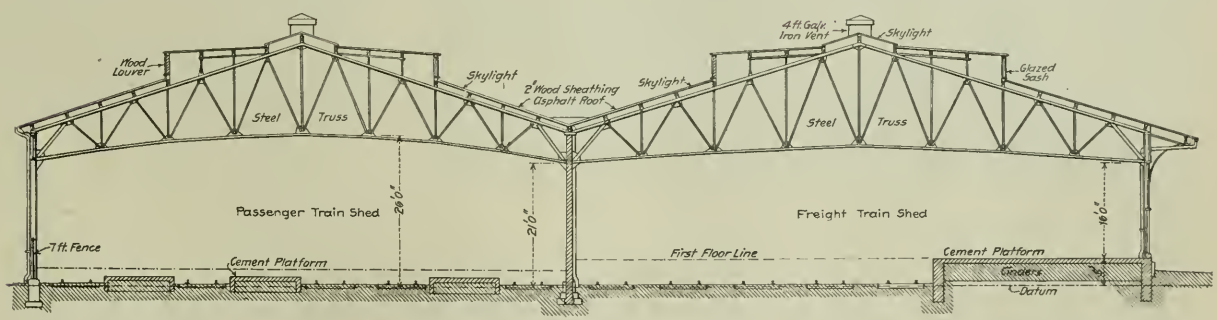


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## Test for Brittleness in Structural Steel.*

BY J. P. SNOW.

It is felt by many users of structural steel that mill inspectors should give more attention than is now usual to the detection of brittleness in our bridge material. Brittleness may be due to improper heat treatment or to segregated carbon or phosphorus. These defects may occur in material rolled from part of the slabs derived from a given ingot, while material rolled from the same melt or even from other slabs of the same ingot may be exceptionally good. If the ordinary tensile and bending tests of the heat from which the material in question is derived should be taken from those parts where objectionable segregation had not occurred and which had received proper heat treatment, the results would not expose the brittle features of the part supposed to be bad.

The desideratum is a practical method of testing, which will furnish the inspector a means of detecting brittleness in any piece that comes from the rolls that he suspects may be objectionable. The object of this paper is to suggest a scheme which seems to me to answer this requirement. Prime essentials of a test of this sort are simplicity and quickness of accomplishment. Mill men say, with reason, that they cannot hold stock until machine finished samples can be prepared and elaborate tests made. I am informed that much of the material now being used is many miles from the mill, on its way to the fabrication shop before the testing machine work is done on the specimens that are supposed to determine whether the material is to be accepted or rejected.

Determining the temperature of the metal after or before the last pass through the rolls is neither efficient, precise, nor conclusive. Delaying the piece before the last pass until the right temperature is reached refines only the outer skin of the material. It is not the function of buyers to tell the manufacturer how he shall produce his steel or at what temperature he shall roll it, but rather to ascertain if the product which he offers is suitable for their uses. This can be best accomplished by testing the finished product in a direct way.

The scheme herein proposed is in substance a nicked bending test on crop ends of plates and shapes as they are trimmed at the rolling mill for shipment. A nicked bend is proposed because the object is not so much to see if the specimen will bend without fracture, as to open up the grain of the steel to see whether it is fine and silky or coarse and crystalline.

It is proposed to take a generously wide piece of crop end so that the effect of the shear at the edges will not affect the result. It is deemed unfair to the manufacturer to depend upon narrow sheared specimens for this scheme of bending, because the injurious effect of the shear should not be assessed against the quality of the steel. Punched specimens are ruled out for the same reason. If narrow specimens with milled edges or punched specimens with reamed holes are used, the vital element of quickness of accomplishment is lost; for, while the specimens are awaiting their turn at the finishing machine the plate or shape from which they are cut is loaded for shipment or covered up in a pile of other stock. The scheme proposed will tell its story, if desired, before the rolling heat has left the piece. It can be executed and a decision reached, almost as quickly as the surface inspection of a plate can be made.

In detail the scheme is: to shear from the crop end a piece, say 12 in. wide, and nick it about three inches from one edge, preferably across the direction of the rolling, with a tool made for that particular thickness; clamp it in a hydraulic vise, and bend the free end over by power. Both the vise and bending roller are to be actuated by hydraulic power which is always available in a rolling mill. The nick is proposed to be made with a tool like a blacksmith's flatter, having a raised bead on its face.

Nicked bending tests by impact have been recommended in the past by many investigators. In 1892, Le Chatelier advocated such tests before the French Committee on Methods of Testing, and since that time work on these lines has been done by Barba, Considere, Le Blant, Aucher, Frémont, Osmond and Charpy in Europe and by S. Bent Russell and others in this country. All of these experimenters sought to determine the resilience of the material by impact tests, thinking to replace the ordinary tensile tests by these determinations. But as shown in Johnson's "Materials of Construction," impact testing is surrounded by so many uncertainties that it has never been found commercially practicable for structural materials. Evidently the constant effort has been to make the test prove too much. In the scheme herein advocated the object is not a complete physical test of the material but simply an examination of the grain, as shown in the fracture, to ascertain if the material is brittle from any cause.

To insure a fracture in ductile material, the deformation must be localized by a nick. The form of the nick, its depth and shape must be determined by experiment, but for a beginning it is suggested that a depth of one-eighth the specimen be tried, the bead with which the nick is made to have the form of the Whitworth screw thread. Investigation may show that a single size of nick may be used for different thicknesses, but it is probable that each thickness should have its particular size. The nicking die may be struck by hand hammers, or a light quick acting steam hammer may be provided for the purpose.

As to the method of producing the deformation it is possible that the distinctive difference between material that is good enough to be accepted and that which ought to be rejected cannot be brought out by making the bend with a press. It may be necessary to use impact, as was done by Fremont in a series of experiments described by him at the Budapest meeting of the European Railway Congress. These experiments show that a ductile steel may be broken short off by a blow of sufficient velocity. We know that ordinary structural steel when nicked and bent will invariably break unless it is exceptionally ductile and in very narrow specimens; hence it seems that a press bend on a wide specimen will certainly produce a break and show up the grain. A press bend if effective is preferable to a blow, on account of its more certain action and because it does not need adjustment for different thicknesses as would be needed if the bending was done by a blow.

It is believed that a test of this kind will expose coarse grain in steel, due to improper heat treatment, segregation, bad chemistry or any other defect that tends to brittleness. The engineer may, under present specifications, demand certain chemical and physical qualities when buying steel. He may not be justified in prescribing the exact ratios of the many "ites" or the precise "eutectic values" of the various compounds that enter into the material which the manufacturer gives him for steel, but he may reasonably demand simple tests like that advocated here to satisfy himself that the material is free from brittleness.

In the past, when puddled iron was the usual structural material, engineers depended largely upon bending tests to ascertain the quality of the output of the mills. Mr. C. C. Schneider has told me that he cared little for the tensile strength, elongation and other physical features of wrought iron as determined by the testing machine, but that he set great value on cold bending tests of scrap ends. Sir Benjamin Baker, when engaged upon the Forth bridge stated that he placed more reliance upon bending tests of mild steel than upon testing machine determination. With the steel of the present day we must test for ultimate strength to secure a grade that can safely undergo the ordinary shop manipulations and examine the chemistry to secure uniform composition, but have we not too much lost sight of the valuable old time feature of bending? The ordinary plain bending will not always show us the grain of the steel. In fact the width of the specimen and the radius of the bend are so selected in our usual specification that ordinarily good material will bend without fracture. Its ability to do this is the gage for acceptance. To this end the sheared edges are planed, which defeats the very purpose of the test desired on account of the time involved in the operation. Moreover, we bend but one specimen for each melt, which assuredly does not attempt to control the rolling heat.

It is true that the proposed test may involve closer attendance of the inspector at the mill than our usual commercial testing requires, and it may be impossible to define the lines by which an inspector shall be governed in rejecting material, as sharply as can be done under our present system, but the inspectors' attendance can be arranged for and the results reached by Frémont give us a clew to what may prove to be a proper criterion for acceptance or rejection.

Frémont's paper shows that when a specimen of non-ductile material is bent, a hardened ellipse tends to form on the compression side which acts as a heel around which the fibers on the tension side have to stretch. If the specimen is nicked, this stretch is localized and confined to the fibers at the bottom of the nick, and breaking is sure to occur as is explained in detail by Frémont. If the material is somewhat ductile and the specimen narrow, the compressed metal flows outward. This flowing out assists compression and tends to decrease the stretch required on the tension side by removing the heel farther from the tension face, and hence helps toward a gradual break instead of a short one. This consideration explains the well-known fact that wide specimens will not bend so successfully as narrow ones.

If in the proposed nicked bend the specimen should break around Frémont's "ellipse of enlargement," instead of square across; or if it did not break clear through, we could safely conclude that the material was not brittle. If the break was square across and the fracture silky or but partly granular, we could presume that the heat treatment was good and segregation not excessive; but if the fracture showed crystalline facets or appeared dull and cokey it would be ground for rejection. After sufficient careful experimenting I am sure that workable limits can be fixed upon for the guidance of inspectors. It is possible that thick and thin material cannot be brought to follow the same law, but rules can be established for varying thicknesses. Material that is known to be good and that which is known to be bad, both from overheating and segregation, can be experimented upon and safe extremes established.

Metallurgical literature is filled at present with complaints of poor structure in rails and to some extent in other steels. The complaint is not quite so common in regard

*Read at the Atlantic City meeting (June, 1904) of the American Society for Testing Materials. A companion paper, by W. R. Webster, was printed in *The Railroad Gazette*, July 22, 1904.

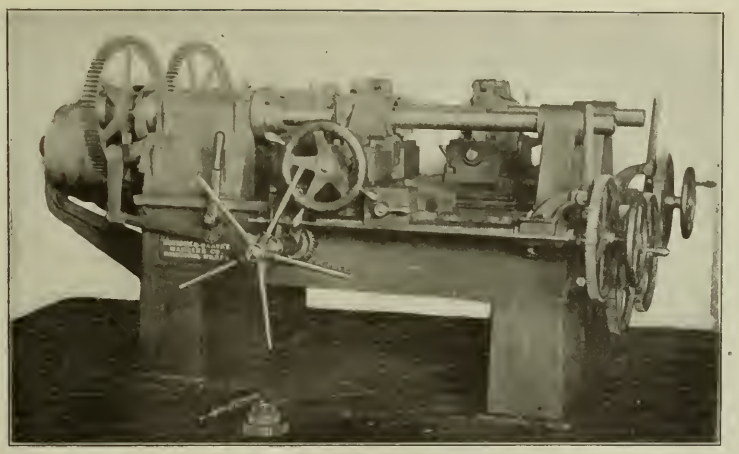


Fig. 1—The Detrick & Harvey Double Car Box Boring Machine.

to structural steel, for the reason, probably, that it is usually in thin sections which cool to a lower temperature than thick ones, while passing the rolls. It is the case, however, that rolled beams have sometimes proved so brittle and untrustworthy that some engineers dislike to use them in railroad bridges. It is likely that the principal reason for this condition is too high heat during the rolling, due to their heavy section. If the crop ends of such beams are sheared up so that a section of the web or flange can be nicked and bent in the proposed machine the coarse structure, if it exists, will surely be exposed and the beam saved from discrediting its species when put into service.

A similar test on crop ends of rails could be made with the rails while passing the straightening press and many of those having coarse structure at center of head, open grain, lamination, pipes, sulphur flaws or other defects that one drop test in five heats does not detect, would be saved from going into the track and causing trouble for both user and manufacturer.

It is intended to supplement the usual tests for physical qualities and is suggested as a means of satisfying buyers of steel that their material is sound and free from brittleness. It is cheap in installation and operation and requires the inspector's continuous attendance at the shearing end of the rolling mill where he belongs. If properly executed it should tend to allay the agitation that is now going on among users of rails and structural steel in regard to heat treatment, open grain and other rolling mill defects. If the scheme is objectionable to manufacturers it is respectfully offered for their free criticism.

## Railroad Shop Tools.

*(Continued.)*

### BORING MACHINES.

The double car box boring machine shown in Fig. 1 is made by the Detrick & Harvey Machine Company, Baltimore, Md. The machine consists of a bed having two pairs of ways on its top surface; on each pair of ways is mounted a headstock carrying a revolving spindle, to which is attached the boring bar; the other end of the boring bar is carried in bushed bearings at the other end of the ways. On the ways between the headstock and the bearings are mounted traveling carriages, and on the top of each carriage is mounted transversely two jaw carriers operated by a right and left hand screw. The machine is driven by a three-step cone for a $4\frac{1}{2}$ in. belt; the largest step is $21\frac{7}{8}$ in. in diameter. The cone is geared to the spindle through a spur gear; each spindle can be stopped independently while machine is running, thus the setting of boxes for one bar does not interfere with the other pair of boxes.

The carriages are strongly ribbed castings gibbed down to the bed and operated by hand through a rack and pinion, and by hand or power through a lead screw with an operating nut. Transversely across the top of the carriage is a square locked tongue on which is mounted two sliding blocks tapped one each right and left hand, and operated by a right and left screw, to which is attached a handwheel. These sliding blocks are flat on top and to them are attached by bolts the gripping jaws for holding the boxes. The jaws are changed for each size box and with each pair of jaws are a top and a bottom spacing block; the bottom block stays in position and the boxes are set in the jaws resting on the bottom spacing block; the top spacing block is put in place and the jaws are screwed up tight by means of the handwheel and the boxes are then bored and filleted.

The power feed is applied through lead screws to the carriages; the feeds furnished are three in number. The feed spur on the end of lead screws is provided with a clutch so that the feed can be thrown out at will and the feeding be done by hand. The opening nuts can also be thrown out and the carriage rapidly traversed by hand. The boring bar is $2^{15}/_{16}$ in. in diameter for standard machine, but other size bars may be used. Each bar is provided with three slots for cutters, i.e., a filleting cutter at each end and a boring cutter in between. A short master bar is furnished with each

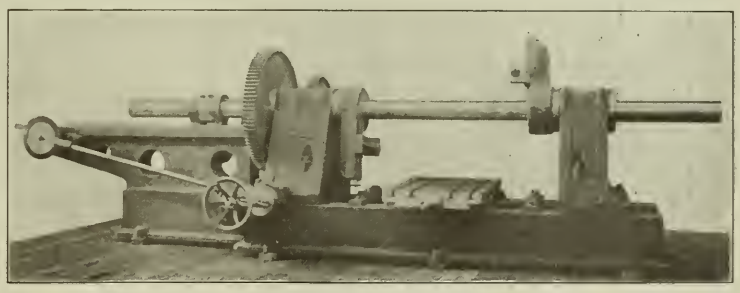


Fig. 2—The Newton Locomotive Cylinder Boring Machine.

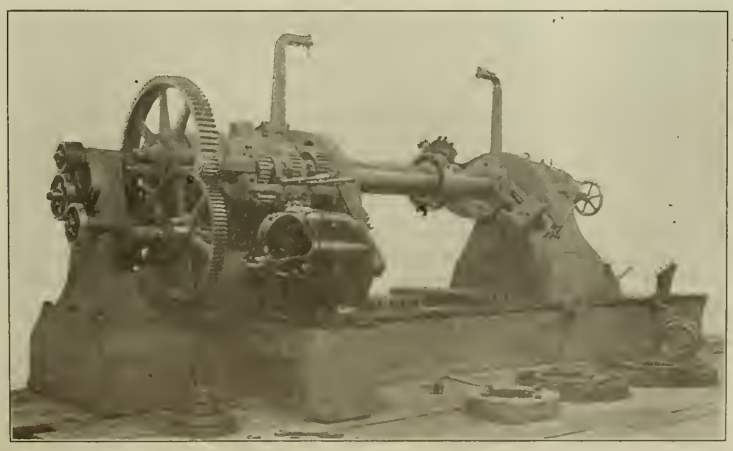


Fig. 3—The Niles-Bement-Pond Cylinder Boring Machine.

machine for turning up and grinding cutters. The cutters are made from flat steel.

The speed of the countershaft is 150 r.p.m. Tight and loose pulleys are 20 in. in diameter for a 5 in. belt. The weight of machine is about 6,500 lbs. The machine is furnished with countershaft, wrenches, three change gears, a short master bar, two boring bars with three cutters each, and two bushings and two pairs of gripping jaws. The floor space required for the machine is 9 ft. 6 in. x 7 ft.

The locomotive cylinder boring machine shown in Fig. 2 is made by the Newton Machine Tool Company, Philadelphia, Pa. The spindle of this machine is 8 in. in diameter, and is driven by a four-step cone, either through spur gearing as shown, or through a worm and worm wheel. The machine has a capacity for boring and facing both ends of cylinders up to 40 in. in diamtere and 50 in. long. The distance from the center of the boring bar to the bed is 36 in. The spindle is fed forward by a rack

and is arranged so as to be gripped in any position. The carriage, which is an auxiliary feature of these machines, is 36 in. wide x 5 ft. long.

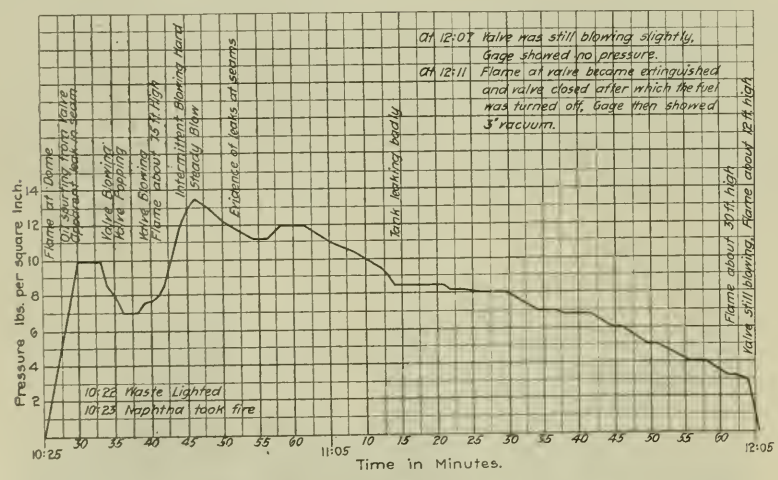
The cylinder boring machine shown in Fig. 3 is made by the Niles-Bement-Pond Company, New York. This machine will bore cylinders up to 37 in. in diameter and 60 in. long. The boring bar is 10 in. in diameter, and is provided with different sizes of interchangeable cutter heads which are adjustable along the bar by both hand and variable power feeds. The bar can be traversed out of the work by moving the tail stock by a ratchet. The speed change clutch-levers are placed convenient to the operator, and with the range of speeds in the motor enables a quick and close adjustment to the desired speed.

*(To be continued.)*

## Test of a 5-in. Relief Valve on a Gasoline Tank.

The American Railway Association having decided at its last meeting that after Sept. 1, 1904, all tank cars of 6,000 gal. capacity or less, carrying volatile inflammable materials, must be equipped with one 5-in. safety valve of approved design, and those of over that capacity be equipped with two 5-in. safety valves. The committee of the M. C. B. Association made a further experiment in order to determine whether tank cars containing as much as 6,500 gals. should be recommended for acceptance with one 5-in. safety valve; the committee not being willing to make such a recommendation in the absence of actual tests. The test was made by the Union Tank Line Company at Lima, Ohio, July 27th, on one of its tank cars taken from service, equipped with a 5-in. safety valve and filled with stove-gasoline. It was a steel tank with a capacity of 6,491 gals. to the base of the dome, but as actually filled contained 6,509 gals., which partly filled the dome. The inside diameter of the tank was 76½ in., and the length between caulking edges 26 ft. ½ in. There were five barrel sheets $^{2}/_{16}$ in. thick, and the bottom sheet was ¼-in. thick. The dome sheet was $^{3}/_{16}$ in. thick; dome head, ¼-in. thick; and diameter of dome, 36 in. All rivets in the tank were ½ in. diameter. The longitudinal seams of the bottom sheet were double-riveted, with a distance between the rows of 2⅛ in. and 2⅛ in. spacing of rivets. All the other seams were single-riveted with 2-in. spacing of rivets, except dome head to dome sheet, in which the spacing was 1 $^{7}/_{16}$ in. The end heads were dished to 7½ in., with a 1⅜ in. radius in corner. The metal used was tank steel, except dome head, dome sheet, and end heads, which were soft flange steel.

The tank was erected in a field on three brick piers, the two outside piers being 12 in. thick and 16 ft. from center to center. The center pier was 24 in. by 24 in. in section, and was placed directly under the nozzle, for protection. The dome of the shell was 42 in. above grade. A basin 27 ft. long, 9 ft. wide and 8 in. deep was dug immediately under the tank, which had been charged with 66½ de. naphtha from a No. 4 agitator by means of a 2-in. pipe. A 1-in. pipe-line was run from the tank to a point about 700 ft. away, for the purpose of recording pressures. One end of this pipe entered the tank through the under nozzle and ended inside of the dome; this end was fitted with a 1-in. elbow. At the other end of the piping there were four gages, and the end of the pipe was plugged. The elevation of the gages was the same as the top of the tank dome. Fuel was supplied by a 1-in. pipe which ran to a point under the tank, and branched into four ½-in. pipes. The ½-in. pipes ended in ½-in. vertical nipples, which were about equally spaced so as to create a uniform blaze under the tank. At the start, the tank was full and the naphtha extended about 4 in. up into the dome. It contained 6,509 gals. at 76 deg. F., which equals, when corrected, about 60 deg. F. and 6,437 gals. The temperature at the top was 89 deg., at the center 71 deg., and at the bottom 68 deg.


Pressure lbs. per square inch.
Time in Minutes.
10:25
11:05
12:05
Flame on Dome
Oil issuing from valve
Appeared from valve seam
Valve blowing
Valve popping
Valve blowing
Flame about 35 ft. high
Valve blowing hard
Evidence of leaks at seams
Steady Blow
Tank leaking badly
At 12:07 Valve was still blowing slightly, Gage showed no pressure.
At 12:11 Flame at valve became extinguished and valve closed after which the fuel was turned off. Gage then showed 5" vacuum.
Flame about 30 ft. high
Valve still blowing, flame about 12 ft. high
10:22 Waste Lighted
10:23 Naphtha took fire

Test of 5-in. Relief Valve of Tank Car.

The test began at 10.22 a.m., when the waste under the tank was lit; the gasoline fuel being turned on 25 sec. later. Within 2 min. and 35 sec., vapor from the contained liquid caught fire at a slight leak in the dome head. Within 5 min. and 35 sec., the expansion of the liquid had filled the tank and some of the liquid was escaping at the safety valve. Within 7 min. and 10 sec., the liquid overflowed violently; and within 8 min. and 55 sec. the safety valve opened and vapor and liquid gasoline were thrown out with violence. The subsequent history of the test is shown in the accompanying diagram, the fire being continued under the tank until complete dryness was reached.

The conditions, so far as the safety valve was concerned, were just such as would be met with in service when tank cars carrying naphtha become suddenly surrounded by fire. The safety valve operated perfectly, opening promptly at the desired pressure at which it was set, namely, 8 lbs., and the pressure never exceeded 13½ lbs. It was especially noticeable that the safety valve, which was in accordance with the design recommended to the Master Car Builders' Association, not only relieved the pressure but also discharged the flame upward in a compact column, the only flame coming down from the safety valve being that through the small vents which are placed around the seat in order to entrain and carry away water from rain, etc., which might otherwise gradually leak through the valve and injure certain oils.

From this test, the committee draws the following conclusions:

First, that tank cars of 6,500 gals. capacity and less, carrying naphtha, will be relieved without dangerous pressure if equipped with one 5-in. safety valve of the pattern already recommended to the Master Car Builders' Association.

Second, that the flame will be directed upwards, allowing wrecking forces to approach the tank to apply cooling streams of water; and,

Third, that the tank, although somewhat buckled and sprung in the rivets by the fire lasting nearly two hours, was apparently in no danger of explosion.

## The Railway Signal Association.

The September meeting of this Association was held at the Great Northern Hotel, Chicago, on the 13th, President J. C. Mock in the chair. Mr. G. S. Pfiasterer (N. C. & St. L.) was appointed Secretary pro tem. Ten new members were elected. Announcement was made that the Committee on Standards would offer at the October meeting a number of plans and a set of specifications covering material and workmanship of mechanical interlocking. Committee No. 4, on special circuits also promised a report for October.

Mr. Clausen (C., M. & St. P.): The committee on track and signal circuits for automatic block signals has held two meetings since the meeting in New York. On account of the breadth of the subject we decided to divide it into track circuits, operating circuits, controlling circuits and indicator circuits. For this year's work we have decided to treat track circuits, because the members of the Association are to some extent decided as to what they deem standard practice in track circuit work. On the other divisions much work would be necessary and the members have not so decided opinions. We intend to make some recommendations at the October meeting.

The committee on copper and iron wires for pole lines will report at the October meeting.

Mr. Peabody (C. & N. W.), chairman of the Committee on Definitions and Nomenclature, reported that this committee had held two meetings since the last regular meeting. At his suggestion the definitions adopted by the American Railway Association were discussed at length, and on motion of Mr. Dunham it was voted that the definitions of the American Railway Association, so far as they pertain to signaling, be adopted by the Railway Signal Association. There was some further informal discussion of definitions, and on motion of Mr. Dunham (I. C.) the meeting thanked the committee for the work it had done, and directed that the committee be continued.

*Cost of Repair Parts.*—The meeting then took up the question of agreeing on a schedule of uniform prices for signal materials bought by one railroad company from another, particularly parts for repairs and renewals at interlocking plants maintained jointly by two or more roads.

Mr. Dunham: Considerable misunder-

standing has occurred by reason of variable prices. The railroads do not have anything like uniform schedule prices for signal parts, and it would seem as though we might adopt arbitrary prices. All of the roads buy their fittings from one or two companies and the price lists of the companies are practically one.

Mr. Clausen: That is exactly the practice that has been in vogue between the roads northwest of Chicago for several years. Within the last two months the agreement has been made effective between nearly all the roads that I know of northwest of Chicago. The bills are made upon the basis of the net prices as shown by the Union Switch & Signal Company's last catalogue. The agreement is not a contract, simply correspondence between officers of the roads, the General Manager or the General Superintendent. It is a first class scheme and I would like to see all the roads adopt it. All the roads crossing the Milwaukee road have now adopted it.

Mr. Peabody: The same agreement is in effect with all the roads crossing the Northwestern.

Mr. Shaver (U. P.): Who absorbs the freight charge on this material?

Mr. Clausen: There is a clause that provides that 10 per cent. on the net charges of all material be added to the bill to cover the cost of handling and freight for all domestic lines.

Mr. Shaver: Some roads in the west have to pay pretty large freight bills on material bought in the east.

Mr. Dunham: As a general rule 10 per cent. charges added to the cost would cover freight and other charges. If the Union Pacific charges other roads cost price, how is it managed when material is bought at less than the schedule prices; does that affect all the material then in stock, or does it simply affect that particular lot? It seems to me if it affects only that particular shipment, it will result in a great deal of work for the accountants.

Mr. Shaver: If we buy an article at less than the usual price, the price at which we buy it is the price which is charged to the other road.

Mr. Peabody: How do you keep track of a large stock of material bought at less than the regular price and put into stock and scattered all over the system? We are maintaining 80 interlocking plants, and we buy large lots of material that go into stock at Chicago and then are scattered all over the system.

Mr. Shaver: We do not buy a very large stock at a time. Material is bought monthly, and it is used up, or supposed to be used up, in the month for which it is bought. There is some little trouble occasionally with items that have been lying in stock for some time, but this is not of much moment.

Mr. Ames (L. S. & M. S.): I do not think any system of accounting can be correct unless a suspense account is established. We buy, for instance, 1,000 lbs. of bare copper wire this month; we pay 13 cents a pound for it and we debit ourselves with $130; we may use a portion of that this month, and next month we may buy some which we may pay 13½ for; it is impracticable to say that the wire used on a definite job was that for which we paid 13 cents. I think there is a great deal of unnecessary haggling over prices. What is needed more than anything else is a uniform system of keeping our stock accounts, particularly a proper expense account. It is manifestly impossible to carry out the idea of using in any given month all material bought in that month, except on a very small road.

Mr. Peabody: Before we adopted our present method there was constant friction between the roads as to prices of material. The present plan does not settle absolutely the cost of all materials, but it settles such a large proportion that we have little difficulty with the remainder.

On motion of Mr. Shaver a committee was ordered appointed to investigate this matter with a view to ascertaining what other associations, like the Master Carbuilders' Association, are doing in this regard, and report at the next meeting; also to take up the question of what could be charged to maintenance and what to construction.

*Distant signals in automatic block signaling on single track.*—Mr. W. A. D. Short, chairman of committee, presented a report accompanied by diagrams showing four different arrangements of automatic home and distant signals on single track. The conclusion of the committee was that home signals should be staggered and that distant signals should be set back about 2,000 ft. from the home, or two-thirds the distance back to the end of the overlap track circuit. If set back 3,000 ft. (the end of overlap circuit) then opposing trains could both get clear distant indications simultaneously.

The report quoted the opinions of officers of the Cincinnati, New Orleans & Texas Pacific as to the value of automatic signals on a single track line, that road being equipped with them for 300 miles. All are sure that the capacity of the road is much greater than it was without the signals, but their estimates vary from 25 to 50 per cent.

Mr. Ames: It has been said that in single track automatic blocking the distant signal does not give a true indication. Does this mean that when the home signal is clear and distant signal at caution, that it does not always give an indication announcing that the first block home is clear, but the second block is occupied?

Mr. Short: The indication of the home is the same as on the double track, but the point is this, that two passing trains coming to a meeting point from opposite directions, the distant signal being located at the overlap point, might both come to the overlap at the same time and both get the clear distant signal. When they get to the home, the home would be against them; that is what is meant by not giving the true indication. But they have got to overrun the entire block of a mile and a half before they get together. We can obviate that to a great extent by locating the distant signal either outside the overlap, or inside the overlap, but that means about $100 more of signaling; and the contingency happens so rarely that it will not compensate for putting it in. . . . In some conditions we use the overlap at each end, in others we use it only once. We use the overlap generally at both ends for the blocks between stations, and at a station block only on one end; it depends on the local conditions. On a very steep grade we overlap everything.

This discussion being closed, the members listened to an interesting paper by Dr. Nelson Miles Black on some tests which he had made with colored glasses (roundels) from an ophthalmologist's standpoint; and on motion of Mr. Peabody, a vote of thanks was extended to Dr. Black, and the paper was ordered printed in the annual proceedings.

Mr. Ames: We use a red light for an open derail; and a man who goes by that light 50 ft. goes on to the ground. We also use the same on train order signals, where it is not an absolute stop signal. There are roads where the train order signal requires an absolute stop before reaching it, but not many; and with heavy freights you cannot afford to require it.

Mr. Clausen: Inasmuch as the American Railway Association has put the stamp of approval upon the custom of using one signal post for both directions on double track you must allow your trains to run by. But it is not right to have a red light at one place mean stop, absolutely, and at another to stop permissively. A red light should mean "stop" under all conditions.

Mr. Short: For 19 orders we display a green light instead of red light in the train order signal.

Mr. Ames: We are going to display on our train order signal masts 18 in. to 20 in. below the regular light, a fixed purple light that cannot be seen more than about 1,200 to 1,500 ft. away.

Mr. Short: The green light we display is a hand signal, displayed by a man on the ground.

## Meeting of Committee on Standard Specifications.

A meeting of Committee A of the American Society for Testing Materials on Standard Specifications for Iron and Steel, was held on September 17 at the house of the American Society of Civil Engineers, for the purpose of meeting Mr. Leslie S. Robertson, Secretary of the Engineering Standards Committee of Great Britain; Dr. Charles B. Dudley, President of the American Society for Testing Materials, occupied the chair. There were present at the meeting, as guests of the committee, a number of chairmen of committees of other societies concerned with work of a similar nature. It appeared that the committee was first formed at the instigation of the Council of the Institution of Civil Engineers, to consider the advisability of standardizing rolled sections. The work of the committee gradually grew in scope and importance, and various new subjects were added from time to time.

Mr. Robertson explained the constitution of the committees, and the representative nature of their membership. The committees are constituted so as to embody in them, representatives of all the various interests affected, and where possible, this representation has been secured by official nomination and not by private selection. Various scientific bodies and trade associations have cooperated with the committee. These specifications have been carefully discussed by the engineer and manufacturer meeting around the table of the institution, where any conflicting interests have been, as far as possible, amicably harmonized.

The committee has published several reports, one of the most important being that on "Standard Test Pieces." The test pieces decided upon by the committee appear to go a long way toward solving the difficulties surrounding this much debated question. The test pieces were arrived at after the most careful investigation by several of the committees, and after exhaustive experiments by Professor Unwin and others. Various speakers expressed their approval of these standard test pieces and their conviction that the general adoption of them in this country would mark a distinct step forward. It was the sense of the meeting that substitution of these standards for those now prevailing in this country was desirable. It appears from Mr. Robertson's remarks that the standards committee has a large amount of valuable work in hand, and as the committee is supported by the British Government and the five leading technical societies in Great Britain, the results of their work will be awaited with great interest by the engineering profession not only in Great Britain but also in this country.

It will be seen from the foregoing that the British Engineering Standards Committee is proceeding on lines quite similar to those followed by the American Society for Testing Materials. Both recognize the desirabil-

ity of according representation on their committees to all parties in interest, including the manufacturers. The work is distributed among numerous sub-committees, whose reports are submitted to the parent committee for revision and adoption.

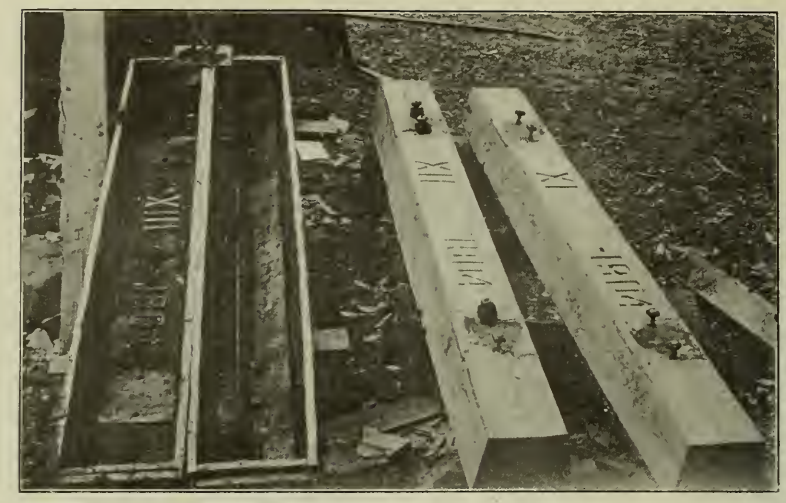
Mr. Robertson is expected to meet members of several of the committees of the American Railway Engineering and Maintenance of Way Association, engaged on similar subjects at a special meeting in Chicago on September 29th. The discussion of the general subject of standardization of methods of testing and of specifications governing the materials of construction will be continued at the International Engineering Congress in St. Louis, October 3 to 8.

## Foreign Railroad Notes.

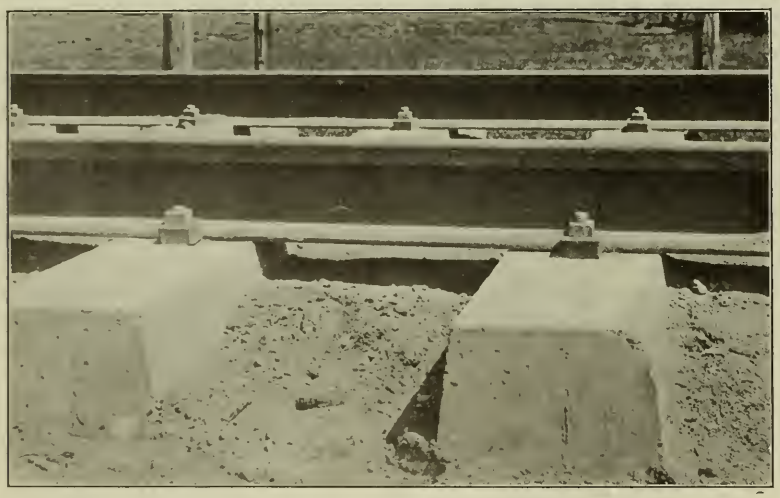
In 1887 the French Minister of Public Works notified the railroad companies that at least one water closet should be provided on every passenger train which run more than two hours without a stop of at least 10 minutes. In 1890 another circular declared that while it was not insisted that such provision should be made immediately in all cases; the gradual fulfilment of the requirement must be borne in mind. Now, 17 years from the issue of the first circular, the Ministry says that the time allowed has not been properly availed of, and that France is behind the age in this matter. Within a year every passenger train running more than two hours without a 10-minute stop really must have at least one water-closet, and within three years there must be one for every class. Seventeen years really does seem a good while to wait.

The opening of the first division, 280 miles long, of the pilgrim railroad, from Damascus to Mecca, was to be celebrated Aug. 31, the anniversary of the Sultan's accession to the throne.

It has been very dry the past summer in Germany and further south, and the forage crops have suffered so that they were insufficient to winter all the live stock. The natural consequence feared was that cattle, etc., would be rushed to market, and there would be an insufficient amount of it for some time to come. To prevent this, which was regarded as a threatening national calamity, the freight rates on forage to the districts which suffered from drouth were reduced greatly (one-half in some countries) in Germany, Austria and Hungary, by the State Railroads, usually followed by the private railroads, which latter are important only in Austria. Another consequence of the drouth has been low water in the rivers, so low that navigation has been suspended in some of them which ordinarily have very important traffic in coarse freights. In view of this, the German State Railroads have been asked to reduce the freight rates on such shipments as usually go by river to the level of the usual river rates. This the authorities have declined to do. The reduction on forage, they say, was to avoid a national calamity; and no such disaster is threatened by the turning of river freights to the railroads.



Reinforced Concrete Ties and Mold.



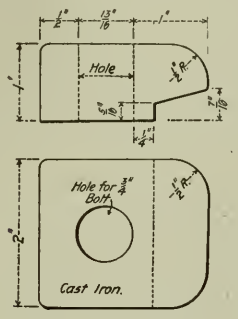
Reinforced Concrete Ties in Track Showing Fastening Clips.

## Concrete Cross-Ties on the Ulster & Delaware.

A number of the reinforced concrete cross-ties shown in the accompanying illustrations have been put in the track on the Ulster & Delaware for experimental purposes within the last year and the results so far have been very satisfactory. As will be seen from the drawing, the tie consists of a solid prism

Reinforced Concrete Ties in Track on the Ulster & Delaware.

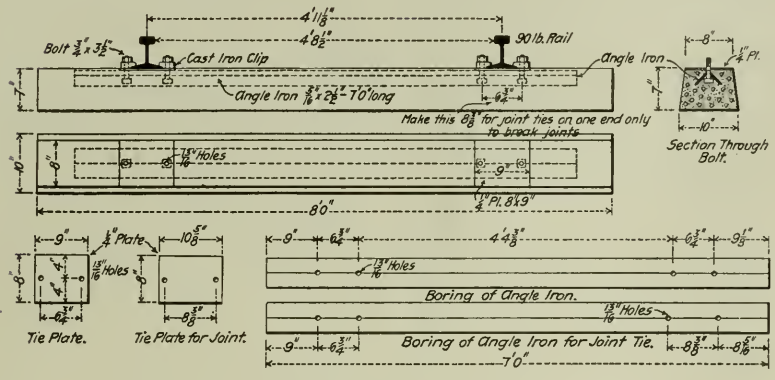
of concrete, 8 ft. long by 7 in. thick, and battered from 10 in. wide at the base to 8 in. at the top, moulded in wooden forms and reinforced with a piece of angle iron placed with the corner about ¼ in. below the top surface. Tie plates ¼ in. set in flush with the top of the tie form a seat for the rail which is held by two ¾-in. x 3½-in. square-head bolts passing up through the angle iron and having clips fitting over the flange of the rail. The concrete was mixed rather wet and shovel-tamped into the forms. It was found that no facing was necessary, the concrete taking a perfect impression of the form even to the grain of the wood and giving the




Rail Clip for Concrete Tie.

tie the appearance shown in one of the illustrations which is from a photograph. A mixture of one part of Atlas Portland cement, two parts of coarse sharp sand and four parts of crushed limestone which would pass through a ¾-in. ring was used and the reinforcement was old angle iron picked up around the shop which varied from ¼-in. x 2-in. by 6-ft. pieces to ⅜-in. x 3½-in. x 7-ft. 6-in. pieces. The cost of a tie is 42 cents exclusive of the cost of the reinforcement, and the weight is about 450 lbs. The reinforcing angles are drilled for the fastening bolts before being placed in the forms and two spacings for the holes are necessary, one for the joint ties and one for intermediate ties. The heads of the bolts fit up between the legs of the angle and are prevented from turning when the nuts are turned up and as the tie plate rests directly on the corner of the angle, there is no crushing down of the concrete when the nuts are tightened.

One of the first of these ties which was made was put in the track in May, 1903, and after more than a year's time shows no signs of failure whatever, despite the severity of the past winter. The nuts and clips holding the rail to the tie are as tight now as when first put in, and this without having been touched during the entire time. It will be seen that no provision has been made for shimming these ties and their heavy weight is also another disadvantage, making them cumbersome to handle on and off cars and in the track, but if they prove to have good lasting qualities these objections will be more than offset.


Bolt ¾" x 3½"
Cast Iron Clip
90 lb. Rail
Angle Iron
Angle Iron ⅜" x 2½" - 7'0" long
Make this 6⅜" for joint ties on one end only to break joints
Section Through Bolt.
15/16" Holes
¼" Plate
Tie Plate.
Tie Plate for Joint.
Boring of Angle Iron.
Boring of Angle Iron for Joint Tie.

Reinforced Concrete Cross-Tie on the Ulster & Delaware.

## Railroad Station Improvements.*

Notwithstanding that improvements to railroad station grounds still fall short of what they might be, or certainly will be, the general improvement in the last ten years has been marvelous. This improvement is not confined to a few roads or to any one section, but is almost universal. A higher grade of architecture and more attention to sanitary regulations, as well as to the parks surrounding stations and to the right of way can be observed on nearly every passenger road in the country. They vary in degree, of course, owing somewhat to the comparative taste and culture of the officials in charge. Speaking of that phase of the subject, I have noticed that in nearly all cases where the landscape work is in charge of the engineering department, there is not the same advancement as where it is in charge of the general manager's department. This is not strange, as engineers are exceedingly practical as a class and work on the straight line idea. There are notable exceptions, as the letters included in this report prove, but we must speak in generalities.

One looks for more artistic appreciation and development in the East and Middle West, but the Far West and the North compare favorably. For instance, the Duluth & South Shore Railroad, traversing the upper peninsula of Michigan between Duluth and Sault Ste. Marie, has lately built three depots, which embody all that is most pleasing architecturally and artistically. The Grand Rapids and Indiana, which also runs into northern Michigan, has lately erected three magnificent depots, whose surrounding grounds have also been laid out by a landscape architect, with successful results. In many instances the square plat of ground fenced off in graveyard style, with the geranium and canna bed, is in evidence in the West, but it is also to be found in the East. I find, as a rule, that this is because no one has pointed out the advantage of hardy shrub planting. In California I found the greatest trouble to be the total disregard of color harmony in the arrangement of flowers, and the tendency to overdo. Nature is so prodigal there that it is hard to realize that little should be done, and that with care. In regard to the paint question (a very important one, by the way) California is far ahead of the East. Subdued colors blended with perfect harmony is the rule. Some of our roads with their orange and red combinations, which, even as you flash by on the "Limited," give you a nervous shock, might learn a lesson by visiting some of the Southern Pacific stations. The Chicago & North Western and the Chicago, Milwaukee & St. Paul are roads which we of the West are justly proud of. All of their stations of recent years are artistic, sanitary and convenient. The surroundings are made as artistic as money and the skill of the landscape architect can make them without sacrificing needed space for the requirements of the business. The idea is to combine utility and beauty. You will notice that I put utility first. It has been conclusively proven that in the hands of persons skilled in the work this can be done without any detriment to business.

The Chicago & North Western keeps a gardener and force of men constantly caring for the grounds and shrubbery already planted. The Chicago, Milwaukee & St. Paul in the last two and one-half years has parked and planted, under the direction of a landscape architect employed by the year, 275 stations, but as the system embraces 7,000 miles there is much yet to be done. They are going a little slowly this year, but the work is to be continuous. The Chicago, Rock Island & Pacific puts up no cheap depots; everything that it does is first class and it has made some pretty parks. Most of the officials are very much in favor of the work, but retrenchment has caused a temporary suspension of it. The Chicago, Burlington & Quincy is thoroughly alive to the advantages of station ground improvements and began the work last fall in a small way. The Chicago & Alton has made the most radical move and is entitled to more credit than most roads for its courage in starting improvements at a time when all other roads were retrenching. The thoroughness with which its officers have undertaken the work of parking their station grounds between Chicago and St. Louis, painting their depots in good taste, regrouping their secondary buildings, putting in new brick platforms with curved corners, employing skilled labor and then trusting to their judgment and taste, entitles them to the approval of the American Park and Outdoor Art Association.

Following are extracts from some of the replies received to a circular letter to officers of 125 railroads. This letter asked what these roads had done or contemplated doing in the near future to improve their station surroundings, and requested an expression of opinion as to the value and benefit of such work.

*Chicago, Milwaukee & St. Paul.*—"In the matter of parking and beautifying our station grounds, we have undertaken considerable work of this nature on different divisions of our systsm and are much gratified with the results. We have not only been able to make beautiful parks of what was formerly unsightly places, at small expense, but find that it is an education to our employees to be neat and systematic and avoid the expense of frequent cleaning up of our depot grounds, so that in addition to being a 'joy forever' we also find that it is economy."—W. J. Underwood, Assistant General Manager.

*Lake Shore & Michigan Southern and New York Central.*—"It is our practice on the Lake Shore and New York Central roads to have laid out each year by an experienced landscape gardener a number of station grounds, which are planted and kept in order from year to year. The planting is done by gardeners, and the foliage is kept in order by section men, except where the amount of work to be done requires the entire time of gardeners. In a general way we endeavor to develop nice shade trees adjacent to the

*Extracts from a report presented to the St. Louis convention of the American Park and Outdoor Art Association, by Mrs. A. E. McCrea, Chairman of the Railroad Improvement Committee.

driveways, and in the station background, generous lawns and flower beds, placed for the best effect. We feel that a moderate amount of this work is very desirable as it adds much to the attractiveness of our station grounds and to the general appearance of our right-of-way."—W. C. Brown, Vice-President.

*Pere Marquette.*—"We have done but little in regard to improving station grounds, and that only at more important points. I should like very much to see all of our station grounds improved and can only offer in explanation of the lack of attention, the fact that it costs to get the improvements started and to maintain them. It is useless to go to the expense in the first instance unless they will be preserved. Personally, I believe the ornamenting of the station surroundings of great value. The presence of order and neatness along properly has its influence upon employees, which in my judgment is of even greater value to the company than the revenue which may be derived on account of the same. There is no doubt, persons in traveling seek attractive routes."—F. H. Alfred, Chief Engineer.

*Union Pacific.*—"For some years past we have been beautifying our station grounds by sodding and by planting trees and trailing vines, and, in some places, where practicable, by planting flowers. In the deserts of Wyoming some of our parks are very fine and quite a contrast to the surrounding country through which the traveler passes. This is notably so at Cheyenne. We keep adding to the number of our parks each year and are very much in sympathy with this kind of work within the limits we are allowed."—J. B. Berry, Chief Engineer.

*Norfolk & Western.*—"Particular attention is given to the cleanness of all station grounds on the Norfolk & Western, and at important points they are beautified by well-kept lawns and shrubbery, omitting flower beds. I think proper efforts upon the part of your association should attain beneficial results for the railroad companies as well as the public."—L. E. Johnson, President.

*Central Railroad of New Jersey.*—"We maintain a park department with a force in charge whose duty it is to set out plants, shrubs and trees, and keep the lawns about stations in first class order. We set out about 15,000 plants every year besides hardy shrubs and trees. The class of travel from our suburban district is of the highest order, and we believe there is a distinct benefit to our company in keeping up the appearance of our parks and station grounds."—W. G. Besler, Vice-President and General Manager.

*Illinois Central.*—"Several years ago the Illinois Central adopted a policy of gradual improvement of its station grounds and right-of-way. We erected a greenhouse where flowers and plants are grown for setting out at stations along the line in the spring of each year, and for supplying ferns and flowers for our dining cars. So far, we have only undertaken the improvement of the grounds at our most important stations where lawns are sodded and flowers and shrubs are planted. At other stations, however, we have sodded around the buildings, and the agents are particularly instructed to keep the premises in as neat and clean a condition as possible. A gradual improvement is being carried on in this way, and we expect to continue the work in line with this policy, believing that our passengers will appreciate our efforts in this direction and that they, as well as ourselves, will be benefited thereby."—J. F. Wallace, General Manager.

*Grand Trunk.*—"While we have done something within the past few years in the way of beautifying the surroundings of our stations by lawns, gardens, etc., we have had so much work of more vital importance that the matter has not received systematic attention. We have confined our efforts chiefly toward beautifying station grounds where we have erected new buildings, and have refrained from expending money in this connection at many of the older stations where, in the near future, we hope to be in position to make improvements. Undoubtedly we are of the opinion that railroad companies are amply repaid for reasonable expenditure in beautifying the surroundings of their stations."—F. H. McGuigan, General Manager.

*Boston & Maine.*—"We first considered the matter of station ground decoration in the early '80's, and on Jan. 31, 1881, the Board of Directors authorized a prize competition for the best decorated station lawn, allowing each agent $10 for the purchase of budding plants. The system thus inaugurated has continued to the present day and competition has been stimulated and interest has become more widespread by the increased prize money. Within the past five years the idea has gained strength that hardy perennials are much more satisfactory than budding plants alone, making more of an ornamentation in early and late season, and grounds of many stations have been laid out accordingly."—C. E. Lee, Assistant General Manager.

*Canadian Pacific.*—"The floral department of the Canadian Pacific was established six years ago. Our object has been to induce agents, section foremen and other employees to beautify the stations and houses, which are practically their homes. In the springtime, I supply seeds and plants, and in the fall, bulbs for outdoor and indoor cultivation, everything being supplied gratis. The work is meeting with great success."—N. Stewart Dunlop, Floral Department.

*Chicago & North Western.*—"There are 1,700 stations on our line with a tributary population of 7,600,000, and the importance of a policy by means of which the traveler on alighting from the train finds himself in the midst of a pleasing landscape of flowers, shrubbery and well-kept lawns, is one the full value of which can hardly be computed. This value is felt not only by the traveler, but in each community so fortunate as to be thus favored. The influence of an example of this kind is one that extends into the civic life of the community very rapidly, and the standard for breathing places, parks and boulevards, and indirectly for improved streets and public buildings in western towns, is being rapidly raised to a plane that is nowhere excelled, largely as the result, it may be said, of the railway's early example. No feature of our beautiful suburbs is more pleasing to the eye than the attractive station grounds which mark the traveler's entrance to the town. Careful attention and liberal expenditure is shown in the pleasing architecture of the station buildings, so that, taken as a whole, there is probably no series of suburban stations in the United States that attain a higher average from the standpoint of beauty.

"While the most complete luxury and comfort is possible on the modern railroad train, yet this attention to outside surroundings has also a most desirable influence and adds to the temporary home of the traveler that sense of attractiveness that makes the American railroad so notable. But the most important feature of this systematic campaign for the beautifying of what is one of the most generally used and widely noticed places in the community—the railroad station—is the educational effect it has had upon each community whereby the universal beautifying of homes and streets has been rapidly brought nearer a fruition that is ideal.

"This work of beautifying station grounds and right-of-way is a part of the permanent policy of this company and, as such, its bearing upon the community with which the road is so closely connected geographically and from the traffic standpoint is, it seems to me, the most pleasing feature of the work that can be done by railroad companies or other transportation lines that keep in close touch with the requirements of the people they serve."—W. B. Kniskern, Passenger Traffic Manager.

## Preservative Coatings for Iron and Steel.

At the Atlantic City meeting of the American Society for Testing Materials, the Committee on Preservative Coatings for Iron and Steel presented an interesting report. The members of the committee had been asked to submit their views as to the best methods of testing preservative coatings. An abstract of some of the individual reports follows. Dr. C. B. Dudley, chemist of the Pennsylvania, said: "We think that the test of service is the ultimate test which will prove whether any protective coating is or is not valuable. But experiments with protective coatings in actual service are extremely difficult to make, and are subject to many vicissitudes. Moreover, they require a long period of time before a conclusion can be reached. If the structure is a permanent one, that is, does not move, the results only apply to the location under which the test is made. If the structure is a movable one, such, for example, as a steel car, there are very serious difficulties introduced into the test, due to the almost impossibility of watching the car while it is in service, and to the danger of losing track of it before the test is completed.

"In view of this difficulty, exposure tests on smaller samples have been proposed. Coat, for example, a number of pieces of metal with the various protective coatings which it is desired to test, and expose them for a period of time. Valuable information can be obtained from exposure tests, but these tests have at least four objections to them: (1) The samples are usually small, and small samples do not quite afford the same opportunity to get the proper amount of coating on them, as if the samples were larger. Moreover, the coating is usually done under more favorable conditions than apply in actual service. And there seems to be a fairly well grounded belief that panel tests, as they are called, are not sufficiently like the actual conditions of service to warrant final conclusions. (2) During exposure tests there is always the uncertainty as to whether something will not happen to the test samples, such, for example, as the record being lost, or the samples being injured in some way, or somebody not conversant with the conditions interfering with them. (3) Exposure tests take a long time, and this long time is not infrequently accompanied with changes in the personnel of those having charge of the test, with a forgetfulness as to exactly what was done with the various samples. (4) Probably, however, the most valid criticism of exposure tests on panels or small samples is that the conditions are not those of actual service. The samples are located at one place with a certain exposure. This exposure is not the exposure which structures actually get. Furthermore, the small panels are not under strain, which is characteristic of almost every metal structure in actual service, and whatever deterioration may be due to strains does not appear in the exposure tests.

"We have spent quite a little time trying to devise a test which will determine whether water permeates paints or other materials de-

signed to be used as protective coatings. Our first thought was to put on glass or other transparent non-absorbent surface, some substance which would change color when water gets to it, and after the gum holding the material had been dried out thoroughly, coat it with paint or other protective coating, and then put the painted object into water. Experiments with anhydrous sulphate of copper and other materials which change color when water gets to them, proved not very satisfactory. Apparently during the drying of paints of which linseed oil is a constituent, water is formed in the layer itself, due to the chemical action. Our experiments showed some blueing of the anhydrous sulphate of copper, even before the specimen had been put in water. The most successful results which we have obtained have been by using a water solution of dextrine. We have made a number of such tests, and have found that almost no paint containing linseed oil as a constituent, is impervious to water.

"There are still some uncertainties in the tests. For example, linseed oil paint does not reach its final state of oxidation, or the change which we call drying, for quite a period of time. We have not yet made any tests, where the paint layer was allowed to harden for more than ten days or two weeks. It is possible that a longer time before the paint was tested would prove advantageous, and there is considerable indication that such would be the case. There are indications still further that the presence of pigment very greatly helps the linseed oil to resist the penetration of water, and also a good deal of evidence that the fineness of the pigment is a most important element in the water resistance of the layer. Furthermore, the nature of the pigment seems to be an element likewise in the problem.

"The query may arise, why is it that a layer of paint made with linseed oil should allow water to get through it?

"It seems almost incredible that an oily substance spread out in a thin layer should not so completely repel water that there would be no permeation of the layer. But it must be remembered that dried linseed oil is no longer an oil. The mass of dried linseed oil, if we may trust Mulder's researches, is a tough, leathery sort of material, which does not leave an oily stain when touched, and which is changed chemically from being an oil into a material which Mulder calls 'linoxyn.' During the drying or the change of the oil to linoxyn, there seems little doubt but that oxygen is absorbed and carbonic acid at least is given off; but if carbonic acid is given off as fast as it is formed, it must escape, and it must escape not only from the outer surface of the layer of paint, but also deeper down in the layer, and it is believed that this escape of the carbonic acid, it being a gas, leaves apertures in the dried layer, through which apertures the water passes when the material is tested, as has already been described. Whatever the philosophic explanation of the porosity of the layer of dried linseed oil paint may be, if our experiments are to be trusted, this porosity is a universal characteristic at least of the layer two weeks old.

"We cannot help feeling that our experiments seem to indicate that it is going to be difficult, not to say impossible, to make a perfectly water-resistant productive coating out of a material which consists largely of linseed oil. Substances brought forward as protective coatings which dry by evaporation of the solvent, seem to offer much more prospect of success."

MALCOLM MCNAUGHTON (JOSEPH DIXON CRUCIBLE COMPANY):—In outlining a test scheme for protective paints, the following points are to be considered: Cost, application, drying, adhesion, elasticity, porosity, resistance to mechanical injury, permanency.

1. *Cost.* This point may or may not be included in a scheme for testing paints. It is properly included when the test is made by the person who is directly interested in the economic side of the question, and may properly be left out by him who has to determine only the value of the paint as a protective coating.

2. *Application.* This bears on the facility with which the coat may be applied, whether it may be properly applied over other and different coatings, whether it may be applied at all ordinary temperatures, and whether or not any special treatment of the surfaces is required. Knowledge on these points is only to be had by actual trials.

3. *Drying.* Continued observation during an actual trial will give all the information necessary on this point. But it is necessary that observations be made up to the time that the paints are actually hard and dry, because it may happen that one paint may begin to dry on the outside more rapidly than another which may finally pass it and become dry first.

4. *Adhesion.* This is a most important point, it being self-evident that any paint to protect must stay in place. Relative adhesion, when decidedly unlike, may be detected when the paints are fresh by simply peeling off at the point of a chisel. But adhesion must persist throughout the life of the paint, so that it becomes necessary to test the paint films after having given them somewhat the effect of age. Probably as fair a way as any, to secure this effect, is to subject plates of painted iron or tin to repeated alternations of heat and moisture. Tests for adhesion should be made before any others, as a paint coat which lacks this quality, when new, should be immediately condemned.

5. *Elasticity.* This quality enables a paint film to accommodate itself to its base during changes as a result of variation of temperature or form. When we consider the great difference in the coefficient of expansion between the metals and oils, we see that, unless there is a certain degree of elasticity, rupture of the paint film must occur. Films of paint, detached from their support, are best for determining relative elasticity. The simple test of bending is enough to give information where the difference in elasticity is enough to be of importance.

6. *Porosity.* Since iron does not rust except in the presence of moisture, it is important that the protecting film of paint should be non-porous in the highest degree, without the sacrifice of other desirable qualities. This is a test which should be applied when the paint is in its most perfect condition as a protecting film. It is not correct to test by repeated evaporations of water in a painted dish, because the deterioration of the paint by these repeated evaporations is also involved. The method of using postage stamps painted on glass, covered with a couple of coats of paint, and when dry, immersed in water, seems good. This may not be exactly correct in its technical aspect, but should give approximately correct results when made for comparative purposes.

7. *Resistance to Mechanical Injury.* Tests to determine this need be made only in special instances where conditions are such that protective coverings may fail from this course. Where such a test is advisable, it is easily made by allowing a stream of sharp sand to flow over the painted surfaces from a hopper, the sand being returned from time to time. The test is easily made more or less severe by varying the height of fall and angle at which the stream strikes the plate.

8. *Permanency.* Protective coatings may be assured as quickly reaching their condition of greatest efficiency. We may consider that when a paint has become what we call dry, it has reached that condition. From that point of greatest efficiency there is a gradual, more or less rapid progression toward ultimate failure. The paint in which this progression is slowest is to be taken as the most permanent. The value of this function must be determined entirely separate from the determinations of the other qualities, and the test should be so conducted as to bring about a slow change, rather than to destroy. The test should be made with especial reference to the conditions under which the paint is to be used. The test should be made with paint films which have been detached from their support. They should be of sufficient thickness, not less than two coats, and probably three would be better. They may be prepared on thin zinc plates, the zinc being dissolved off by dilute sulphuric acid, or they may be prepared on cardboard covered with a paste of dextrine. When dry the whole is immersed in water and the support soaked until it may be separated from the film. Films of various paints to be compared are subjected to the same set of conditions and their relative action observed.

It is much easier to detect changes in films separated in this way than when attached to their supports.

The foregoing tests, while simple, and probably capable of much improvement, are sufficient to give considerable information when made carefully for competitive purposes, yet at the same time they do not give exact values. Under any one test in question, it will be easy to show that one paint is better than another, but not so easy to show just how much better. Judgment in this matter can only come with experience. It is to be supposed that any test of paints is for the purpose of selecting the one most suitable for some set of actual conditions, and that these actual conditions indicate the relative importance of the tests to be made.

The rate of drying, resistance to mechanical injury, porosity, adhesion, etc., may each in turn be the feature of greatest importance. It would certainly be an absurdity to lay much stress on relative porosity of a coating which is to be applied to bridges in Arizona, or to pay much attention to the matter of elasticity in a paint for ironwork in a damp subcellar.

Unfortunately, no paint has yet been discovered which possesses pre-eminently all the qualities needed for iron and steel protection, so it becomes necessary for us, if we hope to get best results, to determine in some way what particular product is at least as good as any other for the case in hand. It seems to be entirely within the scope of this committee, in addition to suggesting methods of making tests, to suggest also a scheme for combining the values obtained by such tests, into an equation, the solution of which will give relative values in particular cases. For instance, the efficiency of a coating may be represented by an equation where one side consists of the sum of the values for the various functions previously determined by experiment, each multiplied by a factor which represents its particular importance in any specified case. Thus in different cases we may take the factors as follows:

| | | |
|---|---|---|
| Cost .....1 | Cost .....1 | Cost ..... 1 |
| Application ...1 | Application ...1 | Application ... 1 |
| Drying .....4 | Drying .....1 | Drying ..... 1 |
| Adhesion .....2 | Adhesion .....1 | Adhesion ..... 1 |
| Elasticity ....1 | Elasticity ....1 | Elasticity .... 1 |
| Porosity .....2 | Porosity ....1 | Porosity .....10 |
| Resistance to mechanical injury .....3 | Resistance to mechanical injury .....1 | Resistance to mechanical injury ..... 1 |
| Permanency ..2 | Permanency ..6 | Permanency .. 1 |

The first set might be used in testing

paints for steel cars, the second for highway bridges, and the third for ironwork in locations subjected to steam and acid vapors. Such a scheme will have its limitations and variations due to the personal equation of the man operating it, but eventually there would come a certain degree of standardization. These suggestions are presented with the idea of showing the advisability of a scheme which will necessitate the consideration of all the points involved.

With regard to time tests, not much need be said except that the pieces to be exposed should have at least 2 sq. ft. of area on each side, and should have two coats, the second applied only when the first is dry. The second coat should be dry before exposure occurs, and the exposure should represent the average conditions it is desired to protect against. The test piece should consist of vertical and horizontal parts, the latter to serve as a resting place for water, cinders, dust, etc. Where such pieces have been examined from time to time, such places should be covered by paint to prevent extension of corrosion from the damaged surfaces. This patching-up paint should be of a different color than the paint which is being tested, to avoid any confusion.

S. B. Newberry:—It is difficult for me to suggest a scheme for testing Portland cement as a protective coating for iron and steel, since the methods of using it for this purpose have not yet been developed. However, I think there is no reason why cement should not be submitted to the same tests as other paints, so far as these are found to be applicable. Cement coatings should, however, be kept in *moist air* at least 24 hrs. after being applied. Whether this will prove practicable on a working scale must be determined by experience.

For these experiments cement in extremely fine state of division will be necessary. We have facilities for furnishing such cement, prepared from our regular product by air separation, and could ship a barrel or so for experiment at any time. The cement should be mixed with water to about the consistency of ordinary oil paint, and kept thoroughly stirred while being applied.

I would suggest also experiments with cement with the addition of calcium chloride to the amount of 5 and 10 per cent. of the weight of the cement, having found by experiment that this aids greatly in producing a thorough set of the cement before drying takes place.

W. A. Polk (Patterson-Sargent Co.):—The preservation of steel cars is a question requiring careful study. The preparation of the cars for painting is obviously of prime importance. An experience will serve to show to what extent this point should be considered. In making an observation recently the writer noticed that the plates of a new steel car were covered with oil which had been used on the rivet holes. This oil had spread over the surface of the car in large spots. The writer instructed the painters to remove the grease entirely from the surface, but before these instructions had been given the men had painted a part of the car without removing the grease. On the following day, after the entire car had been painted, it was found that the coating was entirely dry except on the first section, from which the grease had not been removed. The paint on this section was perfectly wet; that is to say, it was in the same condition as when first applied. In order to expedite the completion of the car, the men were instructed to wipe off both the wet paint and the grease which had caused the trouble. Where the grease remained, both it and the paint could be wiped off, but from contiguous spots where no grease existed the paint was hard and clung so firmly to the steel surface that it was removed with difficulty by the use of a knife.

Another matter of importance in this connection is the removal of mill scale and rust. The painting of steel cars offers an opportunity of painting under precisely the same conditions if each car be cleaned alike. Naturally the conditions of exposure vary to some extent, but a record could be kept of certain cars and by inspection from time to time instructive results might be obtained. Cars might be chosen which remain continually on the same railroad, for example, cars carrying coal from the mines to tidewater.

## The Steamship Minnesota.

The accompanying illustration shows the twin-screw steamship Minnesota, built by the Eastern Shipbuilding Company, New London, Connecticut. The Minnesota is the largest freighter ever built in America, and the fourth largest steamship in the world. She was built for the Pacific trade and is to run in connection with the Great Northern Railroad, which has its Pacific terminal at Seattle. The principal dimensions of the Minnesota are: Length, 630 ft.; breadth, 73 ft. 6 in.; molded depth, 56 ft.; maximum draft, 36 ft. 6 in., or the same as that of the White Star steamship Baltic, which is the largest steamship afloat, and which was described in the *Railroad Gazette*, July 15, 1904. The total space available for cargo and coal is 1,072,000 cu. ft., and her dead weight carrying capacity is between 20,000 and 25,000 tons. With a draft of 36½ ft. her displacement would be 37,000 tons, and with a draft of 33 ft. her displacement would be about 33,000 tons. She is built of steel throughout and is divided transversely into 13 water-tight compartments, and has a longitudinal bulk-head from keel to main deck, which is watertight in both engine and boiler spaces, making in all 15 water-tight compartments above the double bottom. The double bottom is 6 ft. deep and extends from end to end. It is divided into 30 separate watertight compartments in which 3,966 tons of water ballast can be stored. There are five steel decks extending the full length of the ship, and there are four more steel decks in the passenger spaces, making nine decks in all. From the upper navigation bridge to the keel is a distance of about 89 ft. There are ample facilities provided for rapid loading and unloading, there being 34 cargo booms in all. One of these booms has a lifting capacity of about 40 tons, and one of the hatches is long enough to allow a complete locomotive to be lowered into the hold. The steam is generated by 16 Niclausse water tube boilers. These have a heating surface of 40,615 sq. ft. and a grate surface of 1,081 sq. ft. The steam pressure is 250 lbs. The funnel is elliptical, measuring 19 ft. fore and aft, and 16 ft. 3 in. transversely, and its top is 135 ft. above the keel of the ship. Induced draft is used and automatic stokers and ash conveyors will be installed if results of the tests which are now being made with them on her sister ship, the Dakota, prove successful. The total coal bunker capacity is about 6,000 tons, 2,000 tons being stored in a reserve bunker. The permanent coal bunkers are over the boilers and deliver coal through chutes to the firing platform. The main engines are of the triple expansion type with cylinders 29 in., 51 in. and 89 in. in diameter by 57 in. stroke, and develop from 10,000 to 12,000 h.p. at 78 revolutions per min. The twin screw propellers are each 20 ft. in diameter. The average speed of the vessel is about 15 knots per hour.

The Steamship Minnesota.*

*Photo courtesy *Scientific American*.

RAILROAD GAZETTE

## THE INTERNATIONAL ENGINEERING CONGRESS.

An International Engineering Congress, held under the auspices of the American Society of Civil Engineers, will begin its meetings on Monday next, the third of October, at the World's Fair, St. Louis. Eleven years ago, at the time of the World's Fair at Chicago, a similar congress met, and now we are to have, in the papers which will be presented at this meeting, a review of engineering progress throughout the world during the intervening decade. Such gatherings as this and its predecessor are of more value to the engineering profession than is apparent at once from a casual glance over the long list of subjects which are to be considered by the various sections. They are the means of bringing together the most eminent engineers from all over the world, and, just as the national engineering societies promote among their members a feeling of pride and dignity in the pursuit of their profession, so does an international congress of this kind promote as well a spirit of co-operation and friendly feeling which is of quite as much value as the mere interchange of technical information which takes place during the discussions.

The Chicago congress was held under the auspices of the three national engineering societies of the United States: the Civil Engineers, the Mechanical Engineers, and the Mining Engineers. The Institute of Electrical Eugineers was not then in existence. In fact, the science of electricity was at that time hardly out of its infancy, and but little attention was paid to electrical subjects. This year's general congress is to be held under the auspices of only one of the engineering societies, and, naturally, the subjects which will be discussed are more or less limited to the scope of civil engineering. An electrical congress has already been held in St. Louis and was attended by the world's most eminent electrical scientists and engineers. The mining and mechanical engineers have not seen fit to encourage a gathering of this kind, this year, so that, in a sense, the Chicago congress will be remembered as having a broader significance than the congresses at St. Louis in 1904.

The American Society of Civil Engineers has drafted its most distinguished members to direct the work. Each of the men who have been appointed chairmen of the seven sections are men who have world-wide reputations as engineers and are experts in those branches covered by their respective sections. The committee in charge has wisely placed no restrictions on those who may take part in the work of the congress and invitations have been given to all engineers regardless of their affiliation with any organization or engineering society. Undoubtedly a large number of those who participate in the discussions will be men who have no connection with the American society.

The meetings will fill six days. On the first day there will be a general meeting of the congress, and on the four succeeding days each of the sections will hold separate meetings for the discussion of the topics included under their titles. On the last day there will be another general meeting. By this arrangement each section will have four sessions of from two to three hours each for the discussion of its own papers. Ten or 12 hours seems a ridiculously short time in which to consider even a few of the many papers which have been promised. Under section A, Waterways, for example, there are to be 25 papers, each of which might well be the subject of a long and profitable discussion. As in almost every other convention, or meeting, of this kind, those in charge have been too ambitious. It will be a physical impossibility to get through with the long list of papers in the short time which has been allotted, and many must be left practically untouched.

The international character of the congress is evident from the list of authors of papers which will be presented. American engineers by no means predominate, and nearly every country in Europe is represented, with the noticeable exception of Germany. Japan and the Argentine Republic are among the comparatively new members of the family of nations which will have representatives in attendance. A large delegation from the Institution of Civil Engineers of London has already arrived, and members of other foreign engineering societies as well. These visitors are inspecting engineering works in some of the principal cities, taking the opportunity of the congress to see the best examples of engineering progress in the United States; and they will meet our greatest engineers. They will not be disappointed in the things that they see.

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The pamphlet on ventilation of passenger cars, which the Pennsylvania Railroad has just issued, is an important addition to technical literature. The experiments which it describes constitute a distinct addition to railroad knowledge, and in equipping hundreds of its cars with adequate fresh-air intakes the road has put itself ahead of all others in this respect. The studies here reported are important not so much on account of any strikingly original facts brought out as because the subject is dealt with in a comprehensive way. Railroad men and inventors innumerable have dabbled with car ventilation, and many of them have written useful essays, but very little progress has been made. It remained for the expert engineers of a strong railroad company with a persistent policy, to "round up" the true theories and put them into practice extensively. Elsewhere in this issue the method and apparatus which have finally been adopted are quite fully described. The experiments have extended over ten years. The plan seems to be as near the ideal as it is possible to get. The supply of fresh air is always adequate, and it is distributed throughout the length of the car. The currents do not come in contact with passengers, yet, at the same time they go to every part of the car. But little dust and dirt and practically no cinders are carried in from the outside, and in the winter the cold air is warmed and dried by contact with the steam pipes before it reaches the inside of the car. It is hardly necessary to say that this arrangement has been finally approved by the Pennsylvania Railroad only after exhaustive tests to determine its behavior under the most severe conditions.

### August Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of August, printed in another column, contains accounts of 16 collisions and 24 derailments. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | | Killed. | Injured. |
|---|---|---|---|
| 7th. | Eden, Colo. | 94 | 3 |
| 8th. | Plainfield, Ill. | .. | 20 |
| 8th. | Spottsville, Ky. | 4 | 0 |
| 9th. | Chicago, Ill. | 5 | 7 |
| 12th. | Dunlo, Pa. | 1 | 0 |
| 14th. | Silverpoint, Tenn. | 1 | 23 |
| 17th. | Altamont, Mo. | 2 | 15 |

The disaster at Eden, Colorado, resulted in more deaths than were ever before reported in a train accident in the United States. More distressing circumstances have occurred in connection with hundreds of collisions and derailments, particularly those accompanied by fire and those where the victims have been scalded; but measuring solely by figures Eden now heads the list. If we could estimate the suffering it would no doubt fall far below many other cases, the proportion of injured to killed being as 1 to 30.

The circumstances of this accident were reported in the *Railroad Gazette* of August 12, page 226. Both the conductor and the engineman having been killed all questions as to possible errors of judgment on their part must go unanswered. The indications that the train was moving slowly are believed to afford evidence that the men in charge were watching for danger; but the only assurance we have that they watched with reasonable intelligence and caution is their long experience and good record. Unfortunately, men of experience and reputation make mistakes of judgment; and, moreover, they often get into a state of mind where they do not fear danger so much as they ought. Perhaps this is inevitable. The man possessed of the ideally cautious temperament required by the usual railroad rules might not be a success as an express engineman.

Quite likely Colorado becomes the scene of the worst train accident on record because she has more dangerous conditions than exist in the Eastern States, where our past records have chiefly been made. The suddenness of the "cloudbursts" in the Rocky Mountains, and the large volume of water with which they fill dry channels are different from anything that is to be found in more level regions. Indeed, one of the criticisms passed upon the railroad company is that it has been too ready to fill important official positions with men from the east, displacing men who have had experience in mountain railroading. Disasters like Eden have been predicted by old railroaders acquainted with that territory. The road has also been criticized for having too few telegraph offices, one near the Eden bridge having been closed not long ago. With this is coupled the statement that on a week day the track-repairmen might have been on duty near the bridge and have prevented the train from going upon it. It is obvious that if the safety of trains depends on track watchmen, Sunday trains deserve as complete protection as is accorded week-day trains. It is said that the men in charge of the northbound passenger train which had passed over the bridge a few minutes before the disaster did not notify the superintendent that the water was high, because there was no telegraph operator on duty at the station where they would naturally have left their mes-

sage; but this does not explain why they did not stop the southbound train and warn it.

We recount these circumstances, supplementing what has been printed before, for the purpose of suggesting the more important elements of the problem of prevention. To particularly define the problem would require a study on the ground. To settle it perfectly may be impossible. Look for a moment at what is demanded: a bridge high enough and long enough to pass a flood which can be only roughly estimated; a section master who will unerringly order out track watchman at any and all times when necessary, never hesitating a minute; a station agent who will discern the signs of the sky unfailingly and report promptly to the train despatcher; a despatcher who will run no risk, yet will not hinder trains unnecessarily; and finally conductors and enginemen who will be cautious in the extreme yet will "get their trains over the road" to the satisfaction of the superintendent. To comply with all these conditions a railroad company must not only have experienced and well trained men but must have a good volume of traffic to pay the bills. The only alternative is very low speed for all trains, with the understanding that delays must be expected.

There was one serious passenger train wreck in Canada in August; a butting collision near Richmond, Quebec, on the 31st, killing nine persons and injuring 23. This collision appears to have been due to careless reading of the train register. The coroner's jury which investigated the accident brought in a verdict which says that confusion is likely to occur, through the fact that two trains bearing the same number, arrive on the same track at nearly the same time [from different divisions], and that "train registers, besides being kept distinctly apart from each other, should be checked by some special official." The Montreal *Star* says: "These recommendations are good, but why should it be necessary for such simple precautions to be suggested to railroad experts by a coroner's jury and as the outcome of a lamentable disaster?"

The next day after the Richmond collision there was one nearly as bad on the Canadian Pacific at Sintaluta, 300 miles west of Winnipeg, due to a misplaced switch at the entrance to a side track. In this collision five passengers were killed. Concerning the Sintaluta case the Montreal *Witness* says:

> In the Richmond disaster, the Sintaluta wreck, and the many other 'accidents' there is work for the Railway Commission, not only of investigation, but of founding upon the evidence it receives a stringent set of regulations, with heavy penalties for disobedience of the same. The Railroad Commission, too, would find it a good subject for investigation as to how far it is true that certain railway officials wink at disobedience to the rules on the part of the men as long as there is not an accident. The men will assure you, on some railways, that the rules are all right if the men were permitted to live up to them. But an engineer who followed the rules exactly would make bad time, and would (so they say) be 'pulled' from his engine for a week or a month as a punishment. They therefore 'take chances' and disregard rules with the knowledge of the officials. . . . Another thing in which reform is needed is in the inquiry by a coroner's jury. Many people would, indeed, to-day, in all cases of seriousness, abolish the coroner's jury altogether. The services of the jurymen are naturally given grudgingly, as it is forced and unpaid labor; the jury is inexpert and haphazard in receiving and rejecting evidence and in arriving at conclusions. Half the time there are no conclusions, and the other half the conclusions of a jury are not carried into effect. If all railroad accidents were investigated by a commission of experts, as in the case of wrecks at sea, and the blame duly apportioned, that would be a step in the right direction; but a step which should keep it close companionship would be one by which adequate punishment should follow criminal negligence, however, 'high up' the criminal might be. Various attempts have been made to pass legislation having this purpose, but railway influence is strong at Ottawa on both sides of the House, almost every member enjoys direct favors at the hands of the railway, and nearly all such legislation is blocked. The most of these slaughters could be prevented if legislators were determined."

The number of electric-car accidents reported as occurring in the United States in August was 23, in which 13 persons were killed and 203 injured. One of the deaths and six of the injuries are charged to a runaway on a curve, due to the failure of a brake chain; a collision at a crossing, injuring six persons, was due to a failure in hand signaling, and 35 injuries are charged to a collision near Pittsford, N. Y., said to have been caused by the attempt of a motorman to "steal a switch."

Elsewhere in this issue will be found an extract from a paper read before the National Railroad Master Blacksmiths' Association held at Indianapolis, on oil burning furnaces in the shops of the Southern Pacific. This extensive use of oil burning furnaces is to be commended. Although the coal heated furnaces and forges are comparatively inexpensive and use the cheapest fuel, they require men well trained in judging heats, etc., to operate them. The efficiency of coal furnaces depends upon the skill of these men, and this skill can only be acquired after a long experience; consequently, these men demand high pay. The operation of an oil or gas furnace is a comparatively easy matter when compared to the operation of a coal furnace, and when properly designed for special work these furnaces are not only economical but are more efficient, convenient to handle and speedy of operation. Besides this, it has been demonstrated that metal heated in an oil furnace is more homogeneous, is freer from seams, and is more pliable after forging than metal heated in a coal furnace. Although oil is an improvement over coal as fuel for furnace work, it is claimed by many that still better results can be obtained by the use of gas as fuel. By the use of gas the temperature of a furnace can be controlled to a greater nicety than with any other form of fuel. The science of metal working has progressed to such a point that it is pretty generally known even in the blacksmith shop that the temperature of the metal during working bears an important relation to the several elements which made good forgings. It is unquestionably true that, in most cases, it costs more to operate a furnace with oil or gas than with coal. Of course, local conditions and proximity to oil or gas fields is the prime factor in cost of fuel. But even assuming that the use of oil or gas costs more than coal, it nevertheless follows that the higher grade of work produced, the increased output, the greater ease of operation, etc., more than offset the extra fuel cost.

It is announced in Boston that the New York, New Haven & Hartford is going to abandon electric traction on that part of its Nantasket Beach line which is used also by steam locomotives. It will be remembered that this part of the line was electrified some years after the establishment of the original Nantasket electric line. The present announcement has elicited numerous inquiries as to the intentions of the company in regard to the use of the loop tracks in the lower level of the Boston terminal station, and President Mellen has frankly told the people of Boston that they need not expect to see electric cars at the terminal for some time to come. The terminal station has now been in use about five years. The loop tracks, idle all this time, were built in the expectation that electric motive power would soon be sufficiently perfected to warrant the company in adopting it for use on the suburban lines within 10 or 15 miles of Boston, but this expectation is not yet realized. The gist of Mr. Mellen's message to the Bostonians appears to be that when electric motive power has been tried and made successful at the New York end of the road, it will be adopted at Boston.

## President Mellen's Report.

The coming, a year ago, of President Mellen, of the Northern Pacific, to the presidency of the New York, New Haven & Hartford, was a noteworthy railroad event; not only because of the personality of a successful manager but also the unique character of the establishment of which he was to assume charge. The New Haven Railroad was last year 54 years old; it was and is a territorial monopoly; it has been an extremely prosperous corporation. But, in operation it had been defective, even reactionary. There had been no broad and farsighted freight policy; and public sentiment toward the road was not too kindly.

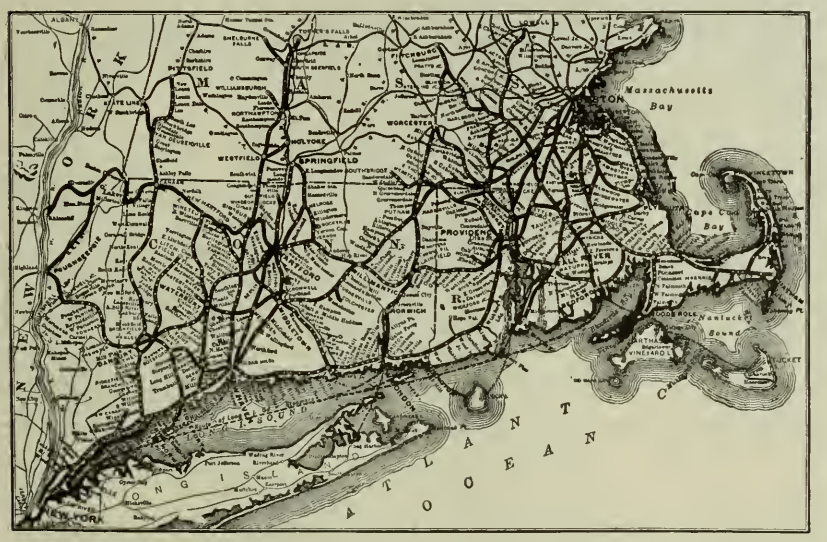
The first annual report of President Mellen now lies before us. He has had to deal with varied and hard problems. There was (1) the full development, so long and carelessly neglected, of freight carrying capacity. The train load had to be increased and Mr. Mellen's Northern Pacific "idea" adapted to New England soil. New cars and engines had to be bought and, to use them, bridges had to be replaced; and terminal grounds acquired, and sidings increased.

There were (2) electrical questions fronting Mr. Mellen in varied and complex shapes. He inherited with the corporation seven electric lines (200 miles of track) bringing in about $700,000 of gross receipts. Some of these, like the Hartford-Bristol line, were profitable, and others, like the Nantasket branch, were essential failures. There were original ventures, such as the self-parallelism of the Norwich & Worcester by the electric road southward from Worcester for some 40 miles into Connecticut. But beyond lay the much more ominous schemes of long distance parallels of combined electric roads, potentially both freight and passenger carriers. This last was much the gravest phase of the many-sided electric proposition.

There was (3) the matter of public sentiment and the attitude of the somewhat heterogeneous New England communities toward the road and bearing directly on its responsibility as a monopoly—a subject closely connected with legislation, neglected suburban development and multiplied branches of public necessity and convenience.

Coming now to the report itself we may fitly refer to its points of information as they apply to the three foregoing heads. Taking up the question of freight development President Mellen outlines results and plans as follows: Many additional side tracks and increased yards; progress in the double tracking of the very profitable Naugatuck railroad; new equipment to the amount of $7,326,781; the Bridgeport four-tracking costing up to date some $4,000,000, with its elimination of many grade crossings; elimination of grade crossings at Fall River; renewal of 107 bridges to standardize the line for heavy traffic; the purchase of the real estate required for two additional tracks through the city of New Haven, giving room for easing grades and curves and increasing head room; and, finally, the purchase of the Central New England road, including the Poughkeepsie Bridge. These are the most important of many improvements in the direction of enlarged freight traffic; and of those which we have enumerated the last three are by far the most suggestive. That President Mellen would attack instantly the road's old defect in rolling stock was to be expected. The enlargement of the New Haven cut, which will cost not less than $1,000,000, will remove a danger point where a comparatively trifling accident would block

almost the whole business of the company; and as to the Poughkeepsie Bridge purchase we may quote the President's own words when he says: "It will be the policy of the company to handle its through freight business by way of the Poughkeepsie Bridge to avoid the delays and expense incident to the present route by way of New York harbor, and the relief afforded the New York Division will enable a more profitable business to take its place." But the purchase of the Poughkeepsie Bridge means a good deal more, which can be read between the printed lines. It forecasts, almost as a surety, future connection with the coal fields —either by a direct line or by an indirect but more expensive scheme of a kind of belt line intersecting the great coal roads. This will be a very costly undertaking but we cannot doubt that it is contemplated. While not mentioned in the report, there should be noted among the changes of bridges for heavier traffic, the prospective early rebuilding of the large Cos Cob, Westport, Housatonic and Warehouse Point structures, and the strengthening of the great bridges at Lyme and New London.




New York, New Haven & Hartford.

*The western terminus of the Central New England is at Campbell Hall, 30 miles west of Poughkeepsie.*

Changes of the kind, though costly and requiring probably two years of time, doubtless commanded quick approval by the directors, as bringing, after completion, immediate returns in net revenue.

The company's electrical policy is touched upon in the most meagre fashion. Brief reference to the great suburban scheme between Harlem River and Portchester with its prospective outlay of many millions; the purchase for $9,666,700 of the Fair Haven & Westville system; the creation of the "Consolidated Railway Company" for control of the electric lines; and a brief word about the financial results of the Fair Haven investment—these short references cover all that Mr. Mellen has to say on a subject which is financially momentous. They mask a plan of concealment which only serves to accent the importance of the thing concealed, and we must again read between the lines.

President Mellen inherited from the Clark-Hall administrations electric properties aggregating 200 miles of track and with annual receipts of about $700,000. His corporation now owns or controls electric properties that include about 350 miles of track and with annual gross receipts of almost $2,000,000. In actual value the electric roads taken in by President Mellen have well nigh trebled the holdings of the corporation. To the Fair Haven & Westville system, it must be recalled, are to be added the Norwich and New London plants, absorbed a few weeks ago and not technically falling within the scope of the report. The effect of the Norwich-New London acquisition is three-fold (1) to thwart any long-distance competition along the shore line; (2) to supply a natural terminal for the company's own electric parallel from Worcester toward Norwich; and (3) when the latter line is pushed through to Norwich to enlarge prospectively the summer excursion business.

In connection with electric expansion should also be noted the accomplished feat of the company of "blanketing" its electric properties under the old Peoples' Tramway charter with its liberal, not to say excessive, powers. By this device the trolley properties in Connecticut are unified and refinanced and room is left for enlargements.

When President Mellen took office in November, 1903, his electric policy was nebulous and he, himself, non-committal. The events of the last five months show clearly that he has taken up the radical policies of his predecessors and gone them many points better; that he is committed to the theory of electric expansion on a large and most progressive scale; and that his company is probably to be bracketed with the New York Central as an American pioneer in the adaptation of electricity to fast and heavy trains, with ultimate gathering, entrainment and redistribution of local passenger traffic. President Mellen does not say all this in his report, but he has said it in effect so often unofficially as to give it official sanction.

In his relations to public sentiment and to the communities along his lines President Mellen has been unfortunate. He took office just at a juncture when public feeling against the road needed, if possible, to be propitiated. Partly as the result of poor coal bought by his predecessor during the anthracite strike, partly in consequence of the bad condition of locomotives, passenger service had become irregular; and an advance in freight rates ordered by President Hall—closely connected with increased wages and demurrage charges—had made the company anything but popular with shippers. If welcomes at board of trade feasts and the compliments of after-dinner oratory could have sufficed, the new president would have been superlatively *persona grata* in southern New England. But the railroad fates sardonically thwarted the best of intentions. The savage winter of 1903-4 kept the service irregular; in the face of falling earnings and the necessity of maintaining dividends on stock increased some $16,000,000 by conversion of debentures and $9,000,000 for the other reasons, the President not only could not give long-demanded improvements in suburban service but was forced last summer to withdraw many trains; and the combination of cheap excursion travel with regular trains has not been pleasant to regular passengers. The wave of unpopularity which has swept against the company and its head will probably be transient, but it certainly is broad and deep. Its most serious aspect is its bearing on legislation next winter when the company seeks for modification of the Connecticut four-days' car detention law.

Turning to the fiscal side of the report we tabulate, omitting cents, some of its more important entries in comparison with last year.

| | 1904. | 1903. |
|---|---|---|
| Miles operated, June 30... | 2,031 | 2,037 |
| Gross earnings. ..... | $48,282,909 | $47,296,078 |
| Passenger earnings ..... | 23,425,173 | 22,953,018 |
| Freight earnings ..... | 24,413,541 | 23,926,150 |
| Miscellaneous earnings.. | 444,195 | 416,909 |
| Passengers carried ..... | 63,130,459 | 63,714,199 |
| Passengers carried 1 mile. | *1,135,702 | *1,114,313 |
| Rate per pass. per mile.... | 1.725 cts. | 1.729 cts. |
| Freight (tons) carried.... | 17,560,485 | 18,283,733 |
| Tons carried 1 mile ..... | *1,661,382 | *1,627,858 |
| Av. No. pass. in train..... | 71 | 71 |
| Av. tons freight in train... | 208 | 218 |
| Operating expenses ..... | $35,159,211 | $34,955,024 |
| Maintenance of way, etc.. | 5,467,201 | 6,237,722 |
| Maintenance of equipm't | 4,703,873 | 4,189,919 |
| Conducting transportation | 23,911,347 | 23,587,106 |
| General expenses ..... | 1,076,790 | 940,276 |
| Net income ..... | 14,030,134 | 12,906,871 |
| Interest on bonds ..... | 779,667 | 1,137,052 |
| Other interest ..... | 279,993 | 52,912 |
| Rentals ..... | 4,420,283 | 4,504,546 |
| Taxes ..... | 2,455,434 | 2,385,390 |
| Eight per cent. on stock... | 6,006,448 | 4,618,438 |
| Assets ..... | 136,436,894 | 114,971,686 |
| Road and equipment.... | 61,363,137 | 61,809,871 |
| Stocks of leased lines... | 16,394,092 | 14,399,292 |
| Stocks and bonds ..... | 25,542,994 | 9,757,468 |
| Miscellaneons ..... | 33,136,671 | 29,005,055 |
| Liabilities ..... | 136,436,894 | 114,971,686 |
| Capital stock ..... | 80,000,000 | 70,897,300 |
| Paym'ts on new cap. stk | ..... | 8,325,780 |
| Conv. debenture certs.... | 185,300 | 185,300 |
| Funded debt ..... | 9,639,000 | 4,364,000 |
| Debentures not convertible | 24,666,700 | 10,000,000 |
| Miscellaneous ..... | 7,296,857 | 7,969,740 |
| Profit and loss ..... | 14,649,037 | 13,819,566 |

*000 omitted.

NOTE.—The gross earnings of the steamboat lines were $4,591,145 in 1904, as compared with $4,668,-031 in 1903.

The increased funded debt is to be set off chiefly to the purchase of the New Haven trolley roads and of the Central New England. New stock to the amount of $1,994,800 was issued for stock and bonds of leased lines, perpetuating the old policy of consolidating the system.

Probably for prudential reasons connected with the labor unions President Mellen makes only the briefest allusion to the strikes on his system; but they were no small factor in his first year's troubles, and his firm and successful stand on principle against the strikers in his marine department is a feature most creditable in his record. No returns are given of the results of operation of the electric roads; and none of the operation of the Sound steamers, except in the note quoted above. Both are now integral parts of the system and fuller statements should be made, both for the shareholders and the public. As to the general administration of the property the former, at least, have grounds for deep satisfaction that, through many hardships, their President has been able to sustain their dividends.

President Mellen began his official work

early in November of last year. His first report, therefore, covers formally but eight months of his administration; and a period of 11 months shows his administration and policy down to the present time. But the year, though incomplete, has been long enough to be singularly picturesque, not to say dramatic. When a new railroad President is compelled to front in his first twelvemonth the hardest New England winter of half a century; labor troubles of a peculiarly complex and vexing character; reconstruction on a great and costly scale; the absorption of a new steam railroad system; the definite adoption of an electric policy involving the vital "yes" or "no" on the question of absorbing extensive plants—when to these is added a sudden and unlooked for falling off of business in the territory served, and reduced train service arousing public anger and antagonism—then such a railroad administrator surely has had his full share of hard experience in ratio to time of service. The fulfilment of President Mellen's large plans is not yet, and probably years must pass before even one of them is compassed fully. It is a time of radical transition in the history of a remarkable railroad which has been prospered in past years, almost in spite of itself. But, whatever the outcome, the first year of President Mellen's headship has had a fertility of incident and a pace in the evolving of policies which leave even the liveliest years of President C. P. Clark far behind.

## Lehigh Valley.

The Lehigh Valley produced in the year ending June 30, 1904, a net income of $5,112,000, equal to 12.6 per cent. on the capital stock, and $3,104,000 larger than the year before. The income account shows:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Gross earnings | $29,881,738 | $26,654,503 | $3,227,234 |
| Op. expenses | 18,870,301 | 18,980,179 | *109,878 |
| Net earnings | $11,011,436 | $7,674,323 | $3,337,113 |
| Other income | 505,477 | 637,592 | *132,115 |
| Total income | $11,516,914 | $8,311,916 | $3,204,998 |
| Dedu | | | |
| Ad | $1,465,290 | $1,266,182 | $199,108 |
| Pacific at Sintalu | 779,110 | 2,806,925 | *27,815 |
| nipeg, due to a mis | 4,286 | 2,950,546 | 33,740 |
| trance to a side track | 667 | 176,673 | *144,004 |
| passengers were killed | $7,200,326 | | $61,026 |
| taluta case the Montreal | $895,918 | | *$39,481 |

In the Richmond disaster, and the many other 'accidents' the Railway Commission, not onl but of founding upon the evide stringent set of regulations, with for disobedience of the same. The mission, too, would find it a good vestigation as to how far it is true railway officials wink at disobedience on the part of the men as long as there accident. The men will assure you, on s ways, that the rules are all right if the m permitted to live up to them. But an en who followed the rules exactly would make time, and would (so they say) be 'pulled' from engine for a week or a month as a punishme They therefore 'take chances' and disregard rul with the knowledge of the officials. . . . A other thing in which reform is needed is in the in quiry by a coroner's jury. Many people would, indeed, to-day, in all cases of seriousness, abolish the coroner's jury altogether. The services of the jurymen are naturally given grudgingly, as it is forced and unpaid labor; the jury is inexpert and haphazard in receiving and rejecting evidence and in arriving at conclusions. Half the time there are no conclusions, and the other half the conclusions of a jury are not carried into effect. If all railroad accidents were investigated by a commission of experts, as in the case of wrecks at sea, and the blame duly apportioned, that would be a step in the right direction; but a step which should keep it close companionship would be one by which adequate punishment should follow criminal negligence, however, 'high up' the criminal might be. Various attempts have been made to pass legislation having this purpose, but railway influence is strong at Ottawa on both sides of the House, almost every member enjoys direct favors at the hands of the railway, and nearly all such legislation is blocked. The most of these slaughters could be prevented if legislators were determined."

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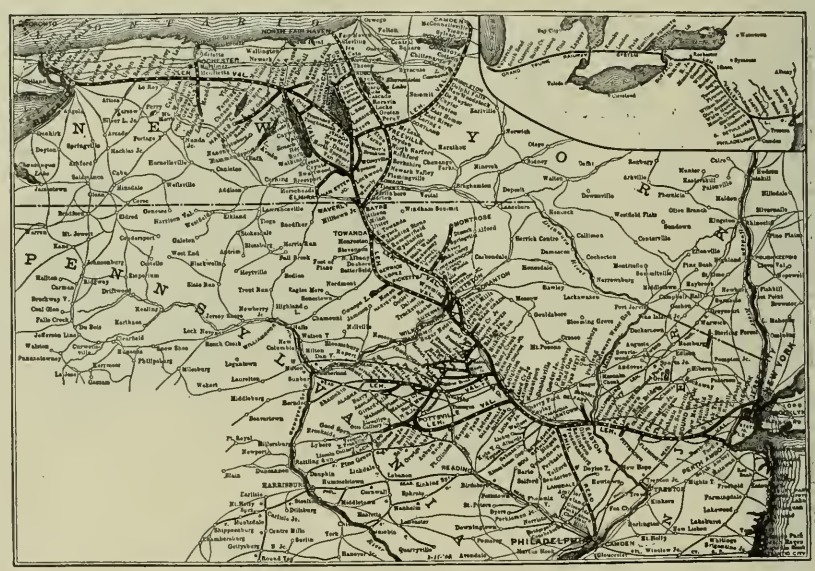
of tonnage that increased the ton mile revenue from 5.98 mills to 6.37 mills, or about 5 per cent. Dismissing the commercial side of operations and passing directly to expenses we come upon the central feature of interest. On the face of it Lehigh Valley shows a decrease in expenses with an increase in business, while almost all other roads so far reporting, barring a few notable exceptions, show an increase in expenses, generally large, and with or without an increase in business. But we find that this net decrease in expenses of a round $110,000 came about by a decrease in maintenance of a round million, and an increase in transportation expense of $900,000. In this view the decrease in expenses is a different matter. The amount withdrawn from maintenance of way was about 25 per cent. of the expenditure in the preceding year. This is not necessarily a basis for criticism but it entirely restates the significance of the decrease in expenses.

From the operating standpoint the increase in cost of conducting transportation



Lehigh Valley.

is noteworthy. The entire volume of freight traffic increased about 7 per cent., while transportation expense increased 10 per cent. The year was marked by an unusually severe winter, but the expense of the year previous with which the comparison is made was itself very heavy. More than that, the heavy outlay of the year and past year for better roadway, more modern power and larger cars, and the larger proportion of coal tonnage, which is cheap to handle, are offsetting factors which should in very large degree compensate for a hard winter. The ransportation officials were able to add only bout a half ton to their train load. Imlovement is usually to be expected in transa tation results by the mere process of pe vth, and from the use of constantly bet- l facilities; and the absence of such imtim ment is in itself a matter of remark. bee the whole the financial outcome of the trac is good, but it is not as large as apexpe from the income account. The consoon g factors that are largely due to compa causes have been favorable. The urban within the control of the manageton, but far as they have had result, have The gist l to reduce the advantage gained tonians a e causes. tive powe

Some of the more important statistics are as below:

| | 1904. | 1903. | Inc. |
|---|---|---|---|
| Average miles operated | 1,392 | 1,392 | .... |
| Gross earn'gs,mile of r'd | $21,456 | $19,146 | $2,310 |
| Freight earnings | 24,829,777 | 21,714,471 | 3,115,306 |
| Passenger earnings | 3,155,715 | 3,191,639 | *35,924 |
| Pass. miles, thousands | 182,373 | 170,118 | 12,255 |
| Passengers per train | 48.8 | 45.1 | 3.7 |
| Pass.-mile, revenue | 1.73c | 1.87c | *.14c |
| Ton-miles, thousands: | | | |
| Coal | 1,765,612 | 1,360,804 | 404,808 |
| Freight | 2,130,890 | 2,271,677 | *140,787 |
| Total | 3,896,502 | 3,632,481 | 264,021 |
| Tons per train | 486.15 | 485.52 | .63 |
| Ton-mile, revenue | .637c | .598c | .039c |
| Frt. train mile, revenue | $3.098 | $2.902 | $0.196 |
| Av. haul, miles | 177.8 | 182.3 | *4.5 |

*Decrease.

On June 29, the directors declared a dividend of 10 per cent. upon the preferred stock, and a dividend of 1 per cent. on the common stock. This dividend was not payable until August 1, and therefore does not appear in the report. As there is now outstanding $40,334,800 of common stock and $106,300 of preferred stock the combined dividends amounted to $404,411. Subtracting this sum from the total net income of $5,111,997 shown in the report there remains a net income of $4,707,586.

Lehigh Valley is especially interesting to operating officers, because it has been put through a severe process of rehabilitation. Prior to 1893 the road was one of the most prosperous in the country. Asa Packer, the father of the property, had dominated its policies for years, taking the public into his confidence very little. As an old canal boat-owner on the canal that carried anthracite coal to market his first conception of the railroad which he had built was as an outlet to his coal mines. He yielded awkwardly to the logic of events which forced the extension of his line across the State of New Jersey to tidewater at New York. When President Wilbur succeeded to control, the established traditions were but little changed. The road was extended to Buffalo on the west and fell into its place as one of the trunk lines; but its established dividend rate was too high and all the fixed tendencies of a generation of isolated growth swept it on to the inevitable break when dividends were suspended and prosperity paralyzed.

After a few years of aimless policy the road fell into New York hands, and Mr. Al-

fred Walter was put in charge. President Walter came to his task with the rich equipment of a Pennsylvania apprenticeship, widened and made available by experience as general operating officer on the Baltimore & Ohio and the Erie. With a vigorous mental grasp and a forceful personality, he conceived and executed on masterful lines. His financial backers did not come forward with the money which the property sorely needed for its renovation, and he was forced to draw it from earnings. Having become convinced as to the only possible policy, he set himself to its execution with a singleness of purpose and devotion to his trust, from which neither clamor nor pressure could swerve him. For six years he held inflexibly to this course and only yielded at last by resigning when the stockholders who misunderstood him could be patient no longer. For only six weeks of these six years did he in any sense have the pleasure of operating the property under some of the conditions he set out to create. But his wisdom and prudence have borne rich fruits. Achievements such as these lift the art of railroading to the level of a profession.

President Thomas, with his great experience, discretion and energy, has taken up the work with vigor as it was left by his predecessor, and while carrying forward the plan of physical renovation has won again the confidence of the stockholders. He has worked out a plan of financing the property for many years to come. Lehigh Valley after its long period of suspended dividends has by safe guidance come again to its own.

## Lightning and Automatic Block Signals.*

BY H. S. BALLIET.

There are two kinds of failures of automatic block signals due to lightning; failure of signals to assume the stop position when the block section is occupied, thereby imperiling trains, and failure of signals to indicate proceed and the consequent delay to traffic.

Platinum was used almost exclusively for contacts on track relays until within the last five or six years. With these contacts there is danger of their becoming fused when lightning discharges of high potential and volume pass through them, thereby preventing the relay armature from dropping and opening the signal circuits, thus causing a clear signal to be improperly displayed.

Either plain commercial carbon or carbon

Fig. 1—Choke Coil.

with copper or silver plating (to reduce the resistance of the contact) is now furnished on all relays unless otherwise specified. These carbon contacts are seldom fused; only when the plating is too thick and a discharge of very high tension is delivered through them. To assist in meeting this latter contingency, the wires (commonly called spider wires) leading from the relay springs and fingers to the various binding posts are made of copper wire of .020 in. diameter (No. 20 B. and S.) which usually melts if subjected to a current of 18 amperes for five seconds, thus opening the circuit and guarding against a false signal indication, even though the point should become fused.

For the second class of failures—non-dangerous stoppages of trains due to open circuits—there are several causes. The most common is the destruction of the relay, the clutch or the signal magnets by lightning "burning out" the windings of the electromagnet, thus causing the armature to open the controlling circuits. If fuses are used, they may or may not be "blown" or "burnt out" depending upon the amount of current delivered through them, their capacity and

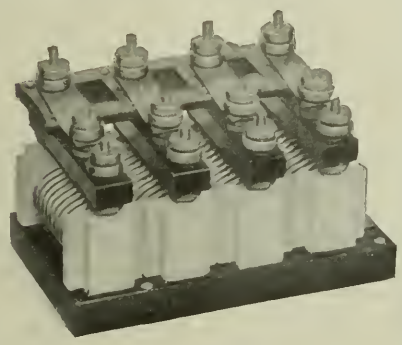


Fig. 2—Lightning Arrester.

the time required to burn them out. A line wire may burn off on account of the excessive discharge, or the spider wire on the relay finger and the springs may be burnt off. An effort is being made to intercept or "arrest" the discharge before it can reach these weak parts. There is at this time no absolute means of protecting these controlling mechanisms from heavy discharges. There are, however, in service a great variety of so-called "lightning arresters," and there is no doubt that each design has its own particular good point for certain special demands. I have tried a great many designs of arresters on automatic block signal apparatus, and at times it is difficult to definitely

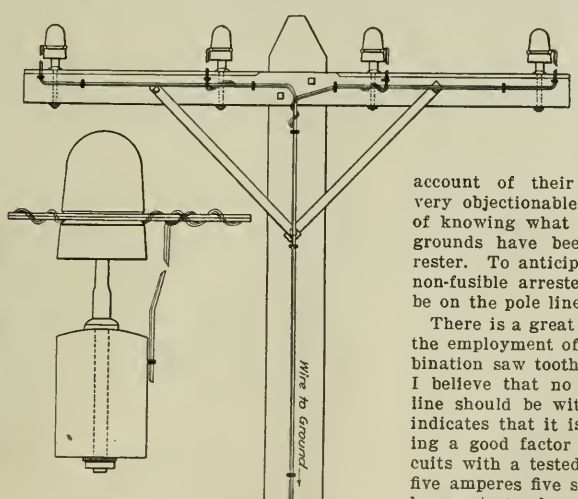



Fig. 3—Cross-arm Lightning Arrester.

state which is preferable. From a careful record for eight years the conclusion seems warranted that the comb or saw tooth arrester, if made so as to be compact and if mounted on a slate base (wood bases warp and close up the air gap) will divert the greater part of the discharge provided, of course, that the ground connection is satisfactory.

Much has been said about the weak points in choke coil arresters; but it must be said that such arresters are makinng for themselves wonderful records. If the ground connection is good and the ground wire of sufficient capacity to carry off the discharge not less than .085 in. (about No. 12), little or no abnormal current will reach the instruments.

The most efficient choke coil thus far tried is made like Fig. 1. If this arrester is properly mounted on a slate base with a large ground plate surface, and the windings around the porcelain and iron core are far enough from the ground plate to allow clearance for two sheets fooiscap paper, very little discharge passes beyond the choke coil.

As it is not satisfactory to depend entirely on either the saw tooth or the choke coil arrester a new arrangement was designed, Fig. 2. This arrester combines both the saw tooth and the choke coil in one.

The arrangement now deemed the best available is somewhat on these lines: Bring the line wire side to saw tooth, from there to the choke coil and thence to the apparatus. Preferably the saw tooth should be connected to the rails, and the choke coil to the ground. This arrester has been known to divert 85 per cent. of the discharge when all conditions are favorable. Cases are on record (the arresters are still in evidence) where the discharge was so heavy as to melt off three or four .085 in. copper wires, which are wound around the porcelain and iron core, on account of the arcing to ground; while the saw tooth showed scarcely a burn. This is apparently due to the fact that there is a better path to ground than to track. In some cases it has been found that most of the discharge flows from saw tooth to track, causing a general derangement of the teeth, some being melted and entirely destroyed.

The principal objection to putting an arrester on a signal pole, signal or relay case is the liability of burning off the wires leading to the instruments, because the lightning passes through the arrester in an effort to complete the circuit. To place the arrester on the crossarm or near the top of the line pole—which is the old way—encourages maintainers to neglect close inspection on account of their inaccessibility. This is very objectionable because there is no way of knowing what points are fused or what grounds have been introduced on the arrester. To anticipate some of these evils, a non-fusible arrester is desirable. It should be on the pole line.

There is a great diversity of opinion as to the employment of fuses in addition to combination saw tooth and choke coil arresters. I believe that no circuit coming from the line should be without a fuse. Experience indicates that it is a happy medium affording a good factor of safety to fuse all circuits with a tested fuse capable of carrying five amperes five seconds; this if using carbon contact relay points; if platinum points are used a fuse of one ampere capacity is sufficiently high. With a five-ampere fuse the safety factor is always maintained, and not so many fuses are blown by sneak currents; and there are fewer train detentions due to blown fuses. When .020 in. wire is used for spider wires on relays, its carrying capacity is found to be too low for the five-ampere fuses and this wire must be .025 in. This does away with the annoyance of relay renewals except in case of a direct stroke of lightning.

No fuse wire should be allowed to remain

*Articles by Mr. Balliet on the performance of automatic signals under unfavorable conditions were published in the *Railroad Gazette*, of Feb. 26, March 25, April 15, May 20, July 1, July 8, Sept. 2 and Sept. 9.

in service over one year, because its resistance increases with age and it is liable to become very unreliable. The better plan is to select copper wire which will fuse at a point equal to that of the lead and alloy fuse wires above described, then the renewals never need be made. The connections holding this wire should receive a regular inspection the same as the rest of the apparatus. Then again this wire will not break so readily; the breaks in ordinary fuses are somewhat annoying.

Tests which have been kept up for three years indicate that it is unnecessary to apply fuses to track circuits, they only introduce unnecessary complications by increasing the resistance. Thus far this year, the Lehigh Valley has had four relay magnets, connected to track, burnt out in their windings; and in each case, there was a well defined mark left on the relay base, clearly showing that the discharge was from line to track.

For a number of years lightning played considerable havoc with relays because the discharge arced from the line finger across to the armature plate, to pole pieces of relay, thence to track. This has been anticipated by increasing the air gap between the points. Any number of relays have been ruined by lightning arcing from relay fingers attached to line, thence to the binding post connected with the track; this air gap has been increased and this source of interruption anticipated.

Before rain sets in, the path to the ground through the track is better than that across the great air gaps which exist in the connections to the ground wires.

In order to intercept the discharges which continually tend to flow to ground by way of the arresters, a new application of pole arrester was installed three years ago on a territory eleven miles in length, and the results are better than could have been expected. The arrester or lightning rod, Fig. 3, is constructed of .100 in. hard or soft drawn bare copper line wire. The wire is stapled to the telegraph pole and run to the ground. The crossarm is fitted with legs soldered to the main ground running parallel with the arm; and branch arms extend upward toward the line wire. These are also stapled firmly to prevent shifting. Every signal wire supported on the arm has a branch copper wire soldered to it. This wire is tied to the insulator to prevent shifting when high winds sway the wires and poles. This latter wire is run about ¼ in. below the bottom of the insulator, and is placed directly over the wire connected to the ground, being separated from it between ⅛ in. and ¼ in. These latter connections are attached to the main line wire before it passes around an insulator to be dead ended, or before the terminal leading to the relay or signal case. The object is to discharge as much of the lightning as is possible before it can reach the fuses and the apparatus. Lightning has arced this air gap so successfully that it was necessary to raise the lower leg and close the air gap thrice in one season on upward of 20 poles. The wires forming the arrester are cut diagonally so as to form a point, somewhat after the principle of a lightning rod point. These arresters are so placed as to average one set for every line wire about every quarter mile throughout the Lehigh Valley lines.

This new arrester is installed in conjunction with an arrester of the type shown in Fig. 2. The pole arrester is placed on its own ground, the saw tooth on track, and the choke coil on a separate ground. The territory where this protection is used is on top of a mountain, along its western slope, thence through rocky, then marshy country, into a coal district, through numerous glens and gulleys to the bank of a river. This territory has been visited by many lightning storms and there was a great deal of detention to trains by the burning out of fuses up to the time of the revision three years ago. In these three years, there have been no failures due to lightning discharges until two months ago when, as an experiment, the saw tooth and choke coils were cut out. During the time that these were out of service three relays were disabled by having their spider wires burnt off. The saw tooth and choke coils have been restored and no further trouble has been experienced.

It is found that track relays wound with .036 in. wire (No. 19) are very seldom burnt out owing to the high carrying capacity of the wire.

No ground wire should be of less diameter than .165 in., and all ground wires should be of copper. Iron rusts off at the ground line. All grounds should be inspected once a year.

There is much discussion about the difficulty of getting good ground wire connections. At times it seems almost impossible to get a good ground. Generally speaking, however, a coil of copper wire, about six turns with a diameter of 2 ft., set into good soil 6 ft. below the surface will do the work. In very poor or rocky soil, it is well to use charcoal or coke to more surely retain moisture. Grounds are made by driving galvanized iron pipes into the ground to various depths; this, like the 4 ft. wrought iron stake, is satisfactory only as a temporary ground. Some railroads have adopted standards for making grounds. These are not all alike, but all aim at the same thing—a connection to damp or moist earth about 6 ft. below the ground line.

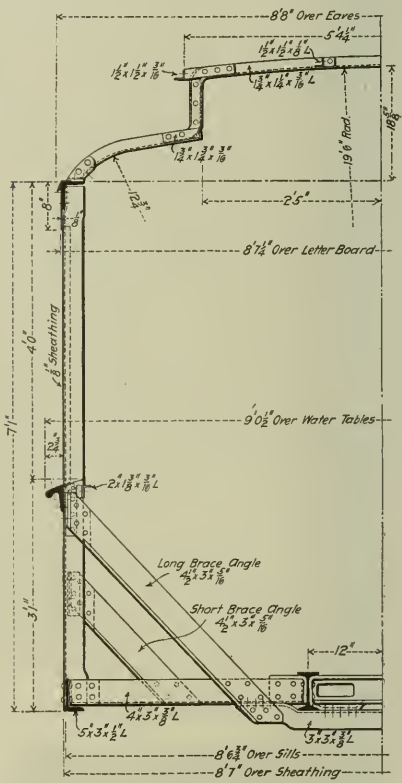
There is a peculiar and unexplained interruption in the working of automatic block signals. A train will find a given signal at stop while there is nothing in the block and all the relays are holding up properly, still there is no current to operate the signal or its controlling magnets. I have seen this condition a number of times at different points along the line during the progress of a thunder storm. The freak, if so it can be called, is perhaps partially explained by the fact that the galvanic current of an electrical circuit may be opposed and counteracted by the successive electrical movements attending lightning discharges. The air seems to be so completely saturated with electricity as to neutralize the currents delivered by the primary cells.

To convey the impression that thunder or lightning storms are only prevalent in the summer would be wrong. Every winter, either with or without snow on the ground, signals situated on some mountain ranges are visited by very heavy lightning storms. Quite often much damage is done to the apparatus. For three seasons in succession such storms have been observed to be more severe than any storms recorded at the same place during the summer. But there are only one or two storms in a winter, whereas probably a dozen occur during the summer months.

## Steel Cars for the New York Subway.

About two years ago the engineers of the New York subway undertook to design a suitable car for use in the tunnels. The cars in use on the elevated lines having been found to be about as satisfactory a general design as could be found, they were taken as a basis for the new cars which were to be built. In a general way the conditions of traffic and congestion at stations were assumed to be the same in the subway as on the elevated lines. The clearances in the tunnel were very limited both as to height and width, and the sharp curves prevented the use of a car of exceptional length. There was, further, the added difficulty of designing a car which would be practically collision proof and fireproof, because, in the event of accidents either because of a collision or a fire due to short circuits the results would be far more serious than on the surface or elevated lines, as was shown by the disaster in the Metropolitan Underground of Paris.

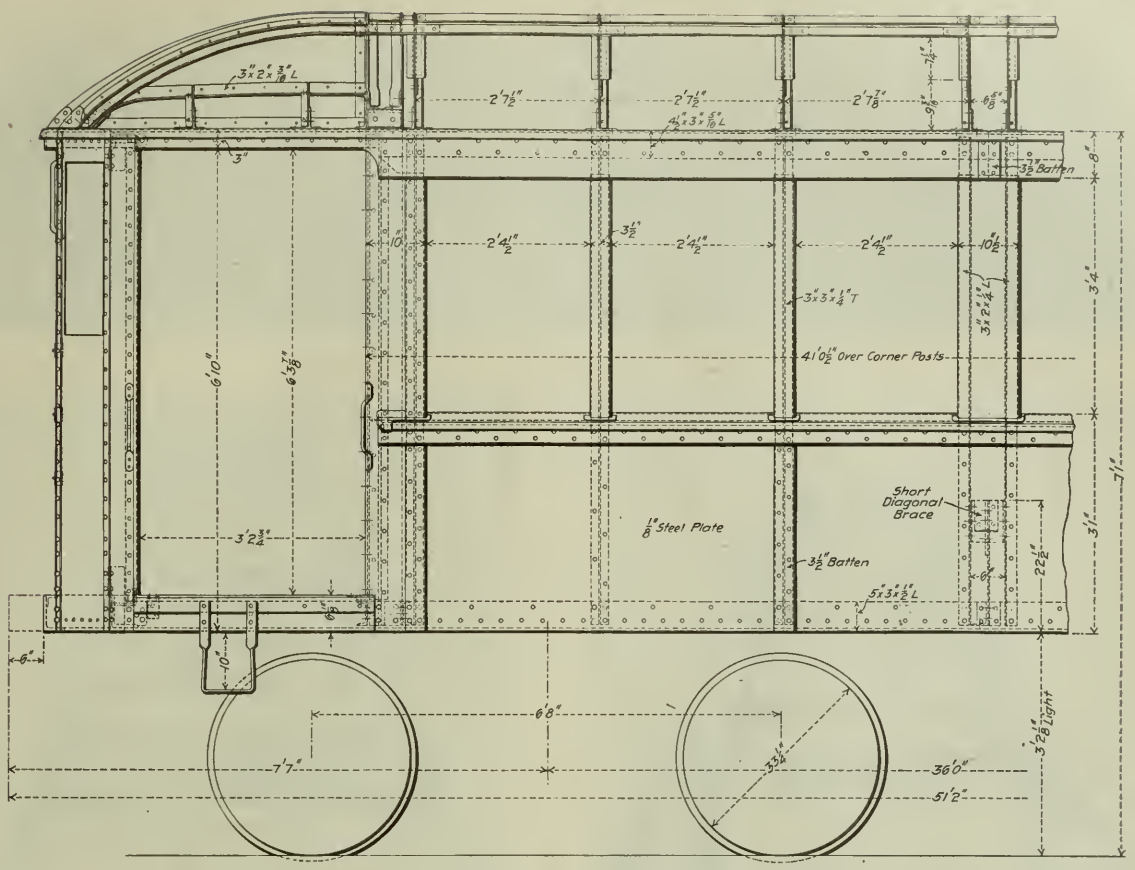
The first cars which were built for use in the subway had steel underframes and were much more substantial throughout than the standard elevated cars. The side sheathing was made of copper-sheathed timber with the view of making the cars practically fireproof from external flames. The chief difference between these cars and the cars built expressly for the elevated lines was that the subway cars had closed platforms with sliding entrance doors instead of platform gates, and



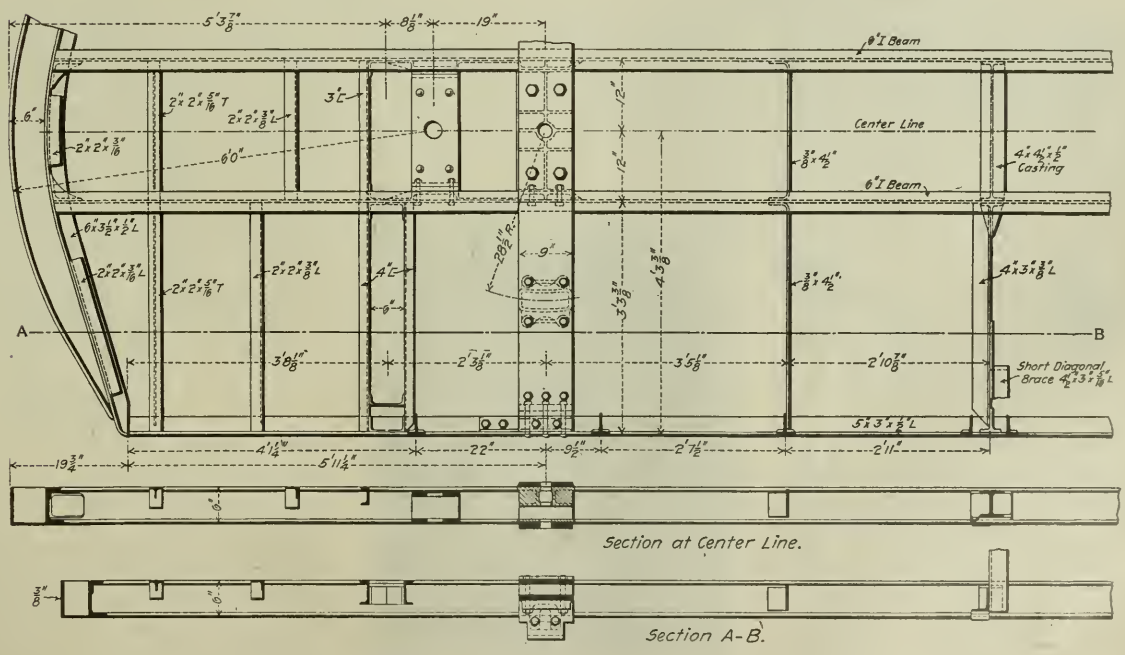

Half Cross-Section of Steel Car.

that they were built with a batter to the sides which gave about 8 in. additional width to the aisles without increasing the width at eaves. About 500 of these cars were built the order being divided between the Wason Manufacturing Company, the Jewett Car Company, the St. Louis Car Co. and the John Stephenson Company. Many of them have been used on the elevated lines, pending the opening of the subway. These cars are practically fireproof so long as the wood does not get splintered and exposed by the removal of the copper sheathing. They would probably suffer little damage from a fire breaking out under the car due to short circuits in the motors, since the floor is protected with layers of asbestos and fireproof felt, but in the event of a collision and the consequent splintering of the woodwork which would take place they would probably be but little less fireproof than the ordinary design of wooden car.

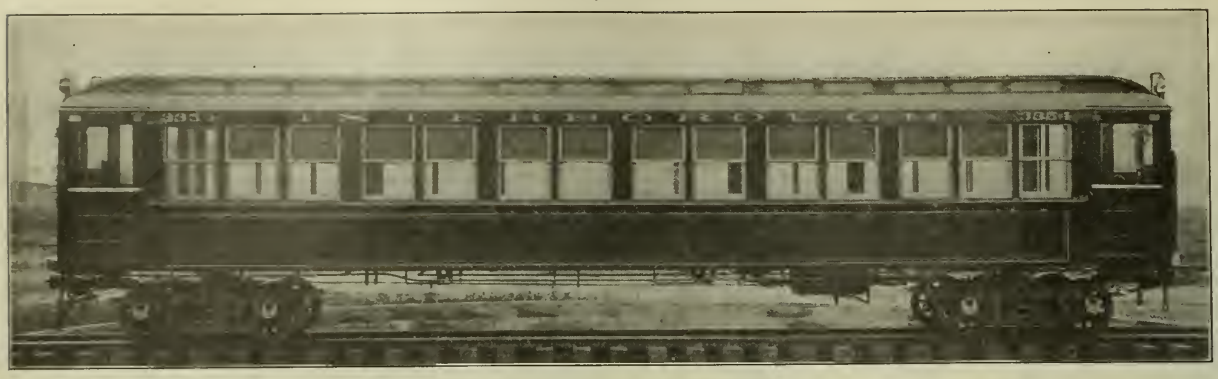
Mr. George Gibbs, the Consulting Engi-



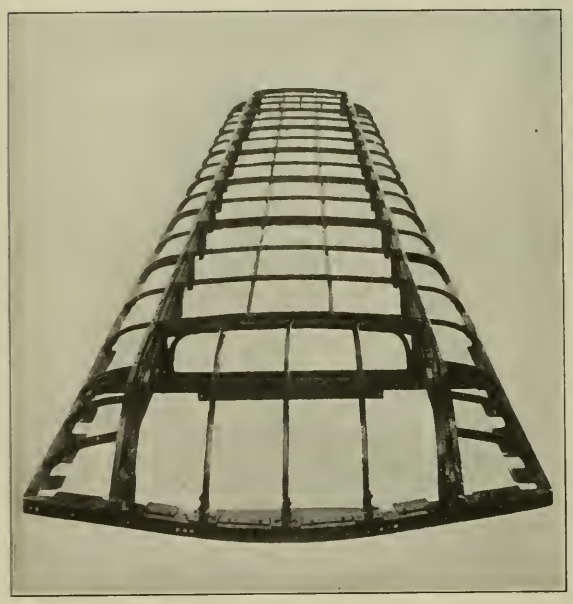

Part Side Elevation of Steel Car for the New York Subway.



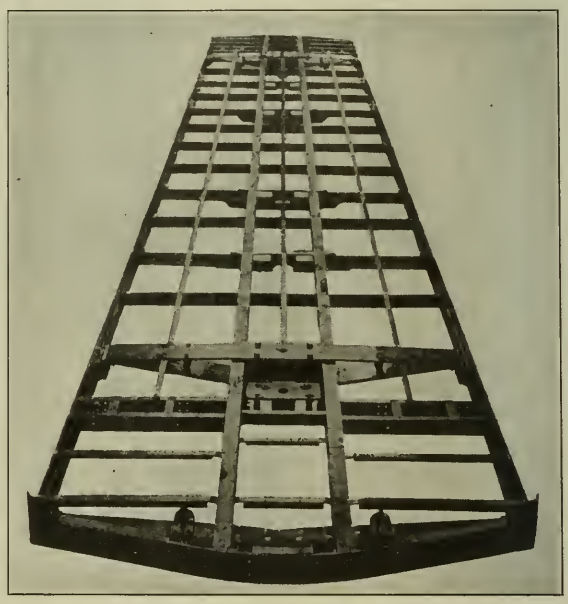

Plan and Sections of Steel Underframing for Subway Car.



Side Elevation of Steel Car for the New York Subway.

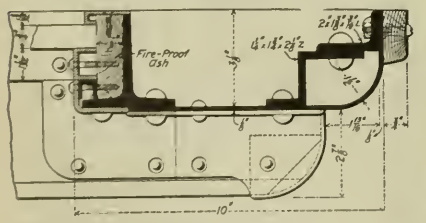


Roof Framing of Subway Car.



Underframing of Subway Car.

neer for the subway company, conceived the idea of departing from previous practice in car building in a radical manner, and some time ago undertook to design a car built almost entirely of steel and non-combustible material. After the first design had been completed, an experimental car was built at the shops of the Pennsylvania Railroad at Altoona, Pa., and was given a severe test to determine its riding qualities and its strength. In erecting this car a number of

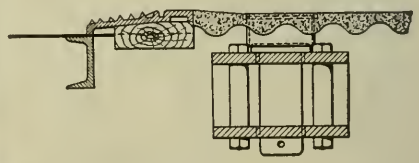



Section through Door and Corner Posts.

difficulties were encountered due to some of the details of the design. Before any large order was placed the plans were revised and a number of changes made in them which would lessen the cost and difficulty of manufacture. About eight months ago 200 of these cars were ordered from the American Car & Foundry Company to be built at its Berwick, Pa., plant, and an additional order for 100 cars was placed about two months ago with the same company. Most of the cars in the first order have been received and are now being run in the instruction trains in the subway and also in some of the regular trains on the elevated lines.

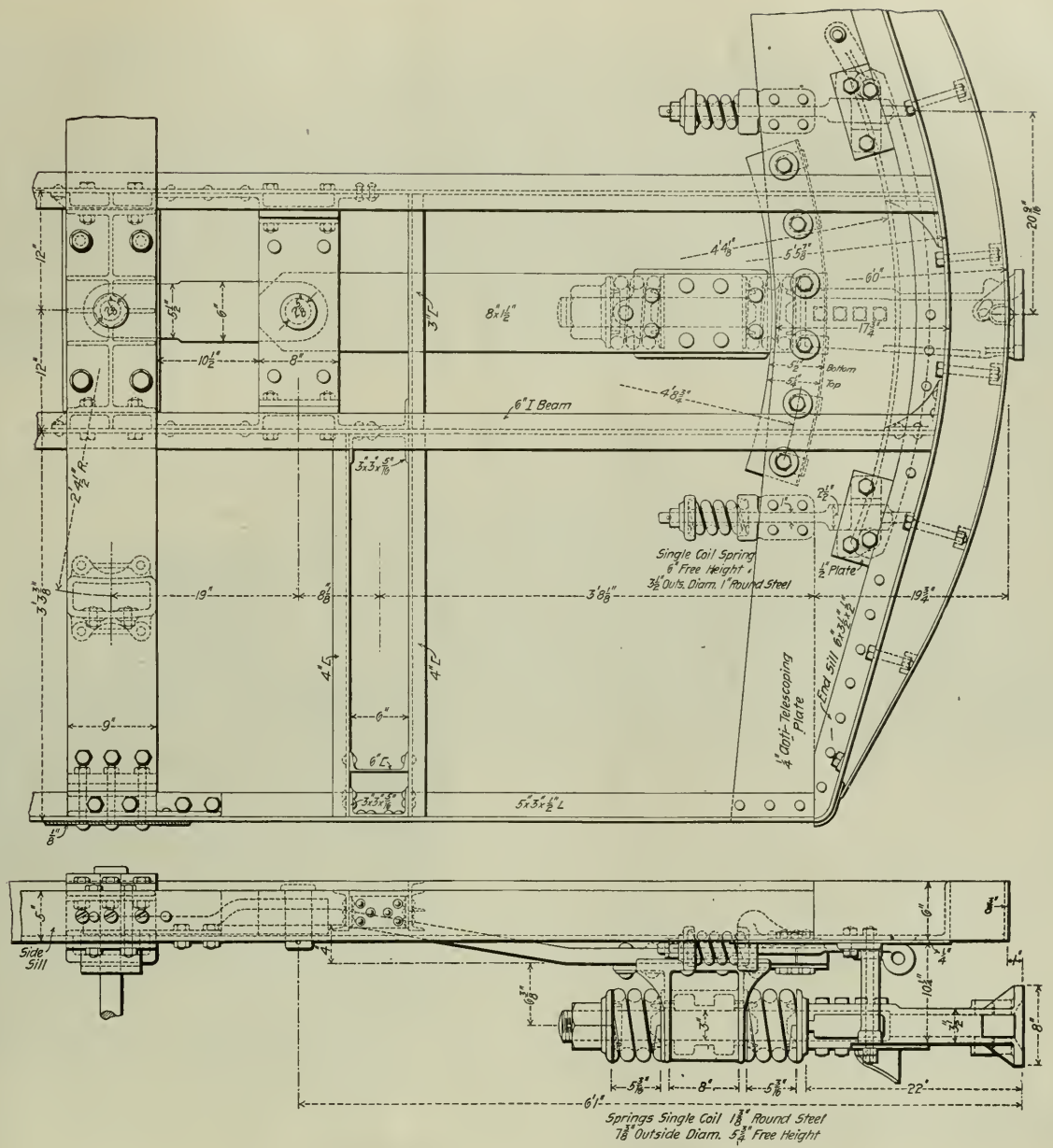
The accompanying illustrations show the general design of the cars and some of the most interesting details of their construction. They are 51 ft. 2 in. long over platform end sills and 36 ft. center to center of trucks. The width at eaves is 8 ft. 8 in., and the maximum width over the water tables under the windows is 9 ft. ½ in. The height from top of rail to top of roof is 11 ft. 11½ in. The sides are vertical and because of their thinness as compared with the side framing of the first design of wooden cars which had battered sides the same width of aisle is obtained, with no greater width at eaves. The underframe is composed of

End View of Car.



Detail Showing Method of Laying Monolith Floor.

two 6-in. I-beam center sills, which are continuous from platform end sill to platform end sill, and 5 in. x 3 in. x ½ in. angles forming the bottom flange of the deep plate girder sides, which are depended upon to carry most of the load. The center sills are spaced 24 in. apart and are separated by 4 in. x 4½ in. x ½ in. castings of an I-section and by ⅜ in. x 4½ in. tie straps. The body bolsters are made up of two flat plates 9 in. x 1 in., which are carried over and under the




Plan and Side Elevation of Van Dorn Draft Gear for Subway Cars.

center sills, with a cast steel filling block in between, which forms the socket for the king pin. The body end sills are made up of a pair of 4 in. channels, built in between the longitudinal sills. They are entirely separate members and are not an integral part of the underframing. The platform end sills are 6 in. x 3½ in. x ½ in. angles bent to a radius of 5 ft. 6 in.

The side framing of the car, which carries most of the load, is made up of the 5 in. angle at the bottom and a special bulb angle running the length of the car body just under the windows, with a ⅛-in. steel plate side sheathing to form the web of the girder. The girder thus formed is stiffened vertically by the 3 in. x 3 in. x ¼ in. T-iron posts, which extend from the bottom of the sides up to the deck. These are spaced 2 ft. 7½ in. center to center. The side frame is braced to the underframe with the diagonal braces shown in the cross section. These braces are placed at each of the double posts and carry the floor load to the side girders, thus permitting a light floor construction. The short brace, which is a 4½ in. x 3 in. x $^{5}/_{16}$ in. angle, extends from about half way up on the plate girder side down to the intermediate cross tie of the underframe. The long brace extends from just under the window down to the main cross bearers near the center sills, and is concealed inside the car by the back of the cross seats. There are two short braces and two long braces on each side of the car.

The roof framing is made up entirely of light angles bent to fit the curve of the deck. The shape of the deck is rather shallow, and this gives the cars the appearance of having considerable head room.

The platform of the steel cars, which is of the Gibbs type, is longer than that on the wooden cars which were built and the entrance doors have been made 10 in. wider, which greatly facilitates the movement of passengers in and out of the car. The platform is entirely enclosed and has a window in each side in addition to the glass in the doors. An end door is cut through the middle of the end of the platform to permit passengers or trainmen to walk through the train. The motor controlling apparatus and engineer's brake valve and a vertical hand brake wheel are mounted against the end of the platform.

One of the illustrations shows a section through the end door posts. It will be seen that some small amount of wood has necessarily been used here to finish off the post. Such wood as has been used is ash, impregnated with a fireproofing compound which renders it practically incombustible. When exposed to flame it will char but will not ignite. Some little wood has been used in the interior finish around the windows and in the lower part of the deck, but this has also been fireproofed, and all of the wood in the car taken together represents only a small proportion of the total amount of material used.

The floor of the car is made of a composition known as monolith, about 1½ in. thick,

laid on corrugated iron which rests directly on the underframe. The seats are arranged as in the cars used on the elevated roads, with four pairs of transverse seats in the center and longitudinal seats along each side for the remainder of the length of the car, giving a seating capacity for 52 persons with standing room in the aisles and on the platform for as many more. The seats are upholstered with rattan, but the framing which supports them is entirely of steel. All of the interior trimmings, panels and head linings are aluminum throughout. The exterior surface of the car has a smooth appearance, and is painted the standard maroon of the Interborough Rapid Transit Company. For a complete description of the trucks under these cars the reader is referred to the *Railroad Gazette* for June 17, 1904, and for a description of the motors and electrical equipment to the *Railroad Gazette* for April 3, 1903. We are indebted to Mr. George Gibbs, Consulting Engineer of the Interborough Rapid Transit Company, for the illustrations furnished.

## Railroad and Industrial Courses at Wharton School.

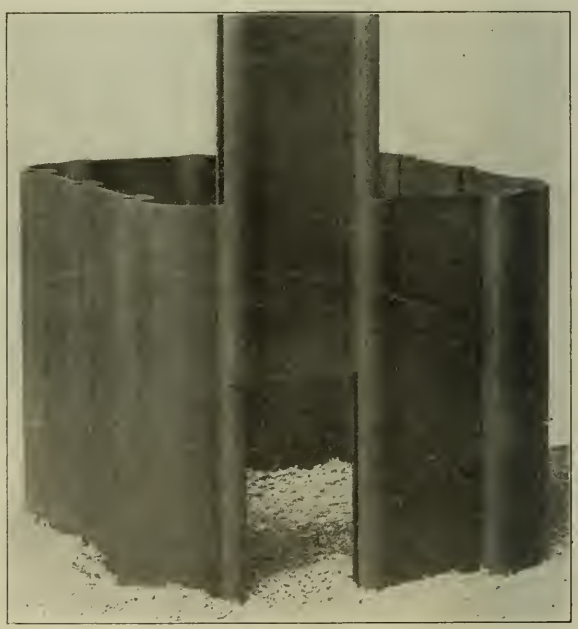
Mr. Joseph Wharton, the founder of the Wharton School of Finance and Commerce, of the University of Pennsylvania, has recently raised the endowment of the school to $500,000 and the school has been reorganized. A large number of specialized business courses are to be offered at the opening of the college year on September 30th, with a view to fitting young men directly for their prospective business careers. In the first two years the work includes besides Economics and the usual Commercial studies, Industrial Processes and Field Work in Industry, also English Literature, Languages, etc. In the third year there are now open courses in Industrial Management which deal with the methods of collection and marketing of raw material, manufacturing and merchandising; Insurance; Railway Transportation, including the practice and principles of rate-making, of the physical and financial characteristics of the leading railroads of the United States, of foreign practice and of the legal and business relations between shipper and carrier; Auditing, and Corporation Finance; a study of the methods of promoting, capitalizing and administering business corporations, and Public Finance; a study of taxation and of the activities of public bodies in borrowing and financial administration.

In Transportation, following the general course in the Junior Year, and also founded upon the preliminary work in commerce, the student is offered courses in railroad Organization and Operation, in Rates and Traffic and in Accounting. During the Senior Year courses are offered in Industrial Management, including manufacturing costs and depreciation, labor management; factory location and equipment, factory organization, advertising and sales. In connection with the industrial courses and Transportation, many business institutions are visited and their methods are studied. A large number of business men are called on to assist in the work of instruction by means of special lectures in their respective fields.

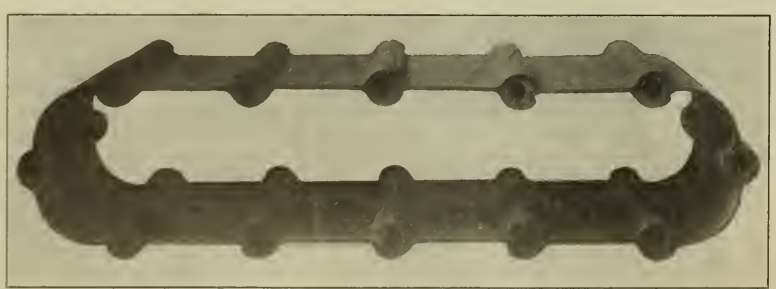
## A New Metal Sheet Piling.

A new form of steel interlocking sheet piling is shown in the accompanying illustrations. Each pile is a single rolled piece of peculiar section, complete in itself and so shaped that a packing groove is formed between the contiguous edges. Ordinarily the piles are made 12 in. wide on centers and in lengths to meet requirements. They are formed from a special I-section, and several passes through special rolls give them the desired form. The packing groove is intended to be filled with dirt, mud, clay, concrete, cellulose or other suitable material at hand, although the material through which the piling is driven will in most cases fill the groove and form a tight and satisfactory joint.

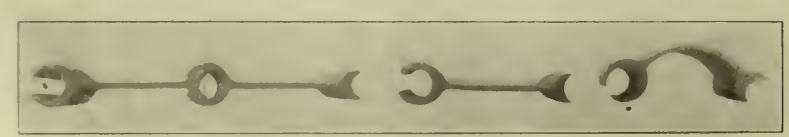
The illustrations give some idea of the perfect alinement that can be obtained as well as the flexibility of arrangement of which the design is susceptible. It is possible to form a complete circle of small diameter without difficulty. Corners and other changes of direction are easily provided for, while for junctions a special form of pile is, of course, needed, having an additional edge at right angles to the web of the pile. The piling is simple in design and cheap to make. It is made and sold by the United States Steel Piling Company, 135 Adams street, Chicago.



Rectangular Enclosure Formed by Steel Sheet Piling.



Steel Sheet Piling Rolled from I-Beam Sections.



Sections of Steel Sheet Piling.

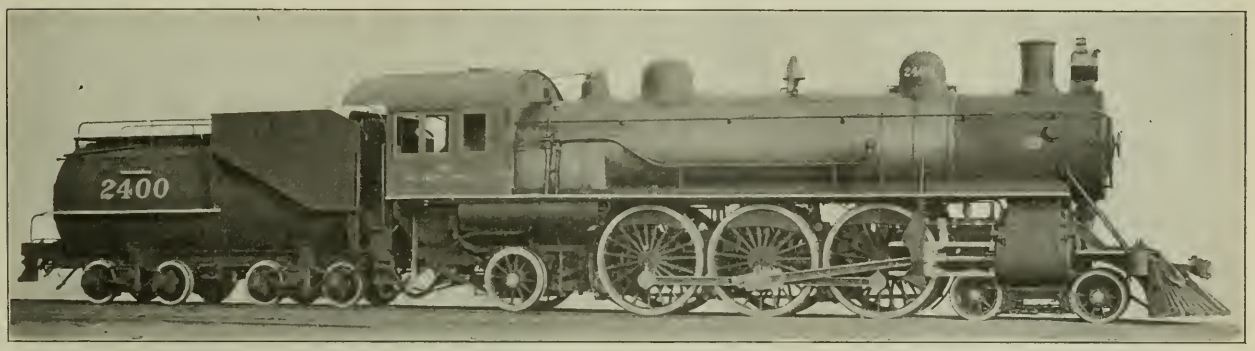
## New Locomotives for the Southern Pacific.

The accompanying illustrations show four new locomotives recently built for the Southern Pacific by the Schenectady Works of the American Locomotive Company. All of these engines use oil as fuel except the Pacific type (4-6-2). As is well known, the Southern Pacific has been experimenting with fuel oil for several years and hence the present order may be taken to mean that the use of oil has been satisfactory. The proximity of the Southern Pacific lines to the Texas and California oil fields makes possible the economical use of oil especially since the cost of coal in that region is pretty high. The extension of the use of oil to switching engines should also prove economical as the intermittent service of switching engines is wasteful of coal. With oil, the intensity of the fire can be varied so that the amount of fuel used is proportional to the power used.

The consolidation (2-8-0) type locomotive weighs 203,500 lbs. in working order, with 181,000 lbs. on the drivers. The weight of the engine and tender in working order is 338,600 lbs. The cylinders are 22 in. x 30 in., and the drivers are 57 in. in diameter. Assuming that 85 per cent. of the working pressure of 200 lbs. is available as mean effective pressure at starting, this gives a maximum tractive effort of about 43,300 lbs. The boiler contains 413 2 in. tubes 15 ft. long. The total heating surface is 3,410.3 sq. ft., with 184.6 sq. ft. in the fire-box. The grate area is 49.5 sq. ft. The tender carries 7,000 gallons of water and 2,940 gallons of oil.

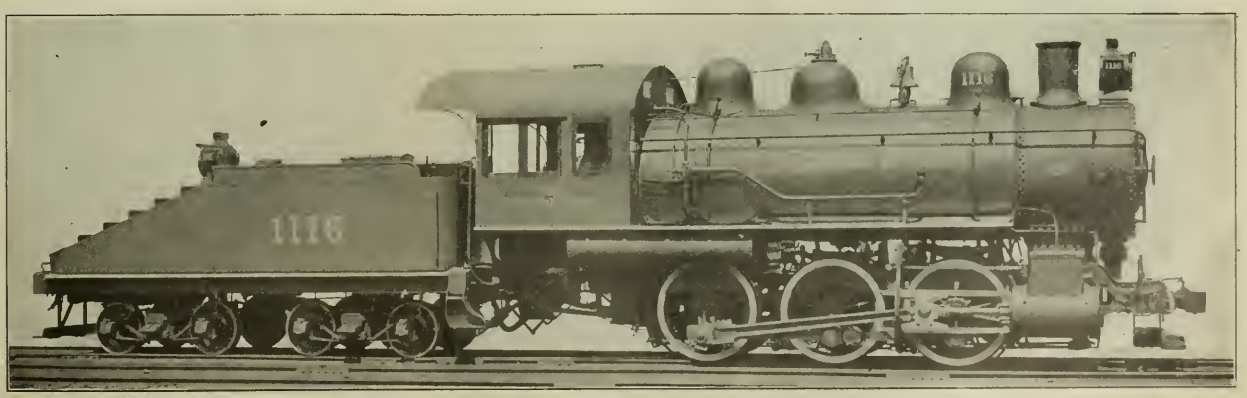
The Pacific (4-6-2) type locomotive weighs 214,000 lbs. in working order with 133,000 lbs. on the drivers. The weight of the engine and tender in working order is 347,600 lbs. The cylinders are 22 in. x 28 in. and the drivers are 77 in. in diameter. Assuming that 85 per cent. of the boiler pressure of 200 lbs. is available as mean effective pressure at starting gives a maximum tractive effort

Oil Burning Consolidation (2-8-0) Locomotive—Southern Pacific.




Coal Burning Pacific (4-6-2) Type Locomotive—Southern Pacific.

Oil Burning Atlantic (4-4-2) Type Locomotive—Southern Pacific.




Oil Burning Six-Wheel (0-6-0) Switching Engine—Southern Pacific.

of about 29,900 lbs. The boiler contains 245 2¼ in. tubes 20 ft. long. The total heating surface is 3,054 sq. ft. with 179.7 sq. ft. in the fire-box. The grate area is 49.5 sq. ft. The tender carries 7,000 gallons of water and 14 tons of coal.

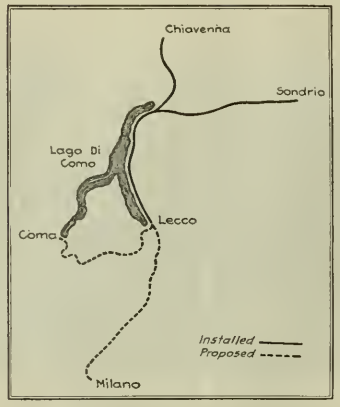
The Atlantic (4-4-2) type locomotive weighs 186,500 lbs. in working order with 97,500 lbs. on the drivers. The weight of engine and tender in working order is 321,620 lbs. The cylinders are 20 in. x 28 in. and the drivers are 81 in. in diameter. Assuming that 85 per cent. of the boiler pressure of 200 lbs. is available as mean effective pressure at starting, gives a maximum tractive effort of about 23,500 lbs. The boiler contains 297 2 in. tubes 16 ft. long. The total heating surface is 2,654.4 sq. ft. with 179.2 sq. ft. in the fire-box. The grate area is 49.5 sq. ft. The tender carries 7,000 gallons of water and 2,940 gallons of oil.

The six-wheel switching engine (0-6-0 type) weighs 147,000 lbs. in working order. The total weight of engine and tender in working order is 227,060 lbs. The cylinders are 20 in. x 26 in. and the drivers are 57 in. in diameter. Assuming that 85 per cent. of the boiler pressure of 180 lbs. is available as mean effective pressure at starting, gives a maximum tractive effort of about 27,900 lbs. The boiler contains 276—2 in. tubes 11 ft. 6 in. long. The total heating surface is 1,806 sq. ft. with 156.1 sq. ft. in the fire-box. The grate area is 30.2 sq. ft. The tender carries 4,000 gallons of water and 1,020 gallons of oil.

## The Ganz Three-Phase Electric Railway System.

BY G. LEVE.

The Valtellina line, a part of the Adriatic System of the Italian Government railroads, has for more than two years been operated by the three-phase alternating current system installed by Ganz & Company, Budapest, Austria-Hungary. The results, so far, have been satisfactory and enough data has been collected to show conclusively the economic advantages of the system. In the preliminary studies to design a suitable electric traction for main line railway traffic such as required for the Valtellina Line, the use of direct current motors and also the single phase alternating current motors were considered. While the direct current has some ideal characteristics for transportation work, nevertheless the low voltage usually employed and the resulting limited distance within which it can be directly transmitted makes it uneconomical for moving heavy main line traffic. Furthermore, the capital outlay for current conductors, sub-stations, etc., is so great, that its use remains limited to special cases covering terminal facilities in large cities or to a few suburban branch lines of existing railroads.

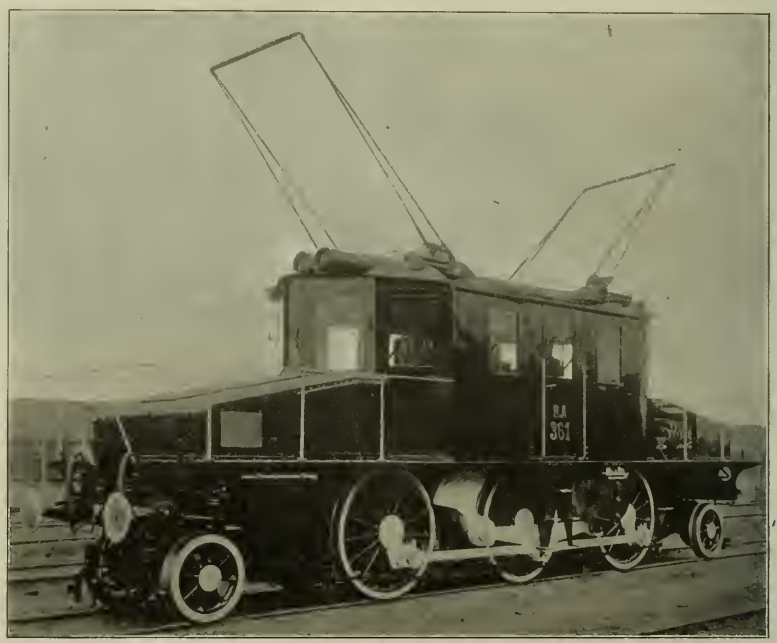



The Valtellina Line.

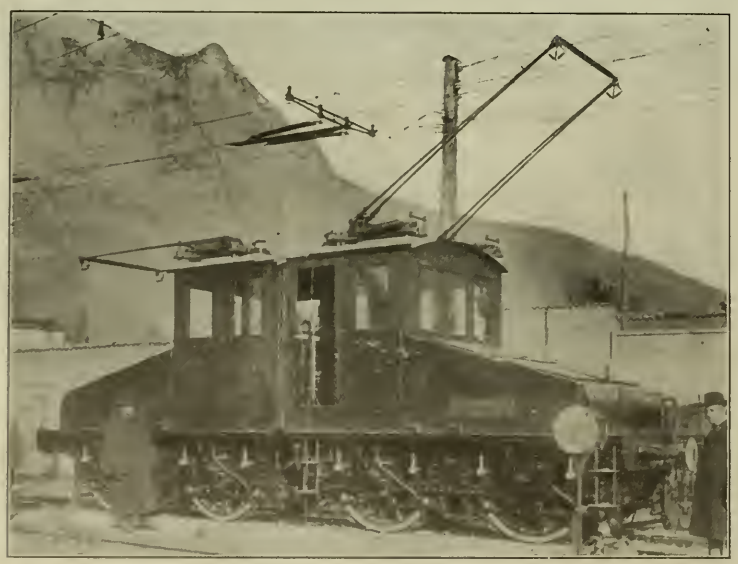
About eight years ago Ganz & Company began to design an alternating current traction system which should have the following characteristics:

(1) Ability of moving main line traffic in such units and at such intervals as is now being moved with steam locomotives, with promptness, security, safety and comfort.

(2) The capital outlay for such equipment should not be prohibitive from a commercial viewpoint.




Latest Type of Three-Phase Locomotive—Valtellina Line.



First Type of Three-Phase Locomotive—Valtellina Line.

(3) By its use the saving in operating cost, as compared with steam locomotives, should be such as to allow the capital outlay to be written off within 15 years, notwithstanding an ample allowance being made for cost of maintenance.

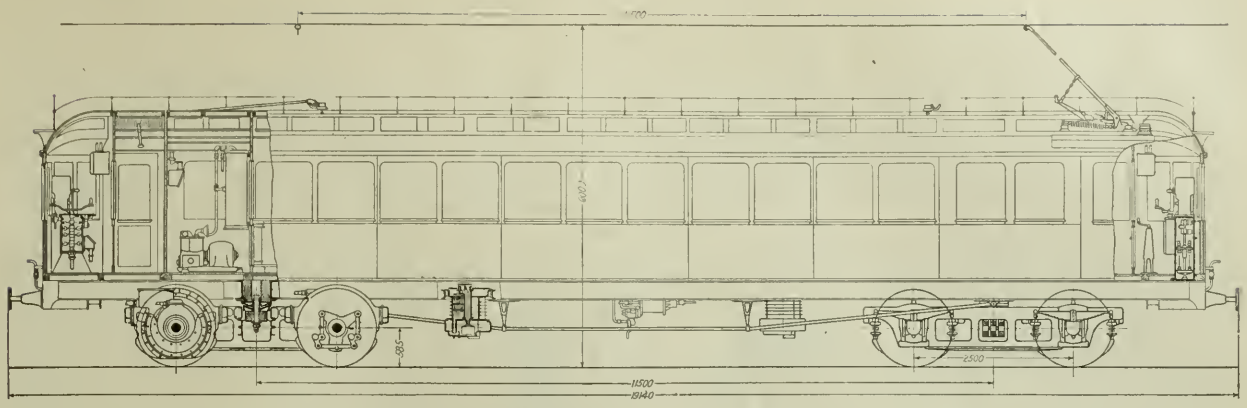
Alternating current permitted two systems to be used—the single-phase and the three-phase. The advantages and disadvantages were very carefully considered by the engineers of Ganz & Company before arriving at a decision in favor of the three-phase system. For more than 15 years Ganz & Company have been engaged in the manufacture of "compensated" single-phase series commutator motors for power transmission, and were therefore thoroughly versed as to its characteristics nevertheless they preferred the three-phase motor for traction work.

Advantages of the single-phase motor for traction purposes are as follows:

(a) Only one current conductor is required.

(b) Voltage control, or resistance control, using a similar controller to that of the d. c. motor, for speed regulating.

(c) Its ability to be used also with direct current, so that a car equipped for service on a single-phase alternating current line can



The Ganz Three-Phase Motor Car—Valtellina Line.

also pass to a line equipped with direct current.

Its disadvantages are:

(a) The use of a commutator which is claimed to be not desirable for heavy railroad work owing to the increase in the cost of maintenance and the risk of interruption of service inasmuch as for heavy railroad work abnormally large quantities of current must be handled.

(b) Owing to the pulsation characteristic of single-phase alternating current, the torque is pulsating and a maximum torque which will slip the wheels results in an average drawbar pull of but 50 per cent. of that of the direct current or three-phase motor at starting and thus requires an increase in weight to obtain an equivalent performance of 80 to 100 per cent. and consequent increased capital outlay.

(c) While but one current conductor is needed, it has to be of so large size to convey the quantity of power required that it allows no saving in the weight of copper when compared with the two wires of the three-phase system.

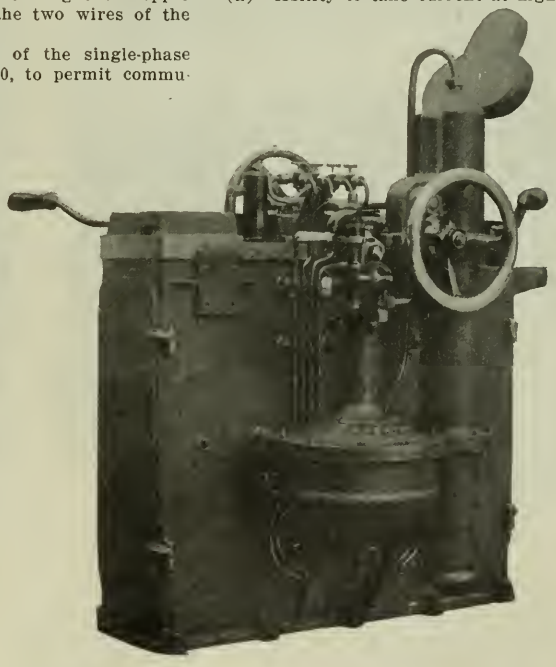
(d) As the voltage of the single-phase motor is limited to 250, to permit commutation a step-down transformer is needed on each car or locomotive for lowering the voltage of the current received from the contact wire, without any corresponding gain in economy or reduction in motor weight such as would result in a three-phase system.

The advantages and disadvantages of the three-phase motor can be summed up as follows:

(a) Ability to take current at high volt-

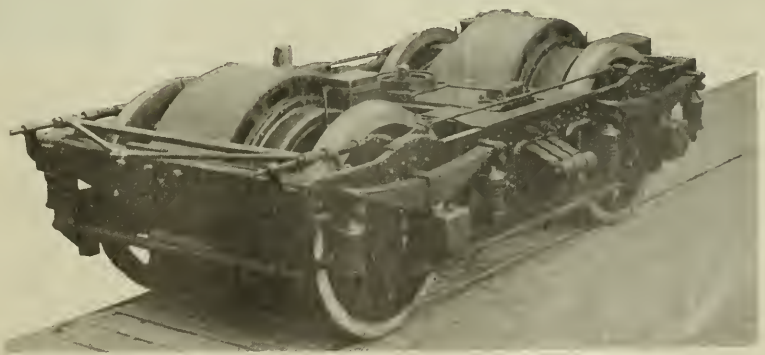
Three-Phase Twin Motor of Latest Type Electric Locomotive.

*(Both high and low-tension motor on one shaft and under one housing, both taking current from one set of contact rings.)*



Pneumatic Control Apparatus for the Three-Phase Locomotive.

Three-Phase Motor Connected by Links to Driving Wheel.



Motor Car Truck with Three-Phase Motors.

age (Messrs. Ganz & Co. decided that 3,000 volts was a satisfactory value). This is taken direct from the contact wires into the motor, which, owing to its polyphase construction, requires no high tension moving contacts and absolute safety can therefore be attained.

(b) It has not a pulsating torque and therefore will render, at about half the locomotive weight required for single-phase, the necessary drawbar pull, giving the same high tractive coefficient as the d. c. motor.

(c) The delicate commutator is eliminated and replaced by heavy contact rings easily accessible and not subject to sparking.

(d) Electric braking. That is, the capability of employing the kinetic energy of the train to generate electric current and to return it to the line. This is due to properties peculiar to multiphase motors and has been fully demonstrated on the Valtellina line and other European lines employing three-phase traction. This special characteristic of the three-phase motor is an advantage as to economy of energy required, not possessed by other electric systems, or steam traction. Furthermore, the necessity of mechanical braking is greatly reduced and hence the wear of the brake equipment wheel tires and rails is reduced to a minimum.

(e) The ability of running three-phase equipment on a line equipped with direct current.

The disadvantages of three-phase traction advanced by its opponents are:

(a) The extra contact wire required, but as already stated the weight of copper is thereby not increased, so that the principal increase of investment is simply the cost of suspending an additional wire.

(b) The use of a low tension motor in addition to the main motor. The former is used for starting and for slow speed running, and usually runs empty when running at full speed. This extra weight of the low tension motor of the three-phase equipment, as also that of the liquid rheostat, is more than offset by the transformer weight and increased weight of the motor of the single-phase system, and is moreover not an inherent necessity of the system.

(c) The fixed speed control which limits the operation to a limited number of predeterminate speeds. Instead of being a disadvantage this is claimed by Ganz & Company to be rather an advantage, as trains irrespective of weight and grade can adhere to uniform speed.

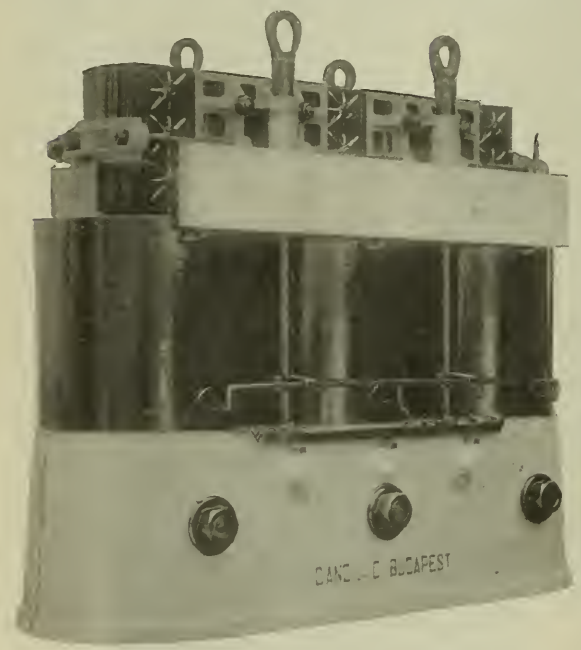
During 1898 and 1899 Ganz & Company operated a specially installed test line about four miles long on an island in the Danube near Budapest. The results there obtained warranted their accepting a contract for the installation of the Valtellina line. The contract was very stringent and provided that in case the installation should not prove satisfactory during the first two years' operation, the contractors should remove the overhead equipment, transformer stations and electric rolling stock and should only be paid for the value of the central station and high tension transmission line. The entire installation, 106 kilometers, or about 65 miles, extending from Lecco to the northern terminals, was completed early in 1902. The Government having, by a practical service of one year and a half, found that all the severe conditions had been more than fulfilled, ordered the settlement to be made for the entire installation several months ahead of time and entered into active negotiations for extending the electric service from Lecco southward to Milan. Roughly, about 60 per cent. of the entire length is composed of gradients up to 2 per cent. tunnels, rock galleries and sharp curves. From Lecco the line follows the shore of Lake Como to Collico, from which point the main line continues eastward to Sondrio and a branch line runs northward from Collico to Chiavenna.

The central station is located at Morbegno, a station on the main line between Collico and Sondrio, and has three turbine generator sets each of 2,000 brake horse-power. Only two of them are kept in regular service, one acting as reserve. The three-phase current is generated at 20,000 volts with a periodicity of 15. The high tension conductors run from Morbegno to Sondrio to the east and to Collico to the west and Lecco to the south; also from Collico along the branch line to Chiavenna. Constant improvements have been made and in the installation of a new line many new features would be used which are not embodied in the Valtellina construction. The Valtellina overhead construction, however, has shown itself in every way to be satisfactory, as will be seen by the low cost of maintenance hereinafter mentioned.

The three high tension wires can be suspended from the same posts as the cross hangers carrying the working conductors, except where tunnels are encountered, in which case the high tension line is generally carried on separate posts over the mountains instead of through the tunnel. The entire line is divided into sections of about six miles each. Each section has a transformer station, where the high tension (20,000 volt) current is reduced to 3,000 volts, at which tension it flows through the working conductor and is at that pressure taken off by the trolley of the locomotive and motor cars.

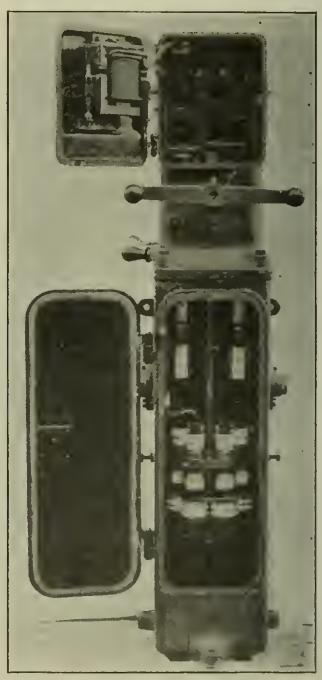
The location of these transformer stations has been selected with a view to having them either near the regular road section houses or near the railroad stations so that the regular service of inspecting the line equipment and the transformer sub-stations can be attended to by the regular road section gang, supplemented by an electrician and several laborers. The transformer is of the air-cooled core type. As all these transformer stations are connected to the working conductors the system gives great elasticity of capacity, enabling any one section to take care of any exceptional load which may suddenly be thrown upon it through an accidental interruption of service on any of the other sections. As all the regular railroad stations, freight stations and repair shops have to be supplied with low tension current for light and power transmission, transformers are located at such stations so as to furnish current for this purpose.

Up to the present the passenger trains have been hauled by motor cars of the type shown. They are equipped with two high tension and two low tension motors, the stators of which are suspended from the



The Ganz Three-Phase Transformer.

Automatic Switch Governor for the Air Compressor.



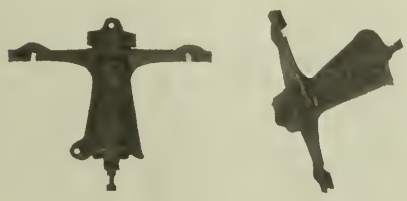
Primary Cut-Out Switch—Ganz Motor Car.

truck frame and the motors are fitted on a hollow shaft which slips over the wheel axle and connected by links to the spokes of the wheel. Thus the entire motor is spring borne. Much has been said about the small air gap of the three-phase motor, but three years' experience has proven that it causes no trouble whatsoever. During all that time the wear on bearings is hardly perceptible. The other electric equipment of the car consists of the pneumatic and electric controlling apparatus as well as an electrically operated air compressor, furnishing the compressed air for the controlling apparatus and for the air-brake. A small step-down transformer furnishes the low tension current for this air compressor as also for the lamps. Starting and regulating of speed is obtained by means of the liquid rheostat, and so smoothly that the start is hardly perceptible to those riding on the car.

The first operation, in starting out, is the raising of the trolley to establish contact with the working conductors, which is done by means of compressed air. When the contact is thus established, access to the high tension switch and leads, which are completely covered in an iron casing, is impossible, as the lid is closed by an interlocking device and can only be opened when the trolley is lowered and the switch and leads are currentless. Any possible defects in the insulation of any parts carrying the high tension current are made harmless because the iron casing connects with the wheels and thereby establishes a ground for escaping current. In starting, the high tension current passes to the stator of the main motor. The rotor of the main motor feeds the low tension stator by cascade connection. The rotor of the low tension motor is in circuit with the liquid rheostat. Thus the low tension motor carries the load with the high tension motor until half speed is reached, after which the low tension motor is cut out and the rheostat is put in circuit with the high tension motor until full speed is attained.

Overhead Construction of Test Line on Island in the Danube.

The Ganz trolley consists of two poles with double roller contacts. It requires two separate bases and poles, as would be the case were there two single trolleys. The outer ends of the two poles are connected by a continuous bar of impregnated wood, the central portion of which for a distance of about eight inches is the full diameter of the rolling contacts. On each side the diameter is reduced and two contact cylinders are slipped over and supported on insulated ball bearings, the current being taken off by carbon contact rings at the ends and is carried by flexible jumpers to the trolley poles. The cross bar with its contact rollers is flexible and is connected to the ends of the arms by



Insulated Trolley-Wire Hanger—Valtellina Line.

horizontal spiral springs, permitting contact when the two wires are at widely different heights. The rollers are steel copper plated and will run over 6,000 miles before replating becomes necessary. The trolley poles are supported by spiral springs in tension, the tension being put on from within the vehicle by compressed air. This trolley cannot run off the wire as is the case with the wheel trolley, and this accounts for the fact that the overhead construction of the Valtellina line required hardly any repairs during the two years of regular service.

There are ten motor cars, the interior of two of which are arranged as parlor cars. Two of these motor cars are generally in reserve and under inspection, and eight are constantly in service. The average passenger train weight is 130 metric tons and the average speed 35 miles per hour. The horse power per car is 300. For freight service two locomotives were used, the electric equipment of which corresponds to the motor cars. Recently, three new locomotives of 62 tons (metric) weight and 1,600 horsepower, were delivered. The motors of these new locomotives are suspended between the driving axles. There are two sets of high and low tension motors. Each set works as twin motors on one axle and is supplied with current from one set of contact rings. The twin motor shaft works a crank, which, in turn, is connected to sidebar drives connecting the three sets of driving wheels.

At the official test several round trip runs were made between Lecco and Collico with a trainload of 330 metric tons at a speed of 40 miles per hour even on a 1 per cent. grade. Furthermore, 20 consecutive accelerations with a train of 430 metric tons from standstill to 18.6 miles per hour were made. The entire locomotive equipment worked well, even when taking 240 amperes from the conductor. The Ganz overhead construction in the yard of Lecco has been successfully used, and demonstrates that the two wire overhead equipment has been successfully adapted for use at switches, cross-overs and side-tracks such as are necessary at terminal yards of main line railroads. Another important fact is that the installing of the overhead equipment and even its existence does not interfere in the least with steam locomotive traffic.

Another great advantage of electric traction is the protection it affords against collisions. If a motorman should disobey orders for meeting another train, or disregard the signal protecting the section he is about to enter, it is in the power of the station agent to throw the current off the line, thereby stopping all trains on this particular section, thus avoiding serious accidents.

As this three-phase traction system has now been in practical operation for over two years on a main line, it is possible to give nearly accurate figures as to the cost of installation as well as operating expenses. Assuming the length of line to be 100 miles and having an ordinary passenger and freight traffic amounting to 800,000 ton miles per day, the capital outlay for line equipment of substantial construction, including the necessary electric locomotives, would not exceed $10,000 per mile.

Careful tests show that the electrical energy consumption per ton mile would average on ordinary main line railroad work (where the daily passenger and freight traffic per 100 miles length of road would not be less than 800,000 ton miles, and that this tonnage would be about equally divided between freight and passenger trains) not to exceed 30 watt hours. This would show that basing a calculation on average typical loads of trains for both passenger and freight service (about 500 tons), that the amount of energy required would be 1,500 k.w.h. for a 100 miles haul.

With most modern equipment (based on cost of coal at $2.50) current can be generated by steam at $50 per k.w. per annum. (This cost could be decreased by using a gas plant and could be brought still lower if water power can be employed.) Therefore:

| | |
|---|---|
| Cost of a 100 mile haul of a 500 ton train, or 50,000 ton miles | $8.50 |
| (The $50 per k.w. includes the writing off and maintenance of the central station equipment.) | |
| Cost of maintenance and writing off of electric equipment (other than the central station) as shown by two years practical experience, with suitable additions to meet American conditions, based on a performance of 800,000 ton miles per day, length of line 100 miles, $330 for supervision and maintenance + $400 for writing off capital outlay per mile per annum brings this item of cost for 50,000 ton miles | 12.50 |
| Motormen and helper (on basis of 200 miles per day) for 100 miles | 3.00 |
| Total | $24.00 |

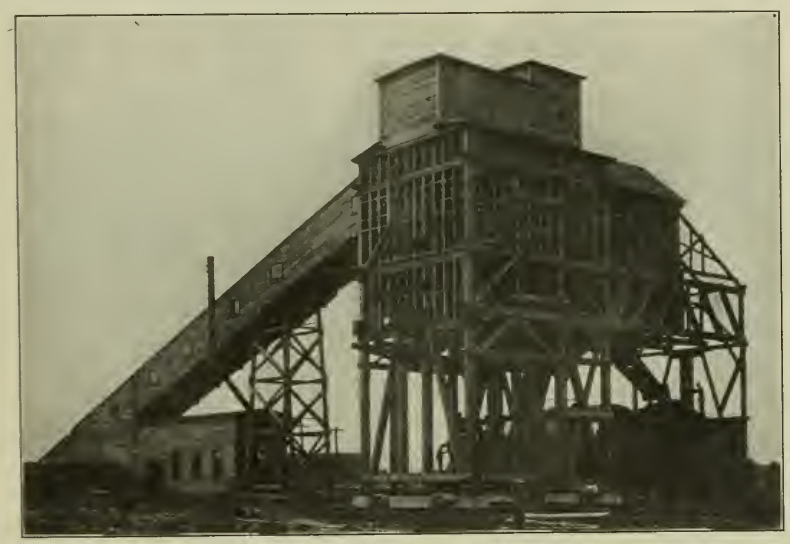
The reports of three prominent American railroads show that the cost of steam locomotive service per 100 miles, without considering the writing off of capital, amounts to about $26. It should, however, be borne in mind that an increase of the ton mileage above 800,000 per day for 100 miles of road would but slightly increase the item of maintenance of equipment, etc., and an increased traffic would therefore show still more favorable for electric traction. Beyond this point electricity will greatly reduce other items in cost of transportation not connected with train hauling, such as train station and signal lighting, as also power for moving turn and transfer tables; also, for loading

and unloading heavy freight. There would also be the saving in repairs on brake equipment, tires, etc., of rolling stock, and the cost of maintenance of substructure would also be reduced, as the balanced rotary motion of the electric motor would replace the unbalanced reciprocating motion of the steam locomotive.

A road in England and also one in Canada is now under construction while active negotiations are in progress for contracts to install several important Austrian and other Continental main line roads, as well as the Vienna City underground, which is now operated with steam locomotives.

### A 125-Ton Capacity Coaling Station.

The accompanying illustration shows a 125-ton capacity coaling and sanding station built by Tate, Jones & Company, Pittsburg, for the Terre Haute & Indianapolis Railroad at Effingham, Ill. The plant consists of a



125 Ton Coaling Station for the Vandalia at Effingham, Ill.

receiving hopper 30 ft. long and 19 ft. wide on top of the girder, having a capacity of 65 tons and placed underneath the track, into which coal is delivered either from hopper bottom cars or shoveled over the sides of gondola cars. It is fitted with a patent reciprocating feeder, shown in the illustration, by means of which coal is fed automatically and regularly from the receiving hopper to a belt conveyor.

The coal goes onto a belt conveyor equipped with Robins idlers carrying coal at an angle of about 19 deg. into the storage bin. This conveyor is driven by a steam engine and moves at 150 f.p.m. It has a capacity of 75 tons per hour.

The coal is discharged from the belt conveyor at the top of the bin by a Tate & Jones patent automatic deflector. When the bin is empty the deflector discharges the coal at the sides of the bin bottom, and after the sides of the bin have become partly filled the deflector automatically reverses and discharges the coal toward the center of the bin. This prevents the coal from separating itself by gravity and eliminates sorting.

The storage bin is made of long leaf yellow pine, and is lined with $^3/_{16}$ in. plates hoppered in all directions toward the gates, eliminating any chance of fire by spontaneous combustion.

The coaling gates are both of the under and over cut type, and it is claimed that a locomotive may be coaled within a minute when so desired.

The sand bin has a capacity of 3½ cu. yds., or 4½ tons, of sand. The sand is dried at the ground level by a sand dryer and elevated by compressed air to the sand bin, from which it is drawn off to the locomotive by pipes and spouts equipped with cut-off sand gates designed so that the flow of sand cuts off immediately without leakage, the sand sealing itself in the gate.

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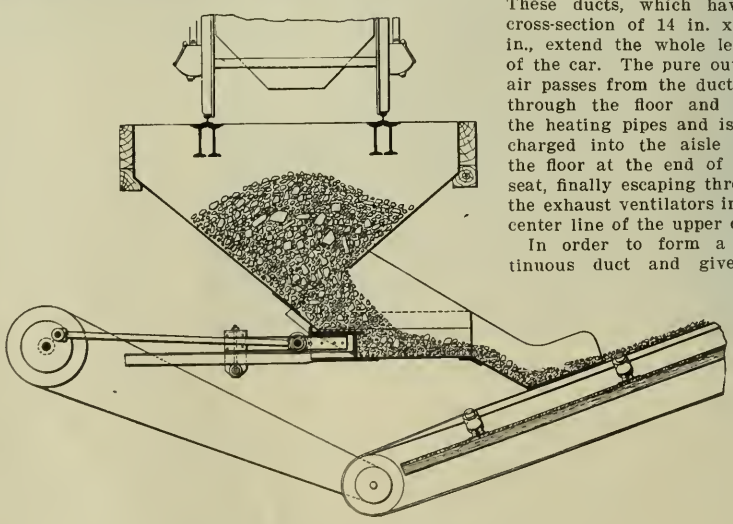
The rail motor car service of the London & South-Western between Plympton, Plymouth and Saltash consists of two coaches coupled together with the engine compartments outwards and not adjoining one another. On the Yealmpton line, however, where the traffic is light, a single motor coach is used, some of the "haltes" or temporary platforms being only long enough for one car. This line runs parallel to the municipal electric tram-cars for the greater part of the distance between Devonport and St. Budeaux, and the competition is sharp. As in the service in the London district, passengers on the motor coaches get their tickets at the ticket office when boarding the car at any of the regular stations, but when taking passage at one of the "haltes" they pay their fares on the car.



Automatic Reciprocating Feeder.

### Ventilation of Passenger Cars on the Pennsylvania.

The Pennsylvania has been making exhaustive tests and experiments during the last ten years in an attempt to design an efficient and satisfactory system of ventilation for passenger cars. A small pamphlet recently issued by the railroad company gives the results of many of the tests made and describes the details of the system which has finally been adopted and which is now being applied to all new passenger equipment on that road.

Early tests and analyses of the air in ordinary passenger cars and sleeping cars showed that only about one-sixth to one-tenth of the air necessary to maintain good hygienic conditions passed through the car; and the new system as finally developed, provides for 60,000 cu. ft. of air an hour, or 1,000 cu. ft. for each passenger, an amount sufficient for maintaining the best atmospheric conditions. In order to keep the cars at a comfortable temperature in winter weather with this volume of fresh air coming in, it was, of course, essential that the ventilating system be combined with the heating system in some way and the air warmed before it entered the body of the car. Another important consideration was the exclusion of dust, dirt and cinders as far as possible. Other experiments having shown that it is not possible to secure true ventilation by merely exhausting the air from the car by means of exhaust ventilators in the roof and allowing fresh air to enter where it can, the system designed provided for ample intake ventilators as well as outlets.

The accompanying illustrations reproduced from the pamphlet, show the system in outline. Air is taken in from the outside through the down-takes, located at diagonally opposite corners of the car, which are fitted with suitable hoods. It is forced into the ducts on each side under the floor which are formed by the floor, the false bottom, the side sill and the first intermediate sill. These ducts, which have a cross-section of 14 in. x 7½ in., extend the whole length of the car. The pure outside air passes from the ducts up through the floor and over the heating pipes and is discharged into the aisle near the floor at the end of each seat, finally escaping through the exhaust ventilators in the center line of the upper deck.

In order to form a continuous duct and give an unrestricted passage for the air currents, the usual cross bracing between sills is omitted and light iron braces are substituted. A shallow pocket is formed in the bottom of the air ducts to collect small cinders and dirt, which find their way

in through the intake hoods. Slots 12 in. long and 2 in. wide are cut in the floor between each two seats and directly under the steam pipes, which are enclosed in a box 5½ in. x 8½ in. The air coming up through these slots passes over the two steam pipes and divides, part going toward the galvanized iron discharge pipe under one seat and part toward the other seat.

During the experimental work attempts were made to take the heated air out from the heater boxing, through registers in the

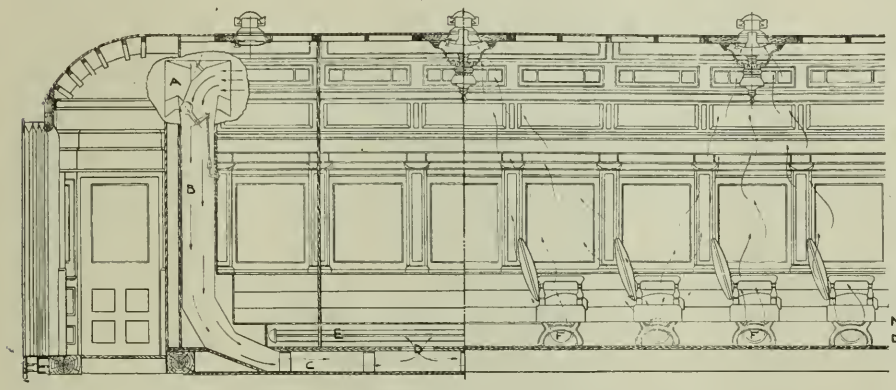



Fig. 1—Longitudinal Section of Car Showing Air Ducts and Intake.

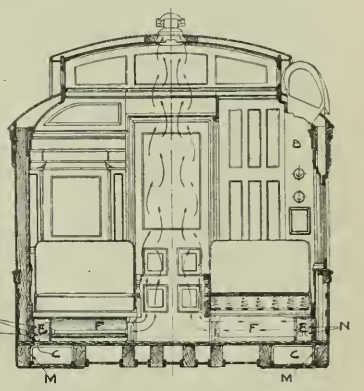



Fig. 2—Cross-Section of Car.

sides of the boxing, into the space between each two seats. But this was found to be so objectionable to the passenger sitting next to the window that it was abandoned. An attempt was also made to take the heated air out through apertures in the top of the boxing between each two seats, the idea being to have a current of warm air direct from the radiators pass up along the windows, to neutralize their chilling effect. It was found, however, that this aperture served as a convenient receptacle for materials thrown in by the passengers. Another scheme tried, during the experimental work, was to make

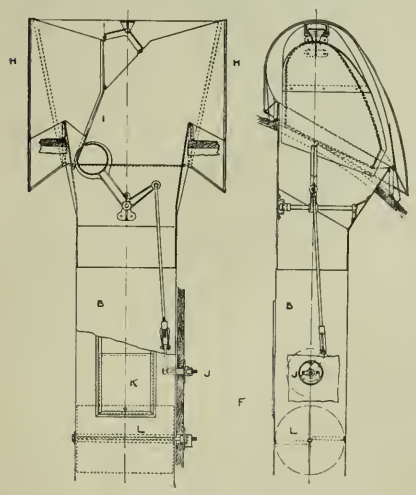



Fig. 3—Hood and Downtake.

the slots in the car floor 4 in. long and spaced 4 in. apart. The radiators were fitted with tin shields so arranged as to keep the air in contact with the radiators as long as possible, but none of these devices worked as well as the arrangement finally adopted.

The hood and down-take construction is shown in Fig. 3. A wire gauze "H" covers the two faces of each hood, the object being to exclude cinders of any appreciable size, especially such as might lead to incipient fires. The flap valve "I" is so manipulated that the air has a free passage into the down-take "B" from the direction in which the car is moving. This valve is controlled by a mechanism operated by the trainmen inside the car, the pointer on the operating device "J" indicating the direction in which the valve should be open. The door "K" in the down-take permits the operating devices for the flap valves to be connected, and also allows a chance for inspection. A strong downward current of air is perceptible when these doors are opened for a moment, while a car is in motion. The down-takes have each an area of about 100 sq. in. In the down-take just below the mechanism operating the flap valve, is a butterfly valve "L," by means of which it is possible to very nearly close the down-take. The normal position of this valve is open, the trainmen being instructed to close it only (1), when going through tunnels, in order to exclude foul air, or (2), when standing in stations with the locomotive detached and it is desired to keep heat in the car as long as possible.

The control of the ventilating system, by which the amount of air taken into the car is increased or diminished, is accomplished by means of the ventilators situated along the center line of the upper deck. The ventilators used are of the type known as the Globe ventilator. There are seven of these of the 6-in. size, five for use over the lamps, and one at each end of the car. The end ventilators differ somewhat in construction from those used over the lamps. Fig. 4 shows the end ventilator. It consists of a register valve and the ventilator itself, which is attached to the car roof. The apertures in the register, when the valves are open, are a little more than equal to the area of the 6-in. ventilator tube. When the valves of these end ventilators are closed, no air passes through except small leakages. The appliances for operating the valves are so arranged that when the valve handle stands lengthwise of the car, the valves are wide open; when crosswise, the valves are closed. The valve handle can have any desired intermediate position, with corresponding control over the amount of air passing through the ventilator. The ventilators over the lamps are shown in Fig. 5. They have the same essential parts, viz.: a register valve and arrangements for fastening to the car roof, and connecting with the Globe ventilator. They have in addition a smoke bell as an essential part of the register. The smoke bell is prolonged upward by a tube 3 in. in diameter, and it and the tube are never closed. The valve system surrounds the smoke bell, and is operated in the same way as that of the end ventilators. The smoke bell and its tube provide a constant opening of about one-fourth of the area of the ventilators over the lamps. The diminution in the amount of air passing through the car, however, when all ventilators are closed, does not correspond to these figures, probably due to leakages in the valves, and to greater velocity of air through the smoke bell, when the valves are closed.

During the experimental work, and on some of the first cars fitted up, the ventilators were all of the end type, and were located between the lamps. It was early found, however, that the lamp ventilators were very important and that they could not be ignored. With six ventilators of the end type, and five lamp ventilators, more air was taken through the car than could be warmed in severe weather, and accordingly on the first cars fitted up, the lamp ventilators were partially closed, only an aperture 2 in. in diameter being left for the escape of the lamp gases. This resulted in smoking the head lining, and accordingly the combined ventilator was devised for use over the lamps. The permanent 3-in. aper-

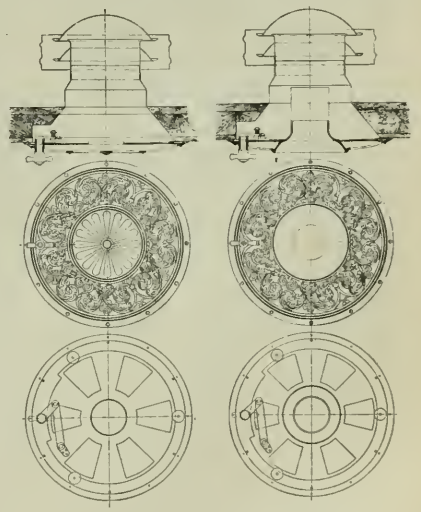


Fig. 4. Fig. 5.

Exhaust Ventilators.

ture in the combined ventilator disposes of the lamp gases very successfully. An essential feature of the arrangement is that all the ventilators may be closed, or all may be left open, or a part closed and a part left open, thus giving great flexibility to the system. The deck sash are not used as an aid to ventilation in any way and are made immovable.

The first tests made with a car fitted with this apparatus were intended to demonstrate whether the air currents would flow in the

direction desired when the car was standing still or whether the success of the system depended on the car being in motion. When there was no heat in the car and the lamps were not lighted there was, of course, very little movement of the air currents in either direction with the car standing, but when there was heat in the steam pipes or any of the lamps were lighted the air moved in good volume in the desired direction. The exhaust ventilators in the roof being 2 ft. higher than the intake hoods, the heated air rises to the top of the car and passes out through the roof, drawing the outside air in through the intakes instead of trying to find a way out in a reverse direction. The same explanation holds when a car has been standing on a siding in cold weather and is then put in a train and supplied with heat. The column of cold air between the car floor and the tops of the exhaust ventilators is longer than the column of cold air from the bottom of the air conduit to the top of the hood. All that is necessary is to open the end doors of the car and allow the cold air to pass out, when proper circulation begins.

Tests which were made to determine whether there was a vacuum or a plenum existing in the car when in motion showed that there was a slight vacuum from which it was expected that trouble might be experienced from draughts caused by cold air finding its way in through crevices around the car windows and also from contaminated air drawn out into the car from the closets in each end. As a precautionary measure a 4-in. Globe ventilator was put in the roof over each closet and no difficulty has been found in keeping the contaminated air out of the car; in fact, tests made while the car is in motion show a movement of air toward the closets rather than away from them.

In order to determine how much air the system would furnish, a car fitted as above described was loaded with men from the shops, who were paid for their time, and were under the charge of a foreman so that they could be controlled in the matter of opening doors and windows. With this car trips were made, from Altoona to Johnstown and return, a distance of about 40 miles each way. Rubber bags and hand bellows were employed to secure samples of the air in the car. Steam heat was necessary since the temperature outside was from 23 to 30 deg. Fahr., and neither door nor window was opened during the trip. The air samples for analysis were taken by pumping air into the rubber bags by means of a hand bellows, moving from one end of the car and back again in the aisle during the operation, and taking the air from about the level of the heads of the passengers. The analyses were made immediately after the return and always the same day. During this test there were 52 people in all in the car, including those who took the samples, and since they were full-grown working men the amount of carbonic acid given off per person was assumed to be 0.72 cu ft per hour. In making the air analyses carbonic acid only was determined, and from this was calculated the amount of fresh air taken through the car per hour by the ventilating system. The figures obtained are as follows:

| Globe ventilators | | | Per cent. of carbonic acid. | Cu. ft. of air per car per hr. |
|---|---|---|---|---|
| | | *Westbound.* | | |
| All | Closed | Bennington . . | 0.18 | 26,700 |
| All | Open. . | Buttermilk Falls | 0.10 | 62,400 |
| All | Open. . | Standing 20 min. at Johnstown.. | 0.21 | 22,000 |
| | | *Eastbound.* | | |
| All | Closed | Cresson . . . . | 0.14 | 37,400 |
| All | Open. . | McGarvey . . . . | 0.10 | 62,400 |
| All | Open. . | Standing 20 min at Altoona . | 0.20 | 23,400 |

The stations mentioned denote locations at which air samples were taken. Bennington on the schedule used is about 23 minutes from Altoona; Buttermilk Falls is about 57 minutes from Bennington, and Johnstown is about 10 minutes from Buttermilk Falls. Returning, Cresson is about 42 minutes from Johnstown, McGarvey about 20 minutes from Cresson, and Altoona about five minutes from McGarvey. These figures give some idea of the interval between samples.

As has already been stated, the system was designed to supply 60,000 cu. ft. of fresh air per hour to a car. When all the Globe ventilators were open, that is when the system was working normally as designed, the actual amount of fresh air obtained was a trifle above the desired figure, as is shown by the samples taken at Buttermilk Falls and McGarvey. The actual amount of air supplied from time to time is affected by several conditions. The speed of the train has an influence, also the differences in temperature inside and outside of the car, and the direction and force of the wind. Just how much each of these variables amounts to is not known. When the Globe ventilators were closed, that is, when the designed control was applied, the amount of air supplied was cut down approximately one-half, as is shown by the samples taken at Bennington and Cresson. In other words, the control makes it possible to reduce the amount of fresh air when it is desired to do so, as for example when there are few passengers in a car, or in extreme cold weather, when the supply of heat may not be quite sufficient to warm the full volume of outside air. The samples taken at Johnstown and Altoona show what the system does, when a car is standing on the track, as at stations en route. It cannot, of course, be expected that the same efficiency be shown when the car is at rest as when it is in motion, and, in fact, this is not essential. The difference between the amount of air supplied when standing still and when the train is in motion, measures approximately the effect of the movement of the train on the system.

The heating arrangements for which the ventilating system was designed had 1 sq. ft. of heating surface for about 240 cu. ft. of ventilating air per hour when the system was in full normal operation. Under these conditions it is obvious that the temperature in the car is a function of the steam pressure maintained in the radiators and of the temperature of the outside air. If the amount of air supplied is constant at any given condition of the thermometer outside, the temperature inside will vary with the steam pressure; or, if the steam pressure is constant, and the amount of air also constant, the temperature in the car will depend on the outside temperature. In order to find out exactly what the system would do in the matter of car heating a car fitted as above described was run from Altoona to Harrisburg, a distance of about 132 miles, in January, when the temperature outside during the whole trip was from 10 to 13 deg. Fahr. above zero. The car was without passengers, in order to afford opportunity for manipulation. The steam pressure maintained, although not measured on this particular car, was, from readings on the gage on the locomotive, about 20 lbs. During the trip the following points were satisfactorily demonstrated: 1st. There is no difficulty whatever in keeping the car comfortably warmed in such weather with the ventilating system in full normal operation. The thermometer on the bell-cord hanger in the middle of the car, at no time throughout the whole trip, showed less than 70 deg. Fahr., and most of the time was from 73 to 75, and on one occasion reached 77 deg. (2d.) The distribution of heat throughout the car was entirely satisfactory. Thermometers in different parts of the car did not show differences of more than 2 deg. or 3 deg. (3d.) Diminishing the amount of air supplied to the car, increased the temperature, which was expected.

An interesting experiment was carried on during this run to determine the behavior of the air on the two sides of the car. There are hoods and down-takes on diagonally opposite corners of the car, one being, therefore, on the front end and the other on the rear end of the car when it is in motion; also each down-take connects with its own radiating system, and these are entirely independent, except that they take steam from the same point of supply. The indications obtained during the trip above mentioned would seem to show that the efficiency of the two sides of the car in supplying heated air when the train is in motion depends largely on the direction of the wind. With the wind dead ahead, both sides seemed to be equally efficient; with the wind ahead and from the right of the line of the train movement, the right-hand side of the car seemed to be most efficient, and with the wind from the left, the left-hand side of the car seemed to do most of the ventilating. The direction of the wind was noted by observing the locomotive smoke and the movement of the air by holding delicate anemometers at the air exits in the car under the seats.

Careful observations of temperature were made at another time during a trip from Philadelphia to Altoona, a distance of about 237 miles, with the thermometers outside from 2 to 5 deg. below zero Fahr. most of the distance. It was easy to keep the thermometer on the bell-cord hanger 70 deg. and above. No record was made of steam pressure on the car, but 30 lbs. were used on the locomotive. The windows were heavily frosted at starting, owing to a little leak in the steam pipes while the car was being warmed up in the station. This frosting entirely disappeared in the course of an hour and a half, owing to the constant passage through the car of dry warm air.

Another and even more severe test was made on a day train during the blizzard of February, 1899. This train was blocked by snow on the east end of Rockville bridge, near Harrisburg, for over four hours. The location gave full sweep for the wind blowing down the Susquehanna River. One of five trial cars was in this train, and during the time mentioned frequent observations were made on the temperature. At no time was any discomfort experienced, and at no time did the thermometer on the bell-cord hanger show less than 70 deg. Fahr.

In regard to the amount of steam required to warm the ventilated cars, no very positive data have been obtained. It is evident that more steam will be required than if the cars were not ventilated, but thus far no serious difficulties have been experienced. A few through trains having from three to five ventilated cars in them have been operated with perfect success for over a year.

If smoke, cinders, dust, noxious gases, etc., are suspended in or mixed with the air which comes to the hoods, they are, of course, taken in along with the air. Cinders, however, of any appreciable size, are excluded by the gauze over the hoods. Small cinders that pass the gauze are deposited in the conduit between the sills. The location of the hoods on the top of the lower deck greatly diminishes the annoyance from dust stirred up under the train. The smoke from the locomotive with the noxious gases which it carries is usually considerably higher than the hoods, or is diverted on one side of the train or the other by the wind. This leaves only long smoky tunnels to be especially provided for. The closure of the valves in the down-takes and the rapid change of air in the car by the system—only about four minutes

being required to completely replace the air in a car, after it has passed the tunnel—so greatly mitigate this difficulty that no serious trouble has thus far been experienced from the introduction by the ventilating system of objectionable matter from without.

Practical experience with the system on the road has thus far been very gratifying. Passengers and trainmen seem to find previous conditions much improved by the new system. The tendency to open the windows is diminished, and the cars are run comfortably with closed doors in the heat of summer.

This ventilating system has been applied on 800 cars running on the Pennsylvania Railroad and on 200 cars of the Pennsylvania Lines West as well as on a few cars of the Baltimore & Ohio. All new cars now building are fitted with it. As yet it has not been applied to a sleeping car.

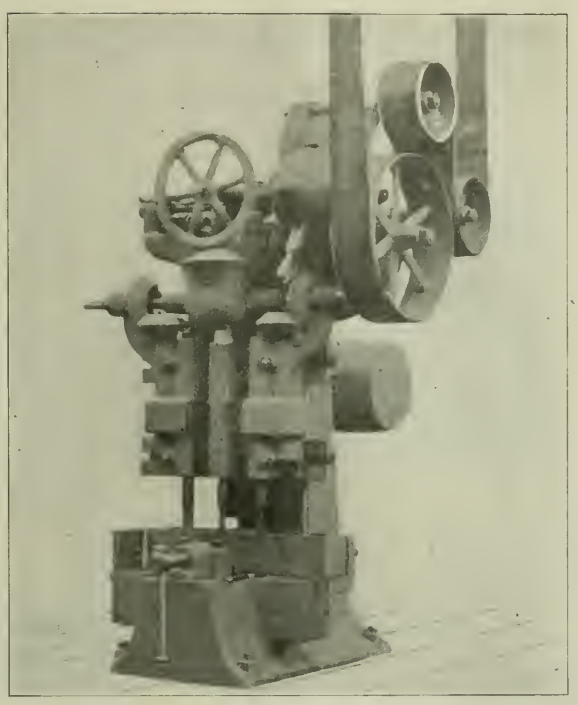


Fig. 1—The Sellers Rail Drilling Machine.

## Railroad Shop Tools.

(*Continued.*)

### RAIL DRILLING MACHINES.

Rail drilling machines are specially designed for drilling fish plate bolt holes in steel rails. A drill of this sort receives severe treatment and therefore must be made very strong with the spindle supported as close as possible to the drills. When drilling, the end of the rail is set against an adjustable stop and clamped in place by a vise. Very often these machines are set up in pairs, one right-hand and one left-hand. One machine is set up slightly in advance of the other and at a distance somewhat greater than the length of the rail. First one end of the rail is drilled and then the other. This class of machine is built with two, three and four spindles, the fourth spindle being an auxiliary. This auxiliary spindle is spaced about 6 in. from the main spindle, and carries a drill, which is used for drilling the bond wire holes in the rails.

The rail drilling machine shown in Fig. 1 is made by William Sellers & Company, Philadelphia, Pa. The spindles are adjustable from 3 in. to 12 in. from center to center. The work table is supplied with a vise which has an adjustable locking plate and reversible end stops. The drills are fed simultaneously by a feed gear operated by a positive clutch. The saddle is counterweighted and has quick hand adjustment. All gears are enclosed in gear cases. The fast and loose pulleys are 20 in. in diameter by 5½ in. face, and should run at 250 r.p.m.

The three spindle rail drilling machine shown in Fig. 2 is made by the Newton Ma-

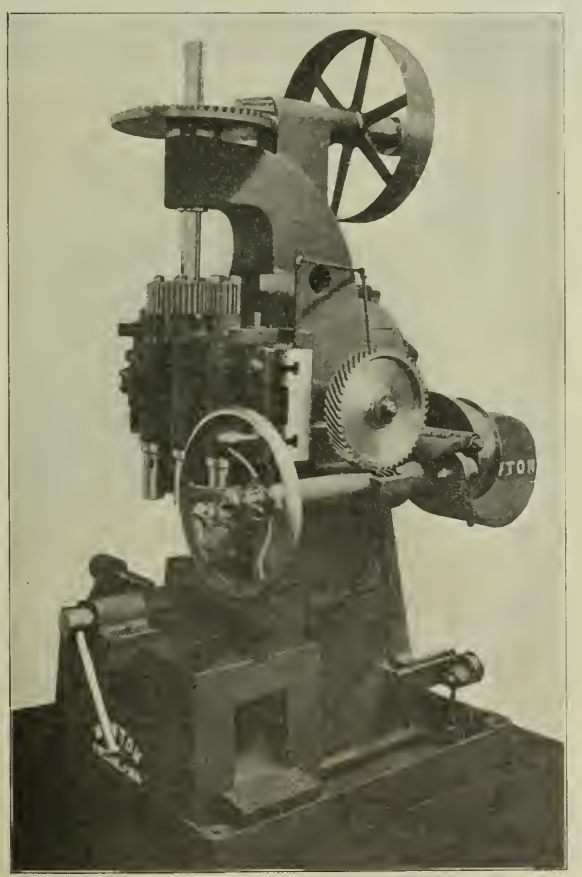


Fig. 2—The Newton Rail Drilling Machine.

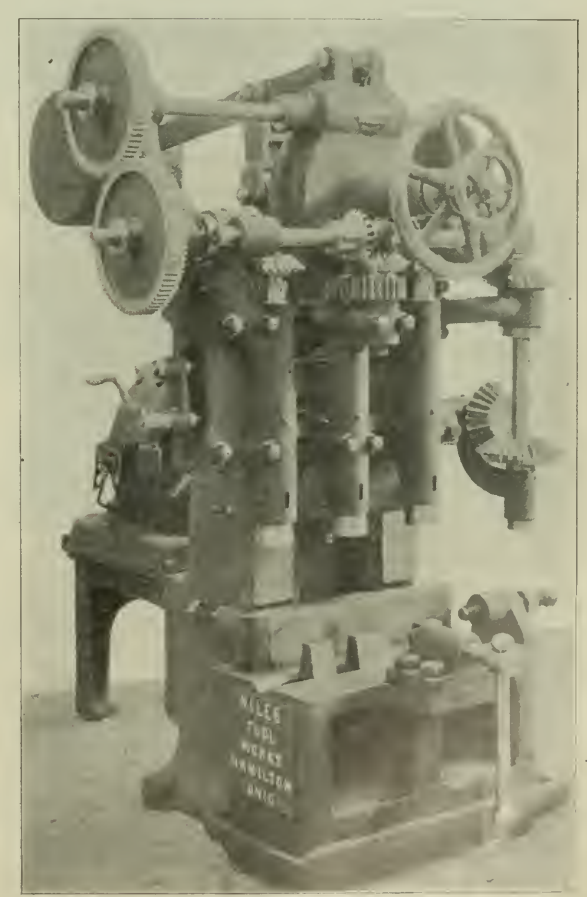


Fig. 3—The Niles-Bement-Pond Rail Drilling Machine.

chine Tool Works, Philadelphia, Pa. The spindles can be adjusted from 3½ in. to 9 in. from center to center. The spindles are carried on one saddle, which is counterweighted and feeds the three spindles simultaneously. Each spindle is made with a straight hole and sockets for adjusting the drills for different lengths. An adjustable vise is attached to the work table. There are two changes of automatic feed and a quick return motion for the spindles. The machine is supplied with a pump which circulates the lubricant for the drills. A pan in which the machine sets holds the lubricant.

The three-spindle rail drilling machine (Fig. 3) is made by the Niles-Bement-Pond Company, New York. This machine is shown motor driven. It has ample power to drill three 1¼ in. holes simultaneously. The minimum distance between centers of the spindles is 3½ in., and the maximum distance between the centers is 9 in. The maximum distance from the spindles to the base is 20 in. The spindles are contained in one sliding head, which has a horizontal adjustment. The head is also counterweighted, and has power down feeds, friction release and quick hand movements. Each spindle has an individual screw adjustment and the table is supplied with a vise and an adjustable end stop.

*(To be continued.)*

## Oil Burning Furnaces.*

In the last 18 months all of the coal heating furnaces in the rolling mill, as well as the larger reverberatory furnaces used for large locomotive and marine forgings, have been converted into oil burning furnaces. The smaller furnaces in the bolt and nut factory, and the forging machine furnaces have also been converted into oil burning furnaces. The main question to be considered in comparing coal with oil for use in reverberatory furnaces is economy. This is governed by the price of fuel oil compared with coal as well as many other conditions that present themselves regarding economy.

The first question to be considered is the number of gallons of crude oil required to bring one ton of scrap iron, put up in piles varying from 200 to 1,000 lbs., to a welding heat. For a rolling mill in the Sacramento shops it requires 40 gallons of crude oil as it comes from the well (14 gravity) to heat 2,000 lbs. of scrap material or pile. In our old coal reverberatory furnaces, it required 500 lbs. of bituminous coal to heat the same quantity of metal. Furnace coal in this locality costs from $5.00 to $6.00 per ton; oil costing 1 cent per gallon, consequently the oil costs us 40 cents to heat one ton of metal while with our old coal furnaces it costs us $1.25 to bring the same metal to the required heat, or 68 per cent. saved in the cost of fuel alone.

The next thing to be considered is the handling of the two fuels. It requires six men to bring the coal to the reverberatory furnaces and bolt factory, from the coal pile. This alone costs $12.00 per day. Our oil tanks are arranged so that one man distributes oil over the whole works. Another thing to be considered is the hauling away of the ashes and cinders that are produced daily. It requires a horse and cart daily to remove this waste to the dumps. Another important consideration is the fireman. He has to handle between five and six thousand pounds of coal daily, clean his grate bars at noon and night, shovel out the ashes and cinders, and oftentimes knock out the brick work in the fire chamber trying to knock off the clinkers. All this hard labor is reduced 75 per cent. by the use of oil. The output of the furnaces heated with oil is at least 20 per cent. more than with the old-fashioned coal furnace. One reason for this is that there is no time lost in cleaning grate bars and wheeling out ashes.

The most important question relative to the two fuels is the quality of the iron produced from the scrap material. Hammered iron for railroad appliances, such as locomotive forgings or for any other purpose where the metal is subject to compression, tensile and vibrating and torsional strains, produced from oil fuel, is far superior than similar metal produced in the old style furnaces. Scrap material heated with oil finds less defect in working by lamination, than with iron brought to a welding heat with coal. We have had 50 per cent. less car axles condemned on account of seamy journals since we have adopted fuel oil in heating. This not only occurs with axles but with all other forgings.

With oil at 6 cents per gallon and coal at $5.00 per ton, the cost of operating a furnace about balances. Another important factor in the expense of operating is the power required to atomize the oil, and furnish sufficient oxygen to produce perfect combustion. Compressed air I find to be an expensive commodity. Steam is also expensive and is not as good as compressed air for the purpose. The old fan blast is the cheapest and best when properly applied. From eight to ten ounces pressure is all that is required for atomizing and perfect combustion. The success of oil burning depends on the shape of the interior of the furnace. In many cases the old method of providing a combustion chamber about 4 or 5 ft. from the bridge wall introducing the oil at the same end of the furnace and the heated gases passing over the bridge wall and coming in contact with the metal, the waste gases passing through the flue is used. The oil is forced into the furnace with compressed air or steam. Openings are left in the lower portion at the end of furnace, permitting the air to be drawn in. Another method is to carry the back wall four or five feet back of the original bridge wall, and build up several courses of perforated brick work a little above the opening made in the lower portion of the end of furnace, for the purpose of heating the air that is drawn in to form better combustion. After examining all the small bolt furnaces, I concluded, to try a different shape reverberatory furnace from any now in use. As an experiment I built the bridge wall up to and joining the roof, cutting out the old coal fire-place, building the roof straight near to the flue. Then I built a perpendicular wall down to the flue, introducing the burner about seven inches from the roof as shown herewith.

I lit the furnace using compressed air, and after one hour the heat was so intense that the slag commenced to pour through the slag hole. We then tried steam instead of air with good results in heating the iron. We still use the fan blast to furnish oxygen for combustion. Finally the fan blast was used exclusively for combustion, as well as for an atomizer. I find this method gives the best results. This furnace can be operated with compressed air, steam or the ordinary fan blast; however, I find the fan blast preferable. The same burner will answer in either case.

Fig. 1 in the accompanying illustration shows a horizontal section of the furnace through X of Fig. 3. Fig. 2 is a vertical transverse section taken through Y of Fig. 1. Fig. 3 is a longitudinal section taken through Z of Fig. 1. The burner passes through an aperture in the brick wall F, directly over the flue, blowing the oil in over the metal.

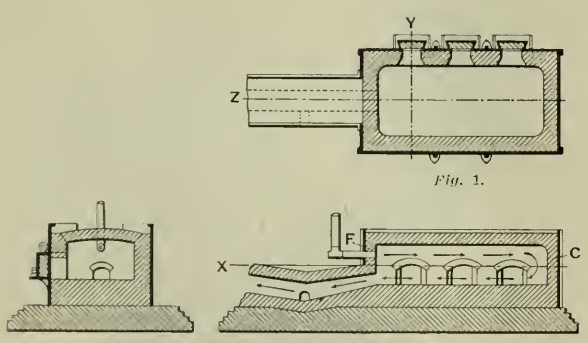



*Fig. 1.* *Fig. 2.* *Fig. 3.*

Reverberatory Heating Furnace.

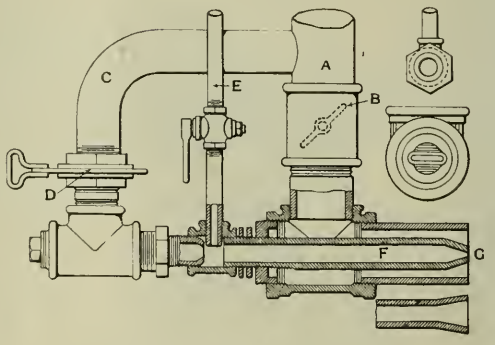



*Fig. 4.*

Low Pressure Oil Burner.

The furnace is 3 ft. beneath the hearth and furnace roof, this height giving plenty of room for perfect combustion by the time it reaches the wall C. A perfect incandescent flame then returns by the draft of the flue, as shown by the arrow points, and when mixed with the metal to be heated, the waste gases can be diverted under the boiler for producing steam, or through a stack as desired. Much care should be taken in placing the burner direct in line and about 7 or 8 in. below the roof so that perfect combustion will take place before the oil comes in contact with the iron on the hearth or the heated walls of the interior of the furnace. Should the oil come in contact with the roof or side walls, lumps of carbon will form, diverting the flame to such an extent that it will not flow in the direction required. The reason I mention this is that I had an unfortunate experience in this regard with my three-door rolling mill furnace. Through

*Extract from a paper read by S. Uren (South Pacific) before the National Railroad Master Blacksmiths' Association, at Indianapolis, August 18, 1904.

some accident the burner lowered on the outer end, causing the oil to strike the roof. A lump of carbon formed, diverting the flame towards the flue to such an extent that we could get the iron to the proper heat at the flue door only. As soon as the carbon was removed and the burner placed in the right position we had no more trouble.

The furnace shown in the illustration is a three-door rolling mill furnace. All our forging furnaces have two doors only, operated by the same method as the three-door furnaces. From my point of view this is the most simple and economical furnace now in use, as it is a perfect reverberatory furnace. Perfect combustion is produced and not a shadow of smoke can be seen from the stacks when properly manipulated. J. G. Camp, General Foreman of the S. P. shops at Sacramento, designed the oil burner (Fig. 4). This burner is used in 13 furnaces in the Sacramento shops. It is known as a low pressure burner and can be operated either with a fan blast as an atomizer with from seven to ten ounces of pressure; or it can be operated with steam or compressed air. When steam is used as an atomizer the blast pipe C should be removed and a steam pipe substituted. When compressed air is used a similar change should be made. (A) represents the fan blast pipe. (B) regulating gate in blast pipe. (C) air pipe leading from blast pipe to the outer end of burner pipe. (D) gate to regulate the blast passing into the burner pipe. (E) oil pipe connecting the burner pipe. (F) oil and wind pipe or burner pipe. (G) outlet to oil and burner pipe.

The German Ministry of Justice has made up a list of "railroad accident experts," 590 in number, for the use of the courts when they have to try men for causing accidents. This is expected to enable the courts to hear experts not attached to the particular line where the accused is employed.

## Ogden-Lucin Cut-Off.

On September 18, the Ogden-Lucin cut-off of the Southern Pacific across Great Salt Lake was opened for regular passenger service. Although the engineering features of this work have already been described at length in the *Railroad Gazette*, now that the cut-off is in full use by the overland trains, a brief review and photographs of the finished work may be of interest. The cut-off was begun in June, 1902, and the official ceremony marking the completion of track-laying occurred in November, 1903. At this time the cut-off was not entirely finished, and it was not until March, 1904, that the new line was opened for freight trains. Even at this date, there still remained some riprapping and filling to be done, so that the company did not open the entire line for regular schedule passenger trains, the tracks being needed much of the time for work trains. For the present, the passenger schedules are not fast, some minor work still remaining to be done. Local passenger trains will continue to be run over the old route via Promontory. The Ogden-Lucin cut-off comprises 102.9 miles of new track, replacing 146.7 miles of track around the old North Shore route via Promontory, saving 43.8 miles in distance, 3,919 degrees of curvature and 1,515 ft. of vertical grade. The sharpest curve on the new line is 1½ degrees; on the old road, there were some of 10. On the cut-off the ruling grade is but 21 ft. to the mile, as against 90 ft. on the old route. The new line has 22.9 miles of trestle, of which 11.1 miles is permanent and 11.8 miles temporary. The permanent trestle, which has a ballasted deck, stands in from 30 to 34 ft. of water at the present level of Great Salt Lake. The accompanying photographs show examples of the excellent ballasting which is to be found throughout the line. The track is laid throughout with 80-lb. rails. On the trestle portion, the ballast (gravel) is 15 in. thick under the ties.

Temporary Trestle, Ogden-Lucin Cut-Off.

Looking West Toward Wasatch Mountains.

Fill Across East Arm of Great Salt Lake, Ogden-Lucin Cut-Off.

Permanent Trestle Across Great Salt Lake, Ogden-Lucin Cut-Off.

Permanent Trestle and Roadbed at Midlake.

## Train Accidents in the United States in August.[1]

eq, 2nd, Louisville & Nashville, Breton, Ky., a passenger train was derailed by the breaking of a flange and two passenger cars were ditched; conductor and four passengers injured.

unx, 2nd, Central Vermont, Norwich Town, Conn., a passenger train was derailed and the engine and baggage car fell down

[1]Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| re | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defects of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

a bank. The engineman, fireman and five passengers were injured.

bc, 3rd, 11 p.m., Louisville & Nashville, Horse Cave, Ky., butting collision between southbound passenger train No. 1 and northbound passenger train No. 2, wrecking both engines, one baggage car and one mail car. The engineman of No. 1 was killed and four trainmen and 16 passengers were injured. It is said that No. 2 was entering a side track, following a freight train which had entered a minute before, and that the engineman of No. 1 took the headlight of the freight for that of the passenger train.

4th, 4 a.m., St. Louis & San Francisco, Vinita, Ind. T., a passenger train was derailed, and the tender and five of the six cars were ditched. Twelve passengers were injured.

4th, Chicago, Peoria & St. Louis, East St. Louis, Ill., a passenger train of the Illinois Central was derailed at a switch and five of the seven cars were ditched. It is said that none of the persons on the train were seriously injured.

eq, 5th, Baltimore & Ohio, State Road, Ohio, a freight train was derailed by the breaking of a journal and five cars were wrecked. A trespasser riding on one of the cars was killed.

dn, 5th, West Jersey & Seashore, Woodbury, N. J., express train No. 5 was derailed at a misplaced switch and the engine and three cars were wrecked. The engineman, fireman and four passengers were injured.

5th, Texas Southern, Winnsboro, Tex., a freight train was derailed on a bridge and 10 cars fell through to the stream below.

xc, 6th, Houston, East & West Texas, Garrison, Tex., passenger train No. 1 ran over a misplaced switch and into some freight cars standing on a side track, damaging the engine and one car. Eight passengers were injured.

7th, Southern Railway, Elk Valley, Tenn., a passenger train was derailed and the baggage car and three passenger cars were overturned. Three trainmen and nine passengers were injured, all of the passengers slightly.

†unf, 7th, 8.45 p.m., Denver & Rio Grande, Eden, Colo., southbound passenger train No. 11 broke through a trestle bridge, which had been weakened by a flood, caused by a cloudburst a short time before, and the engine and first three cars fell into the swollen stream. The bodies of the cars were carried down stream a long distance. Eighty-four passengers and four employees were killed and the fireman and two passengers were injured, the three last named being the only survivors among those who went down with the wrecked cars and engine. There are still missing six persons who were presumably on the train but whose bodies have not been found. One dining car and one sleeping car remained on the track. This accident was reported in the *Railroad Gazette* of August 12, page 242. It is believed that parts of the bridge had been knocked down by the wreck of a highway bridge which floated down from a point up the stream.

8th, Vandalia Line, Plainfield, Ill., eastbound passenger train No. 21, running at high speed, was derailed and the engine and most of the cars were badly wrecked. The wreck fell against some freight cars standing on a side track and these were also badly damaged. The wreck took fire and, with two factories nearby, was burnt up. Fourteen passengers and six trainmen were injured. It is said that the derailment was due to a broken wheel or axle.

dn, 8th, 9 p.m., Louisville, Henderson & St. Louis, Spottsville, Ky., freight train No. 64 ran into an open draw and the engine and nine cars fell into Green River. The engineman, fireman and two tramps were drowned. The stop signals were properly displayed and the engineman's mistake cannot be explained.

rc, 8th, Southern Pacific, Cisco, Cal., a passenger train standing at the station was run into at the rear by a following freight train, wrecking a dining car and damaging several other cars. Two passengers were injured.

bc, 9th, Missouri Pacific, Fort Scott, Kan., butting collision between a freight train and a train consisting of an engine and a caboose. One fireman was killed and four other trainmen were injured.

†bc, 9th, Chicago, Ill., Western avenue and Thirty-ninth street, a passenger train of the Baltimore & Ohio ran into a freight of the Chicago & Erie at a crossing, wrecking several cars. The freight was moving backward and it ran against and overturned one of the passenger cars of the other train. Five passengers were killed, four of them belonging to one family, and seven others were injured.

bc, 10th, Southern Railway, Riceville, Tenn., butting collision of freight trains, wrecking 15 cars and injuring two trainmen. It is said that the engineman of one of the trains misread a telegraphic order.

unx, 11th, East Tennessee & Western North Carolina, Blevins, Tenn., a freight train was derailed on a high bridge, and six cars of lumber broke through and fell to the stream 60 ft. below. One brakeman fell with the cars and was severely injured.

bc, 12th, 11 p.m., Atlantic Coast Line, Elba Junction, Ala., butting collision of freight trains, wrecking both engines and many cars. One of the enginemen was killed and five other trainmen were injured. It is said that the eastbound train had disregarded a meeting order.

unf, 12th, Pennsylvania road, Dunlo, Pa., a passenger train moving backward was derailed by running over a cow, and a track foreman riding on the front of the leading car jumped off and was killed.

12th, St. Louis Southwestern, Texarkana, Ark., passenger train No. 5 was derailed at a switch, and the engine and first four cars were wrecked. The engineman and fireman were fatally injured. A sick employee in the baggage car died soon after the accident, and one mail clerk was injured.

dr, 14th, Central of New Jersey, Elizabeth, N. J., a passenger train was derailed by a loose rail, while running at low speed, and the engine was overturned. The engineman was killed and several passengers were injured.

†eq, 14th, Tennessee Central, Silverpoint, Tenn., passenger train No. 2 was derailed by the breaking of the flange of a wheel of the last car, and two passenger cars were wrecked. One passenger was killed and 25 were injured.

unx, 17th, Chicago, Rock Island & Pacific, Altamont, Mo., a passenger train was derailed and the baggage car and two passenger cars were overturned and fell down a bank. Fourteen passengers and three trainmen were injured, two of the latter fatally.

†unx, 17th, Atchison, Topeka & Santa Fe, Scranton, Kan., a special westbound passenger train was derailed and ditched. Twelve passengers were injured, one of them fatally.

bc, 18th, Southern Ry., Seneca, S. C., butting collision between a freight train and a work train, wrecking both engines and several cars. One fireman and three other trainmen were injured, the fireman fatally.

bc, 18th, Cleveland, Cincinnati, Chicago & St. Louis, Elizabethtown, Ohio, butting collision between two trains, each of which consisted of an engine and a caboose, badly wrecking both. One engineman was killed and eight other trainmen were injured.

unf, 18th, Illinois Central, Bogue Chitto, Miss., a freight train was derailed at a washout, and the engine was overturned. The fireman was killed and the engineman injured.

unf, 20th, 1 a.m., Pennsylvania road, Conewago, Pa., the third section of train No. 19, composed of express cars, was derailed by a rock which had fallen on to the track in a cut, and the engine and first four cars fell down a bank. The engineman, fireman, conductor and one express agent were injured, the latter fatally.

bc, 22d, Norfolk & Western, Kenova, W. Va., butting collision of freight trains, wrecking both engines and several cars. Two tramps were killed and the conductor and engineman were injured, the latter fatally.

xc, 22d, 3 a.m., Massillon, Ohio, a freight train of the Baltimore & Ohio ran into a passenger train of the Wheeling & Lake Erie, at the intersection of the two roads, and one passenger car was badly damaged. A brakeman of the passenger train was killed and one passenger was injured.

bc, 23d, Chicago, Burlington & Quincy, Violet, Neb., butting collision between passenger trains No. 15 and No. 16, badly damaging both engines. Seven passengers and two trainmen were injured. It is said that one of the trains approached the station at excessive speed by reason of some difficulty with the air-brakes.

unx, 23d, Chicago, Rock Island & Pacific, Princeton, Mo., westbound passenger train No. 3 was derailed and 40 passengers and three trainmen were injured.

unx, 23d, 1 a.m., Atchison, Topeka & Santa Fe, Topeka, Kan., passenger train No. 17 was derailed and all of the cars except one were ditched. A mail clerk and express messenger, one passenger and a tramp were injured, the latter fatally.

bc, 24th, St. Louis & San Francisco, Sarcoxie, Mo., butting collision between a passenger train and a freight; 11 passengers injured.

bc, 27th, Lake Shore & Michigan Southern, Sturgis, Mich., butting collision between a westbound passenger train and an eastbound empty engine; engineman, two mail clerks, and one passenger injured.

xc, 27th, Texas & Pacific, Fort Worth, Tex., a passenger train collided with some freight cars, and one passenger and three trainmen were injured.

unf, 27th, Seaboard Air Line, Pee Dee, N. C., a freight train was derailed at a culvert which had been washed out, and the engine and nine loaded cars were wrecked. The engineman and fireman were killed.

bc, 28th, Baltimore & Ohio, Hayes, Pa., butting collision between a passenger train and a freight, badly damaging both engines and several cars. Ten passengers were injured.

30th, Chicago, Milwaukee & St. Paul, Bardwell, Wis., a freight train was derailed at a derailing switch and the engine and 18 cars were wrecked. The engineman, fireman and one brakeman were injured.

## Time Package Freight on the Southern.

Last week we printed a full description of a system recently put in use on the Canadian Pacific for promptly despatching and carefully keeping track of fast through freight shipments. The Southern Railway has in use a less complete and complicated

Fig. 1—Red Card for Time Package Cars.

system which is applied to all cars requiring quick transit such as refrigerator cars containing vegetables, fruit, meat, poultry, eggs, beer, etc. A large part of the freight business of the Southern is made up of shipments of fruit and vegetables to the northern markets and of meat south. All cars loaded with such commodities are forwarded with one of the cards shown in Fig. 1 tacked on the door on each side of the car. This card measures 9 in. x 14 in. and is printed

in red with white letters and blank spaces. The card is properly filled out with blue pencil with the destination, originating point and date and train number in which the car was forwarded. If the car or cars originates at a station between division points the agent fills out the form shown in Fig. 2 and telegraphs the report to the Superintendent of Transportation as soon as the train taking the car has left the station. When a train leaves the yard at each division point the yard foreman makes out one of these reports showing all the cars of package freight in that train and this is telegraphed in, the same as the agents report. In case a car is set out for any reason, the Superintendent

SOUTHERN RAILWAY COMPANY.

_____ DIVISION.

_____ 190

SUPERINTENDENT OF TRANSPORTATION,
WASHINGTON, D. C.

Below please find correct list of all cars loaded with Vegetables, Fruit, Melons, Poultry Eggs, Beer, etc., Received from

*A *B *C

_____ Train No. or Connecting R. R. (Time) _____ M. _____ 190

*D *E *F

forwarded by Train No. _____ Section No. _____ or Delivered _____ R. R.

*G *H *I

leaving here at _____ o'clock _____ M. (date) _____ 190

| *J INITIAL. | *K NUMBER. | *M CONTENTS. | *N FINAL DESTINATION. | *O RECEIVED AT | *Q EXPLANATION OF ANY DELAY. |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 21 | | | | | |
| 22 | | | | | |

_____ *Agent or Yardmaster.*

**INSTRUCTIONS.**

This report to be made up by *Yard Foreman* or *Agent* and telegraphed to Superintendent of Transportation as soon as train leaves his station.

Cipher letter "O" Received at, to show connection received from or local starting point on line of Southern Railway.

Make full explanation of any delay.

If Cars are transferred, show Car Number and Initial into which transferred.

Operators will transmit only written portion of this report, and use Cipher Letters for that purpose indicated thus*.

Fig. 2—Form for Reporting Departure of Time Package Cars.

of Transportation is informed by wire immediately, and when the car is picked up, the fact is noted in the yard foreman's report at the next relay point. The car service office, knowing the destination of each car, can follow up its movement with little labor by checking over the successive reports from relay points. For a comparatively short road such as the Southern, where trains are not on the road more than two or three days at a time, this system is well adapted. The more complicated system of the Canadian Pacific avoids confusion and delay on a road where trains are often a week or ten days en route from terminal to terminal.

We are indebted to Mr. J. N. Seale, Superintendent of Transportation of the Southern Railway, for the forms shown and information furnished.

## Motor Cars as Feeders to Railroads.*

After a general discussion on motor cars and motor car working, Mr. Campiglio cites the following specific instances of the use of motor cars as feeders to steam railroads. A public service with five motor cars is in operation at Speyer in Germany. In 1900, these motor cars conveyed 100,000 passengers in making eight daily trips, out and return, on two of the lines, and four on another line, which forms a continuation. The average daily run of each car was 37.3 miles. The cars weigh 15,430 lbs. each; they carry from 18 to 20 passengers seated inside, and eight standing on the rear platform. They have 10 horse-power two-cylinder motors, and this is enough during the good seasons of the year. But owing to the bad state of the roads in winter, the management advises that in similar cases 12 to 14 horse-power motors should be employed.

In winter it becomes difficult to keep the service going, as the resistance is much greater owing to the bad state of the roads, and it is then necessary to reduce the speed, or else the motor may fail to act. When there is snow, there is even more trouble, and it is necessary to fit special tires to the wheels. But if the snow is very deep and soft, these tires are no longer effective; this is a very rare case, however, and in the service in question has only happened once in the winters of 1899-1900 and 1900-1901. Trouble has arisen in winter through the freezing of the cooling water, but this has been overcome by adding a certain proportion of glycerine to the water. This in its turn makes everything dirtier.

In this service, later on, open trailers weighing 3,300 lbs. were used in summer; the trailer had twenty seats, so that the motor car and trailer together could take about 50 passengers. The trailers were coupled up by a sort of fork so arranged that the trailer followed in the same track as the motor car. In addition two safety chains were used. The trailers have solid rubber tires, which make them run very smoothly, and the public preferred the trailers to the motor cars. This service, which has now been running for over three years, is carried on regularly and the management states that it is quite satisfied with its motor cars, with the reservation that if any new cars are required the power should be increased to 14 or 15 horse-power, particularly if trailers are to be used.

A service of motor cars with Daimler petrol motors was started last summer, between Genoa and Torriglia, 21.7 miles, on a rising gradient. The distance was covered in two hours and a half up and in one and a half down. The car bodies were apparently subjected to too great loads, so that repairs became necessary.

Another public service, of three Daimler cars with 18 seats each, was run between Cortina di Ampezzo and Toblak (Tyrol), over a distance of 19.3 miles. It was stopped because it did not pay, and it is impossible to obtain any further particulars as the company which ran it has been broken up.

A motor car service (petrol motors) about which information is available, is that of the *Société Anonyme des Messageries Francaises Automobiles* in Tunis. It has five Panhard cars, of 16 horse-power, which can carry a load of 3,300 lbs. (sixteen passengers and luggage) at an average speed of 13.7 miles per hour if the roads are in their ordinary condition. The back wheels of these cars have iron tires, the front ones solid rubber tires. The cost of maintenance has been estimated to amount to $4.00 per car per day, the car making a daily run of 62 miles. It is assumed that the cost of renewals: wheels, etc., up to the end of the year will certainly not average $10.00 per day, and it is estimated that the solid rubber tires will run 18,640 miles before they will have to be renewed. An experimental motor car service (Dietrich petrol cars, with 12 seats) has also been organized between Luneville and Blamont.

A service of motor cars, with de Dion-Bouton steam motors, has been organized at Rouen by the *Compagnie des Messageries Automobiles*. There is a regular service of three omnibuses, two of 35 horse-power and one of 25 horse-power. The cars have been running about a year, with satisfactory results. There was occasional trouble in winter, during times of rain and snow; nevertheless, though the runs amount to 25 and 31 miles, the cars were never more than about three-quarters of an hour late. The average speed is 7.5 miles per hour, whereas it should amount to from 10 to 11.2 miles per hour. Concerning the motors, the management recommends that great care should be paid to the boilers: "It is advisable to clean them out with steam every evening, to scrape out the spaces between the tubes every week and to take out the tubes frequently." Another recommendation is to have a spare boiler to each two cars, so as to make it possible to replace the boilers whenever necessary.

It is estimated that 15 or 16 lbs. of coke

*Extract from a paper by A. Campiglio, President of the Italian Union of Light Railways, in the Bulletin of the International Railway Congress.

are burned per mile run and that 3½ lbs. of grease, 3½ lbs. of cylinder oil and 4½ lbs. of lubricating oil are consumed for every hundred miles run. The crew of each car consists of a skilled driver and a fireman, and in Italy a service of steam motor cars made by the same firm is run between Spoleto and Norcia, 31 miles, over a very undulating road, which is 1,050 ft. above sea level at Spoleto and then rises to a maximum of 2,400 ft., goes down to 1,093 ft. and then up again to 1,980 ft. above sea level. The grades average from 5 to 6 per cent. and in some places are as high as 7½ per cent. The service was inaugurated Oct. 20, 1902, with motor cars which could carry 22 passengers. The boiler is of the multitubular type, with a heating surface of 48.44 sq. ft., and the maximum pressure is 256 lbs. per sq. in. The power is transmitted through a jointed shaft and bevel gear to the back wheels, which have tires 4⁵/₁₆ in. wide.

The cars can carry a load of 6,600 lbs. and their maximum running speed is from 9 to 11 miles an hour, which is reduced in ordinary practice to 7⅘ miles an hour, the cars making the run from Spoleto to Norcia in four hours, whereas horse vehicles took six hours. The cost of each car is about $5,200. The cost of working during the first 72 days, during which a total distance of 5,650 miles was run, was as follows:

| | |
|---|---|
| Wages | $1,675 |
| Fuel | 506 |
| Lubricants | 98 |
| Lighting | 17 |
| Cotton, waste, etc. | 9 |
| Maintenance | 71 |
| Total | $2,376 |

But some exceptional circumstances entered into this table, and it is estimated that in original circumstances wages would work out at the rate of about 9 cents per mile run, fuel at about 6 cents, lubricants at about 1½ cents, maintenance at about 2⅘ cents and interest, sinking fund, general expenses and insurance at about 11¾ cents.

A detailed comparison of the cost of conducting a run of 9¼ miles on fairly level country where horse traffic can be run which would obviate the necessity of using extra horses on any of the steeper grades shows quite an economy in favor of the motor car service, entirely apart from the additional advantage of the higher speed. The author estimates that to run a three-trip-per-day service of horse vehicles under the ordinary conditions as to price of horses and carriages existing in upper Italy requires a capital expenditure of approximately $8,200 and a daily expenditure of approximately $13, while a similar service with motor cars requires a capital expenditure of about $9,600 in the first instance, but a daily working cost of only about $12. This is calculated on the assumption that the average day's work per horse is about 19 miles.

The author considers that the motor car is, however, not to be considered as a possible rival of the electric interurban line, but rather as a co-operator in its development. In cases where the electric road cannot be built because of the doubts as to its success, a motor car service can determine how much traffic there actually is and develop it without heavy expense, since the motor car can be run elsewhere as soon as the electric road is built and takes care of the traffic previously developed.

As to the respective use of steam and petrol motors, the author believes that the explosion engine is the most satisfactory. For the same number of passengers, the same speed and the same length of run, without requiring fresh supplies, the petrol cars are lighter than the steam cars, and by a small increase of weight, their speed can be materially increased, while the steam motor requires a much more considerable increase in the dead weight and in the supply of fuel and of water. It may be asserted that steam motors have been improved nearly up to their possible limit and that, owing to their unavoidably great weight and the cost of the material of which they are made, there is no reasonable hope that their cost can be materially reduced. On the other hand, explosion motors are still in an initial stage and a considerable reduction in their mechanism may certainly be expected from the simplification of manufacture due to the intense competition which prevails.

In petrol motors, there is another advantage which has to be taken into account, and that is that they can always be started at once, whereas a steam motor requires about three-quarters of an hour before a sufficient head of steam can be accumulated to start. If at any time in public service it is necessary to start a reserve car owing to a sudden rush of traffic or to replace a broken-down car, this can be done much more quickly with an explosion motor than with a steam motor.

## The Weir Frog Company's New Works.

The accompanying illustration shows the floor plan of the Weir Frog Company's (Cincinnati) new shops at Norwood, Ohio. The plant was designed by Bert Baldwin & Co., architects and engineers, of Cincinnati and New York.

The buildings are two, two-story brick buildings 100 ft. by 60 ft., one used for general offices and draughting room, and the other with men's wash and locker room on the first floor, and pattern shop and storage room on the floor above. Each of these buildings is connected to the shop by covered passage ways.

The main shop is a single story brick building, 125 ft. wide and 662 ft. long, having an area of nearly 83,000 sq. ft. under the roof. The main aisle is 61 ft. 2 in. span, and the two side bays are 31 ft. wide. The roof is carried by steel truss supported on steel columns. The light comes from the windows in the side walls, which are set about 6 ft. above the floor, from the four skylights in the roof, and the side windows above the roof of the bays. The shop is heated throughout by the American Blower Company, Detroit, Mich. and the Webster vacuum systems, using exhaust steam from the engine. The erecting and main machine floor is 125 ft. by 260 ft., it has a concrete and cement floor, as have also the drill press, engine, filter and boiler rooms.

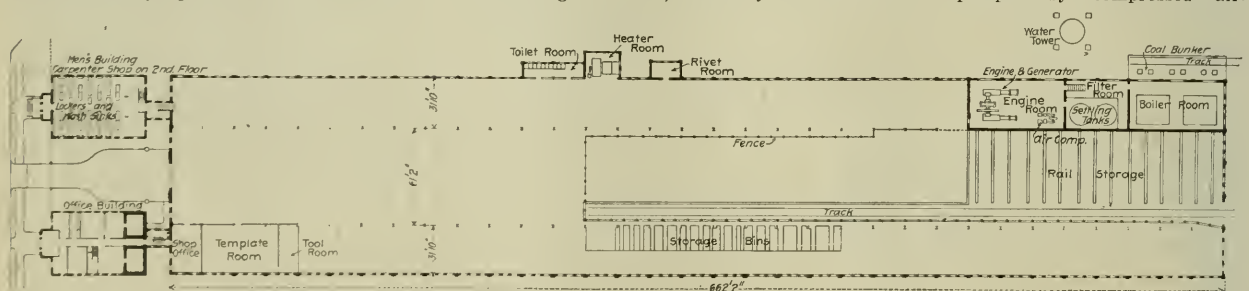
The 60 ft. span is served by two electric cranes made by the Case Mfg. Company, Columbus, Ohio. One is used principally to load and unload cars, and the other to supply the erecting floor and machines with material from the stock department. On this floor are the planers, straightening machines, and some special machines.

Beyond the erecting floor is the stock department, where is kept all the material received into the shop. Into this end of the building is brought the railroad track, which holds ten cars, and is set enough below the general level to bring shop floor even with level of the car floor.

The stock department is 60 ft. by 400 ft., and is enclosed by a fence, and is in charge of a stock-keeper. The heavy material such as rail, plates and bars, are piled on the floor. Small supplies like rivets, bolts, nuts, etc., are placed in storage bins.

The forge department, on the south side of the main building, is equipped with forging machines, presses, hammers, heating furnaces, and blacksmith fires. On the north side of the building, opposite the forge department, are located special tools for bending, curving and drilling rails, etc.

The power plant consists of a 500 h.p. Brown automatic compound engine, made by I. & E. Greenwald Co., Cincinnati. This is direct coupled to a 300 k.w. Bullock generator, made by the Bullock Electric Mfg. Co. (Allis-Chalmers Co.), Cincinnati; the current is 220 volts. Every machine in the shop has an individual Bullock motor, except a few small machines taking power from a line of motor driven shafting. An Ingersoll-Sergeant air compressor made by the Ingersoll-Sergeant Drill Company, New York, furnishes power for riveters and pumping water. An 8 in. artesian well, 320 ft. deep, supplies all the water used for boilers or other purposes. The water is pumped by compressed air and stored in an elevated tank 60 ft. above the ground, with a capacity of 20,000 gallons. This was erected by Flint & Walling Mfg. Company, of Kendallville, Ind. The floors of the filter and boiler room are 10 ft. below the level of the engine room floor, and about 8 ft. below level of outside ground. All coal is received in hopper bottom cars, and dumped direct on the floor of the boiler room. There are four 250 h.p. boilers made by The Stirling Company, Chicago, Ill. These are equipped with American stokers, made by the American Stoker Co., Erie, Pa. The well water is softened and filtered by the Wefugo process, and heated in a Webster exhaust steam heater made by Warren Webster & Co., Camden, N. J.




Floor Plan of the Weir Frog Company's Shop, Norwood, Ohio.

## WATCHMEN OR AUTOMATIC BELLS?

The grade crossing accident at St. Louis, September 3, in which six persons were killed, was followed by an animated discussion, in the newspapers, and it came out that the railroad company had asked special permission from the proper bureau of the city government to allow certain crossings to be watched by men without putting up gates. The city had demanded that gates be erected without delay and the railroad company begged off on the ground that that was not the best way to promote the safety of people crossing the tracks. It turned out that Sarah street, where the collision occurred, was not one of those concerning which this arrangement was made, although at first it was so claimed. This, however, has nothing to do with our present purpose. Neither shall we take up at this time the question of the protection of electric cars, as distinguished from the protection of horses, carriages and pedestrians; the only adequate protection at grade crossings for the heavy and fast cars which nowadays are run on electric railroads is to put them on precisely the same basis as the cars and engines of the steam railroad; that is, to require a complete equipment of interlocked signals for both lines, the same as in the case of a crossing of one steam railroad with another. The point we wish to make now may best be introduced by quoting a letter published in a St. Louis paper, sent by an officer of the Wabash to the commissioner of the street department of the city four months ago. In this letter it is said:

"In regard to the crossings at Newstead, Boyle and Delmar avenues, at which this company has agreed to place gates provided it is necessary for the protection of teams and pedestrians, I find from long experience with gates in this city, Chicago, Detroit, Buffalo and Cleveland, that they are of very little practical use so far as perfect protection is concerned. When there are gates at a crossing the man who attends the gates stays in his house and looks out for trains; as soon as he sees one approaching he turns his back to the crossing to pump his gates down, and from that moment until the time the train passes he is of no value as a crossing watchman. From the time the gateman begins to pump his gates until they are down is about two minutes, if they are in order. During these two minutes there is absolutely nothing to prevent a team from driving on the track, or a pedestrian from walking on it; as a matter of fact, over half our claims from Chicago arise from cases where the driver or the pedestrian have passed under the gates while they were being lowered, in the hopes to beat the train.

"It is my opinion that a good watchman who stands on the crossing at all times and continually keeps his eyes on the tracks and upon the teams can do much more towards making a railroad crossing practically safe than crossing gates ever can.

"If you are willing to allow us to operate these crossings without gates I will place a good, reliable day and night crossing man at each street named, and keep them there. And, while I cannot guarantee that no accidents will happen at any of these crossings, I can say that the service will be much nearer perfect than gates could make it."

We print these views of the Wabash officer because they have a considerable basis of reason. (Though his own statement of reasons is defective.) Crossings are guarded in three ways; by gates, with an attendant; by men, without gates, waving a flag, and by automatic bells without either gates or men. The common view is that the three are effective in proportion to their cost, the bells being the cheapest and the least reliable. But this is by no means to be unreservedly accepted as everywhere true. Bells may give many a useful warning that is never put on record, making the cheapest method the best. Our gates are not perfectly effective barriers, because they are so easily broken and because pedestrians can crawl under them; so that the costliest method may not give the protection that it seems to give.

The gate being only an imitation or a partial barrier, why is not an efficient man with a flag about equally good? It may be that to carry our point we should have to amplify our flag into a "big stick," for if the man be disposed to be "efficient" he will often find it necessary to club foolhardy people into submission to his commands, or at least to threaten to do so. But whether with a stick, or a commanding voice, or a frowning countenance, a man of the right kind certainly can give a fully adequate warning to any person not blind or deaf. The real difficulty is in finding the right man. Those who can subdue reckless drivers by a look, and who will be vigilant to protect every absent-minded pedestrian, are not to be had for a dollar and a quarter a day. But that is half the trouble with the gates. The vigilant man is needed with the gate. With attendants of feeble body or mind, or even with men of considerable energy, if they are not carefully disciplined, there must always be occasional lapses, gates or no gates. Given the necessary ability on the part of the attendant, the gate is not necessarily a hindrance, for the apparatus need not be arranged (as described by the Wabash man) to require the attendant to turn his back to the crossing. On the whole, therefore, it may be said that there is potentially much sense in the theory that a man is as good without a gate as with one; though practically, with a large share of the crossings everywhere manned by more or less dull or unskilful or superannuated men, the theory is not proved.

But there is a prominent officer of a large Western road who holds that a bell is better than either a man with a flag or man and gates together. This opinion is based on long experience and extensive study of the records of the claim department; and while not susceptible of demonstration is worthy of respect, because of its source and because an automatic apparatus ought to do away with most of the troubles due to human fallibility. Bells properly cared for are now free from most of the deficiencies that gave them such a doubtful reputation a few years ago. Unfortunately, it is probably too much to assume, even now, that every municipal government could be safely assured that if it got all its crossings equipped with bells it would be securing the protection that it bargained for. Poorly managed signal departments, and poorly managed roads that have no signal department, are not yet quite extinct, and bells neglected by the inspector are no more reliable now than in the past. But competent batterymen, repairmen and inspectors are not so rare as formerly, apparatus has been more fully perfected and bells can be made to do what they purport to do; so that the theory that a bell "fills the bill" deserves careful consideration. A bell should not be required to do more than it is designed to do. It should not be expected to give satisfactory service in and near yards, where there is much backing-up and many low-speed movements. A bell should receive as careful inspection and maintenance as an automatic block signal. But with all the conditions intelligently considered, there would seem to be no reason why the obvious advantages of the automatic bell should not be availed of. The cost is far less than for an attendant, and it is on duty 168 hours a week; and it affords a practicable means for forestalling the demands which municipal officers feel it their duty to make on the railroads every few months or years. It is perhaps hopeless to think of smothering city or town officials by kindness; of safeguarding crossings before they think to ask for a gateman; but the idea is worth thinking about.

## CRANES IN ENGINE HOUSES.

The weakest point in the organization and equipment of the motive power department on most railroads is the lack of adequate roundhouse and engine terminal facilities. While so much attention has been paid to building modern and well equipped general repair shops for making the heavy repairs to locomotives, the equipment and organization of the smaller shops and roundhouses at outlying points has been sadly neglected. It is true that there have been decided improvements in the general design of engine houses in the way of better lighting, heating and ventilation, and all of these have had their effect in making work easier and in reducing the cost of running repairs to some extent, but there is still much to be desired. On most railroads the running repairs and light repairs which are made on the road and in the engine houses amount to considerably more than half of the total cost of locomotive repairs, both light and heavy, and proportionately there is usually more need for improvement in the facilities of the small shops than there was for improvement of the main shops, because the conditions were worse to start with. It is not sufficient to simply provide plenty of light and heat and fresh air, in order to bring the cost of repair work down to the lowest point; the repair shop must be equipped with the best machinery, and not with tools which have been discarded from the main shop because no longer fit to use.

One of the points which seems to have been overlooked in designing roundhouses is the installation of the labor-saving devices which are considered absolutely essential in the main shop. A general locomotive repair shop without cranes of some sort would be almost useless for any kind of repair work, either light or heavy. But is there not almost as much need of cranes in engine houses as in shops? They would be such a distinct advantage in so many ways that they would pay for themselves over and over in the saving of labor and in lessening the time required to make repairs. Most of the parts of the modern locomotive are proportionately as much heavier than the same parts of the locomotives of fifteen years ago as the whole machine is larger and heavier than the engines which they have replaced and, in short, the methods in use ten years ago in making roundhouse repairs are no longer practicable; often no longer possible. A single instance observed recently is typical of what occurs daily in many engine houses. A heavy freight engine had been

run into the roundhouse, and in order to make some necessary repairs one of the side rods had to be taken off. As many hostlers, sweepers and laborers as were in sight were called to help on the job. After much time and effort had been spent, it was found that more men were needed; and, none being within call, the men already gathered, stood idle while additional help was obtained from outside of the engine house. With a crane at hand, the job could have been done in a fraction of the time and by two or three men.

In some roundhouses overhead traveling cranes have been erected. In others post cranes attached to the supporting columns of the roof between each two pits have been used. A somewhat roundabout method is that which the Santa Fe recently used on its enormous 2-8-2, Santa Fe type engines. A light crane is fixed to the side of the smoke-box above the cylinders and most of the heavy parts of the running gear in front of the cross-head can be handled with this. One reason, doubtless, why traveling cranes have not been put up in roundhouses, is the great difficulty of avoiding the smoke jacks. In some of the applications which have been made the crane has been placed adjacent to the inner circle, but this limits its usefulness in a great degree. Another method is to do away entirely with the smoke jacks and depend upon ventilation through the roof to dispose of the smoke. A third method employs forced exhaust ventilation. The pipes are fixed so as not to interfere with the crane, and the smoke jack is done away with entirely. Still another method is to use a telescoping smoke jack which can be lifted out of the way to allow the crane to pass. The installation of a traveling crane in a roundhouse is, of course, more difficult than in a rectangular engine house or shop where the main runway can be made straight. One of two methods is required to keep the crane always in a radial position. Either the wheels on the inside runway must be made of smaller diameter than those on the outside, or the traversing shaft must have a differential gear. Even with the most careful workmanship in building the crane and manipulation in handling it, the bridge cannot be kept in a true radial position, and it is necessary at least once or twice a day to run it up against squaring blocks placed on the runway. This, however, is not a serious objection, since the same thing must be done periodically on most cranes which run on a straight track.

Do American railroad men realize that within a few years they may wake up some morning to find that one of their most familiar acquaintances is no more? We refer to the American type locomotive. An American landscape without a railroad track would hardly be an American landscape; and an American railroader's imagination that does not contain one or more images of the ubiquitous eight-wheeler is inconceivable. Is there anything more familiar to all of us? Professor Goss, in the course of a discussion before the International Engineering Congress at St. Louis, referring to the work and worth of this type of locomotive, said:

"In the early days, it made little difference whether the service was freight or passenger, or whether the locomotive was for use on heavy grades or level track; the fitness of the American type was rarely questioned. As a response to early conditions, the type was almost perfect. Adherence thereto made the problems of the builder few and the cost of production low, and these were important factors at a time when track-mileage was increasing at enormous bounds. As the same patterns were used over and over again, the form and proportions of every detail were tested in service on hundreds of locomotives, hence the cost of maintenance was low. The type is well adapted to the rough track common in pioneer work, and is, moreover, very efficient as a steam power plant. . . . The decline of the American type is due to the fact that it cannot take on proportions which the modern locomotive must possess. Many different means were adopted in transforming the American locomotive of 1876 into the American locomotive of 1893. The boiler was raised above the frames that the fire-box might be made wider. The axle spacing of the driving axles was increased that the grate might be made longer, and wheel-loads were augmented that the tractive power might be increased; but when all of these measures had been carried to their limit, still more power was demanded, and the abandonment of the type became imperative. It is not unlikely, therefore, that a machine which for forty years has been in a remarkable degree typical of American railroad practice will soon disappear from the roads of this country."

And in its place we shall have to set our affections on the "hog," the "battleship" and the ungainly Atlantic—or else turn our affections into new fields. Perhaps our next new love (or that of our children) will be only a rectangular mass of iron, with little to distinguish it from a huge metallic mole except a copper wire sticking out somewhere!

## Gross Earnings for August.

Railroad gross earnings for the month of August are favorable and indicate that on the whole traffic is on the mend; that the business depression may be near its end. For the month 97 railroads report an increase of $1,551,206 over August of last year. This is most encouraging when one considers that in July, 82 roads reported a decrease of $4,306,589. Of 72 of the more important roads reporting earnings, 42 show increases and 30 decreases. The final ending of the meat-packers' strike caused a freer movement in live stock and dressed beef, the shipments in these two commodities showing large gains over the shipments in July. There was also a much larger grain movement in the West, the high prices in the grain market apparently acting as a stimulus to shipments. Cotton, too, began to move in freer quantities than last year, the receipts at the southern ports being over 100,000 bales as against 6,000 bales in August, 1903. There was also a heavy increase in passenger receipts from the World's Fair business. The only adverse feature in the month was the depression in the iron and steel business; but this seems to have been more or less offset by a slight increase in traffic of a lower class. In fact, traffic has not really fallen off, but is heavier than last year at this time. To take an unfavorable view we must join those "optimists" who expect large gains to go on forever.

Gross earnings, when divided geographically, show that the largest proportionate loss was in the anthracite and southwestern groups of railroads and that gains were recorded in all the other groups, notably among those railroads running through the Southern and Middle States. Earnings arranged geographically may be summarized as follows: Southern group (12 railroads), increase $738,818; Middle and Middle-western group (14 railroads), increase $588,096; Northwestern and North Pacific group (14 railroads), increase $298,850; trunk line group (eight railroads), increase $150,188; anthracite group (five railroads), decrease $451,110, and Southwestern group (10 railroads), decrease $93,881.

Among the separate railroads showing considerable gains in gross were the Canadian Pacific (gain of $398,084); Wabash, $359,361; New York Central, $228,640; Southern, $287,545; Northern Pacific, $177,315; Chesapeake & Ohio, $174,490; Missouri Pacific (including Central branch), $157,000; St. Louis Southwestern, $125,650, and the Pere Marquette, $119,935. The heaviest losses were made by the Erie and the Lehigh Valley, which showed decreases for the month of respectively $351,721 and $344,110. The Denver & Rio Grande still appears to feel the effect of the labor troubles in Colorado, and showed a decrease in earnings amounting to $176,400. Other losses reported were: Great Northern, $153,585; Atchison, Topeka & Santa Fe, $150,398; Baltimore & Ohio, $119,096, and Reading, $118,124.

One Russian official seems to have won great credit during the war with Japan, and that is Prince Khilkov, the Minister of Transportation, part of whose early railroad training was obtained in this country, which he visited again a few years ago. When the war broke out, the line east of Lake Baikal, which was not entirely complete, had stations on the average 35 miles a part, and it was possible to pass very few trains daily—quite as many, doubtless, as the commercial traffic was likely to require. The war changed all that; vast forces must be carried over the road and supplied. The preparation for this naturally began immediately. Rolling stock was brought from Europe and carried across the ice of Lake Baikal, and many additional sidings built; while work was pushed on the very difficult line around the south end of that lake, which it had not been expected to finish for two years to come. This railroad is not yet open, but the improvements of the line west of the lake have been proved to be effective. A German who passed over the railroad from Manchuria to Europe writes to the Cologne *Gazette* that he traveled by the mail train from Kharbin to Irkutsk in seven days, including the passage over the lake and 12 hours delay at the Chinese border. He counted the trains which were met and found them to be 14 to 16 daily; which means an average of about eight daily passing eastward by any stationary point. These trains consisted usually of 20 to 25 cars, marked to carry 48 men or eight horses each (what we would call box cars); but usually not having more than 30 men per car. It appeared that about 2,200 men were forwarded daily, or 1,800 infantry, 500 horses, and eight pieces of artillery. Nowhere appeared any disorder in the movement. The mail train kept the time-table, which provides for a slow rate of speed. He was 16½ days going from Mukden to St. Petersburg, which is only 2½ days more than the time-table called for in time of peace. The operation of the road has been so much better than was expected that Prince Khilkov is almost deified throughout the empire.

Mr. Bion J. Arnold's presidential address before the International Electrical Congress at St. Louis, which is printed elsewhere in this issue, is a most rational and comprehensive statement of the probabilities of electric traction replacing steam. Although he treats the situation in a broad way and although critics might justly claim that the discussion is academic, his statements remain valuable for their fundamental truths. One point is particularly striking; the conception of the ideal conditions for electric traction on trunk lines. His idea would be to have two or more tracks, arranged in pairs, each pair of tracks being used exclusively for trains of one class running at approximately the same uniform speeds and making the same stops. In this way the heavy through freight could be handled in a large number of comparatively light trains running at medium speeds, instead of a few

long, heavy trains hauled by one or two powerful units. Much has been claimed about the future possibilities of electricity replacing steam on the great trunk lines; but mostly by men who have not given the subject careful study. Being filled with optimism, they have taken it for granted that because interurban passenger roads can make money out of local business, the same economies can be accomplished in handling through passenger and heavy freight business, and without much change in operating conditions. The success attained by interurban roads is due to the running of a comparatively large number of light trains, and the consequent equalization of the load on the power house at all times. This is an essential feature of the economy of electric traction, and the application of electricity to existing steam roads must necessarily conform to it.

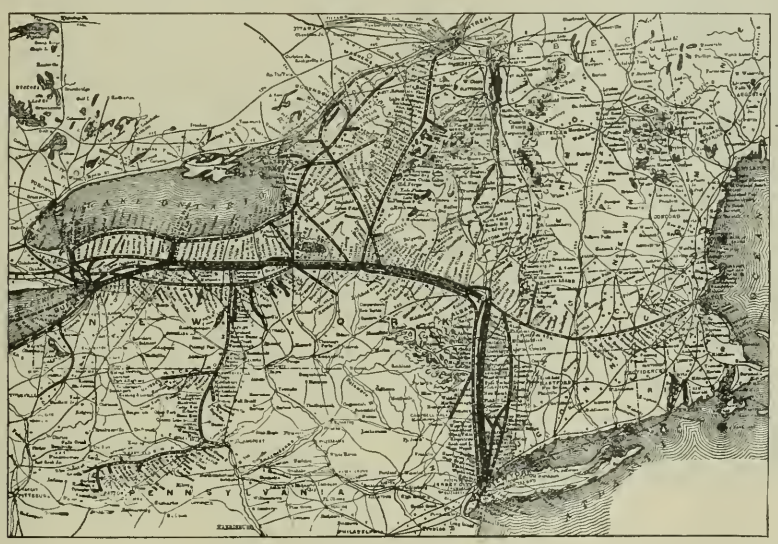
## New York Central.

The New York Central & Hudson River Railroad reports for 1904 a surplus from operations of $7,715,863, or 5.83 per cent. earned on the stock. But among the items of extraordinary expenditure we find an item, "Additions to and replacement of equipment, and improvements to roadway and structures and charged to expenses $3,196,452." Unfortunately this total includes "replacements" which are not betterments but merely extraordinary renewals. If, however, in the absence of definite information, we consider the entire amount betterments we may increase the stated net income by this $3,196,452. The actual net income of the year then becomes $10,912,315, which amounts to 8.25 per cent. on the capital stock. It is probably safe to say that the road earned over 7 per cent. in the year just closed.

The mileage operated was this year 3,490, as compared with 3,423 last year, an increase of 67 miles. The increased mileage consisted of four spurs into the bituminous mine territory, providing outlets or additional outlets on lines of better gradients.

Much heavy work has been done during the year on the Pennsylvania Division. There has now been completed a water level line from the coal mines down the Susquehanna to a connection with the Reading for the low grade outlet to tidewater. The very heavy mountain sections have been avoided by the new links constructed, and the company is now able to haul 75 loaded cars with one engine over a section of 150 miles. Over this same section one engine formerly was able to haul but 20 loaded cars, and it required help at nine sticking points. The grade problem of the same division on the line to the north connecting with the New York Central main line is not so simple but the ruling grade is being brought to a practical working basis for heavy traffic. The capacity of this line for movement has been increased by construction of a second track, on the hills.

The grade of 40 ft. to the mile on the main line just west of Albany has been cut out by construction of the Schenectady detour. This is an important piece of work. At New York city good progress is being made in the great plan of depressing the yard at the Grand Central terminal, erection of a new terminal station and electrification of the first 30 miles north of New York. The report is exceedingly meagre in information about the large plans for electrification and for control of the trolley lines throughout its territory. New York Central is probably well in the lead in the movement by railroads to use electricity where practicable; but the officers are naturally cautious in giving details. The financing of the year was as follows:



New York Central & Hudson River.

| | |
|---|---|
| *Resources.* | |
| Liabilities increased: | |
| Funded debt | $5,346,045 |
| Current liabilities (net) | 5,385,008 |
| Profit and loss | 20,673 |
| | $10,751,726 |
| *Application of Resources.* | |
| Assets increased: | |
| Cost of road | $3,641,567 |
| Stock ownership in other lines | 313,200 |
| Ownership of other property | 3,896,929 |
| Advances to lessor and other companies (net) | 693,306 |
| Sinking fund | 238,805 |
| Liabilities decreased: | |
| Special improvement fund | 1,967,919 |
| | $10,751,726 |

These changes are not great. The increase in funded debt of over $5,000,000 was due to the issue of bonds for the terminal improvements. Being debentures they will not harass operations in any period of declining earnings. The increase in current liabilities of over $5,000,000 was due to the withdrawal of over $2,000,000 of sinking fund assets, by purchase of bonds and their reappearance under the head of "ownership of other property." This accounts for $2,000,000 of the increase in "ownership of other property," while the balance is composed of the cost of a coal mining property and sundry smaller items. The income account stated comparatively with that of the year previous is:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Earnings | $77,682,221 | $77,605,777 | $76,443 I. |
| Expenses | 55,760,061 | 53,459,314 | 2,300,746 I. |
| Net | $21,922,160 | $24,146,463 | $2,224,303 D. |
| Other income | 6,005,981 | 5,272,744 | 733,236 I. |
| All income | $27,928,141 | $29,419,208 | $1,491,066 D. |
| Deductions | 20,212,278 | 20,394,904 | 182,626 D. |
| Net income | $7,715,863 | $9,024,303 | $1,308,440 D. |

The net income has fallen off 14 per cent. The factors to this result are, first, increased expenses; second, increase of other income due to raising of the Lake Shore dividend; third, reduction in the interest charges due to refunding. The final result therefore we see was saved by financial rather than operating considerations. The earnings were:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Freight | $46,233,675 | $46,858,712 | $625,037 D. |
| Passenger | 24,050,121 | 23,581,575 | 468,545 I. |
| Express | 2,615,894 | 2,387,938 | 227,955 I. |
| Mail | 2,405,312 | 2,398,284 | 7,028 I. |
| Rentals | 2,208,270 | 2,175,076 | 33,194 I. |
| Miscellaneous | 168,945 | 204,189 | 25,243 D. |
| Total | $77,682,221 | $77,605,777 | $76,443 I. |

The loss in freight earnings was offset by a slightly greater increase in passenger, mail and express revenue, so that the earnings for the year were practically stationary. On the whole the result is a good one, for the year 1903 was a phenomenal one in the history of this road. Its earnings that year increased nearly $7,000,000 over 1902. It has done well to maintain the same high level this year.

The decline in freight earnings was due to a still larger decline in ton miles, offset by a 5 per cent. increase in the ton-mile revenue. The passenger business has shifted largely from way passenger business to through movement. This is said to mark the inroads of the trolley.

The general detail of expenses is:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Maint. of way | $10,090,892 | $10,469,570 | $378,677 D. |
| Maint. of equip | 11,358,295 | 10,882,375 | 475,919 I. |
| Sinking fund | 32,289,026 | 30,317,129 | 1,971,897 I. |
| Gen. expenses | 2,021,846 | 1,790,238 | 231,607 I. |
| Total | $55,760,061 | $53,459,314 | $2,300,746 I. |

The increase in expenses did not lie in maintenance, but in conducting transportation and general expense. It amounted here to $2,200,000. With a decrease of nearly 6 per cent. in revenue ton mileage there was an increase in transportation and general expense of nearly 7 per cent. The explanation offered is the severity of the winter, the advance in wages, and the higher prices and wages.

The general results of the year may be summed up as not bad in view of the extreme conditions imposed. They are encouraging because they are no worse. The labor situation appears to have become a serious element in expenses. Many of its problems lie beyond the solution of a single road. The management are to be congratulated that they held their own so well.

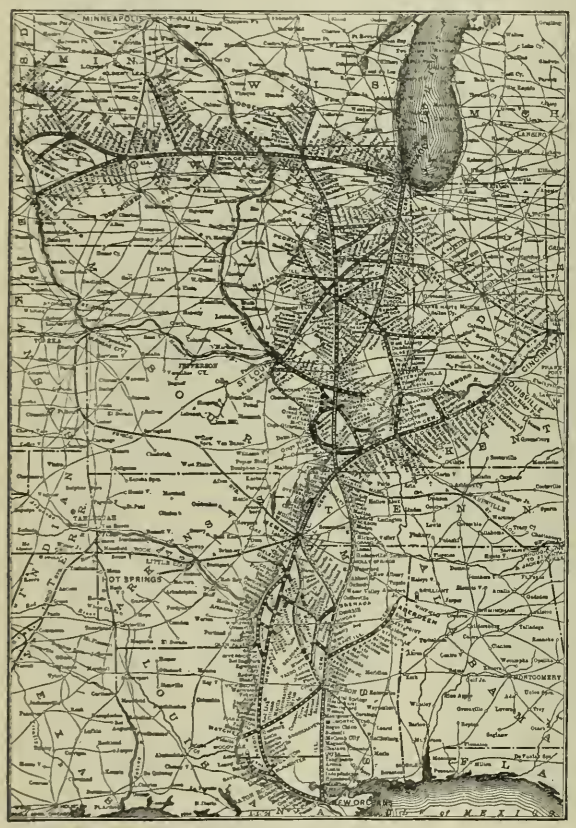
## Illinois Central.

For the year ending June 30, 1904, Illinois Central earned $8,865,927, or 9.33 per cent. on its capital stock. This was a decrease from the net income of 1903 of $1,863,466, or 17 per cent. The dividend paid was $5,702,400 (6 per cent.). There was little change in the mileage. Some 47 miles were added during the year by construction and purchase. The largest single piece thus added was the 32 miles from East Cairo to Paducah, Ky. The rest of the new mileage consisted of half a dozen short spurs.

The equipment roster was increased by purchase of 83 new locomotives, 2,466 new freight cars, and 34 new passenger cars.

The expenditure for new construction and new equipment aggregated nearly $10,000,-

000. Over $6,000,000 of this amount was applied to the roadway and structures. The money there spent was devoted mainly to increasing running facilities, comparatively little being put into yards, terminals or buildings. Thus $3,142,000, or more than half of the entire outlay upon the roadway and structures, went for second main track and a half million more for sidings, and $952,000 for change of grades. There was more attention paid to the condition of track for $313,000 went to grading and track laying and



Illinois Central.

$182,000 for ties and rail fastenings. This latter is described as "construction." It therefore was not renewals but must have been due to raising the type of track maintenance. Of the entire outlay for new equipment and roadway of nearly $10,000,000 over 26 per cent., or $2,597,000, was charged to income, the remainder being charged to capital account except for a small amount ($273,000) defrayed from a special fund. The financing of the year is indicated below.

*Resources.*

| | |
|---|---|
| Increase of liabilities: | |
| Funded debt, Illinois Central | $12,168,750 |
| Funded debt and stock of subsidiary lines | 3,328,300 |
| Special funds | 12,975 |
| Decreased assets: | |
| Advanced to other roads | 2,558,976 |
| Current assets | 11,571,662 |
| | $29,640,667 |

*Application of Resources.*

| | |
|---|---|
| Increased assets: | |
| Road and equipment | $9,415,461 |
| Real estate | 12,025 |
| Materials and supplies | 566,273 |
| Stocks and bonds | 16,144,297 |
| Subsidiary lines | 3,328,300 |
| Special funds | 174,311 |
| | $29,640,667 |

It will be seen that about a third of the $29,640,667 increased resources went into roadway and equipment. Subsidiary lines absorbed $3,328,000, and $16,000,000 were put into stocks and bonds, but $12,162,000 of this is an offset to the increase in the funded debt, $12,162,000 of the bonds of the company being still in the company's treasury. The remainder of the $16,000,000 increase in stocks and bonds is due to the financing of the advances to the Yazoo & Mississippi Valley into 3½ per cent. gold bonds to the amount of $2,245,000. A similar change has been made from the form of advances against subsidiary lines to securities of the Dubuque & Sioux City Line, $571,000.

Summing up the financing of the year Illinois Central has laid out a plan for taking over into one financing consolidation the subsidiary properties which it has so far been operating by control of stocks. But it has not proceeded further upon this schedule than the issue of $12,162,000. Because it has not marketed the bonds which it has issued it has drawn heavily upon current assets and created a floating debt of $3,000,000, while bills receivable and loans on collateral have been reduced over $6,000,000, and open accounts with solvent companies nearly $2,000,000. This reflects the unfavorable condition of the market for railroad securities during the year, and cannot be looked upon as a reflection on the company's credit.

The physical condition of the property is apparently very high. The average weight of rail in main track is 72.78 lbs. to the yard. The average capacity of a locomotive on general level track is 3,734 tons, or 5 per cent. greater than last year. The average capacity of revenue freight cars has been pushed up from 32.87 to 33.77 tons during the year.

Below is the income account for 1904 compared with 1903.

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Earning | $46,831,135 | $45,186,076 | $1,645,059 |
| Op. exp. & taxes | 34,735,682 | 31,697,955 | 3,037,727 |
| Net earnings | $12,095,453 | $13,488,121 | *$1,392,668 |
| Other income | 2,716,548 | 3,461,147 | *744,599 |
| | $14,812,001 | $16,949,268 | *$2,137,267 |
| Rentals and int. | 5,946,075 | 6,219,876 | *273,801 |
| Net income | $8,865,926 | $10,729,392 | *$1,863,466 |
| Betterments | 2,579,329 | 4,881,253 | *2,301,924 |
| Balance | $6,286,597 | $5,848,139 | $438,458 |

*Decrease.

The salient facts in these figures are the small increase in earnings and the large increases in expenses and taxes. When the decrease of over $700,000 in other income is added we have a final net decrease of nearly $3,000,000. The adjustment for this is made by the reduction of the betterment appropriation of the year, so that the surplus for dividend is kept at about the same as last year. The central feature of the whole exhibit is expenses, in which the main points are:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Maint. of way | $5,679,310 | $5,909,195 | *$229,885 |
| Maint. of equip. | 7,323,343 | 6,274,586 | 1,048,757 |
| C. T. | 18,785,938 | 16,676,332 | 2,109,606 |
| General exp. | 1,004,658 | 975,768 | 28,890 |
| Total | $32,793,251 | $29,835,883 | $2,957,368 |

*Decrease.

The increase in actual business handled was only a little over 1 per cent. If we look at it from the standpoint of the actual dollars we find that with its better rates the average business done in 1904 brought in $1,645,059, but the added expense of transportation alone was $2,109,606, or a half million more than the added money taken in. The management frankly calls attention to the excessive increase in expense and explains it as due to the severe winter, the higher cost of coal, and the increase in wages. The last named cause accounts for over $1,200,000 of the entire increase. To these explanations they might have added a fourth in part resulting from the weather conditions, namely, the decline in train load from 289 to 277 tons. It reflects in part also the inferior balance of traffic this year. Altogether Illinois Central has had a rough time of it in operating this year. But its resources are so ample that it is easily able to absorb the irregularities of the year's results, in the amount of its betterment appropriation. It remains for the management to demonstrate in this coming year whether transportation expense has permanently shifted to this higher level. So far as the annual report would indicate the use of big engines and large cars has failed to work the economies expected from them.

## Norfolk & Western.

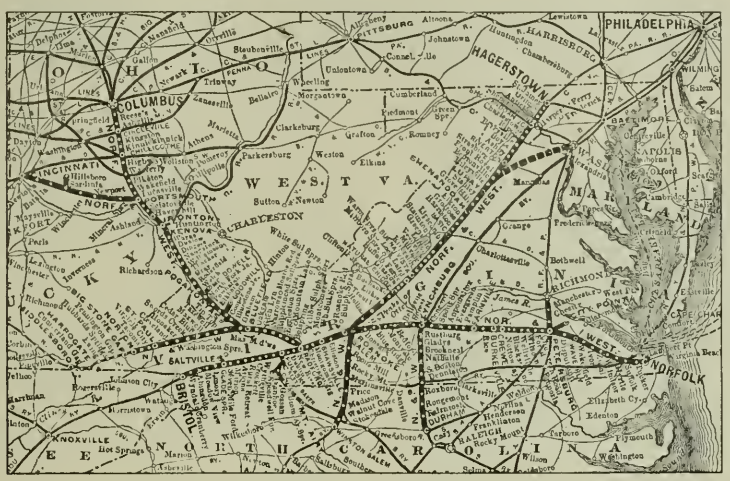
The report for the fiscal year ending June 30 shows gross earnings of $22,800,991, or $1,640,316 more than the previous year. Operating expenses increased $1,516,299, leaving a gain in net earnings of $124,017. The increase in receipts is due largely to the active traffic in bituminous coal, which contributed about 50 per cent. of the total tonnage moved. The shipments of this commodity alone increased 554,648 tons. This more than offset the losses in other commodities caused by the decline in the iron and steel industry. The ton miles increased nearly 20 per cent. The average ton-mile revenue on all freight was 4.93 mills, as against 4.86 mills in 1903 and 4.63 mills in 1902. The number of passengers carried was 3,594,965, an increase of 425,391, which makes a total increase during the past six years, since the reorganization of the company, of over 100 per cent. The growth of freight and passenger traffic and the maintenance of rates, enabled the company, notwithstanding adverse circumstances, to set aside $2,000,000 for betterments, besides paying the regular dividends of 4 per cent. on the preferred stock and 3 per cent. on the common.

During the year, the funded debt was increased by the issuing of $3,500,000 first consolidated mortgage bonds, the proceeds being used to liquidate expenditures made in former years for capital account. The extra interest on these bonds caused an increase in fixed charges, so that net income decreased from $6,040,189 to $5,819,303. The sum of $368,333 for discount and commission on securities was, however, added to income account, leaving $3,156,973 to the credit of the profit and loss account, as against $3,000,588 last year.

The increase of $1,516,299 in operating expenses was not as large as the increase last year, for the reason that the company restricted all work which was not absolutely essential. As a result of the settled policy of the company to put and keep the property and equipment in the best possible condition for moving freight at the lowest possible cost, the road has been able to keep its operating expenses down through the recent business depression without materially hurting its position from an operating standpoint. The expenditures for maintenance of way and structures were $2,860,056, or prac-

tically the same as last year. The maintenance of equipment expenses for the year, $3,532,058, show an increase of about 16 per cent. over 1903. This, however, was caused largely by a heavy increase in the item of repairs to locomotives owing to the severe and protracted winter. Fuel also was extremely high. The heaviest charges were in the conducting transportation account, where the increase over last year amounted to $839,495, due in a large part to higher cost of materials and labor, as on every other road this year.

In accordance with its policy of constantly improving its property, the company completed, during the year, several spurs to coal fields, including the Tug Fork, North Creek and Widemouth branches. Grades were also reduced extensively on the main line so as to lessen the cost of hauling coal. The company expects to have its low-grade line from Naugatuck to Kenova, 59 miles, finished before the end of the year. The total mileage on June 30, 1904, was




Norfolk & Western.

1,769 miles, and the average mileage worked was 1,723, an increase of 10 miles over 1903. The more important statistics of operation follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 1,723 | 1,713 |
| Gross earnings | $22,800,991 | $21,160,675 |
| Freight earnings | 18,894,941 | 17,676,349 |
| Passenger earnings | 3,150,859 | 2,841,491 |
| Operating expenses | 14,213,730 | 12,697,430 |
| Maint.-of-way and struc. | 2,860,056 | 2,754,199 |
| Maint. of equipment | 3,532,058 | 3,041,414 |
| Conducting transportat'n | 6,853,963 | 6,014,468 |
| General expenses | 967,653 | 887,348 |
| Net earnings | 8,587,261 | 8,463,245 |
| Net income | 5,819,303 | 6,040,189 |
| Surplus | 3,156,973 | 3,000,588 |

## Missouri, Kansas & Texas.

The report of this company covering its operations for the 12 months ending June 30, 1904, covers 283 miles more than the last previous report. In the year ending June 30, 1903, the mileage worked amounted to 2,601, while this year it was 2,884. The total mileage operated at the end of the year was 3,043, an increase of 329 miles. Gross earnings increased $558,492, but there was an increase of $536,339 in operating expenses, leaving as a gain in net only the trifle of $22,153. Of the total receipts, freight earnings contributed $13,102,909, a decrease of $153,991, the aggregate tonnage for the year being only 5,204,103 tons, as against 5,319,968 tons in 1903. This loss in freight traffic is chiefly in coal and grain, President Rouse estimating the loss in grain tonnage alone at 11,000 cars for the year. It is undoubtedly a fact that the Missouri, Kansas & Texas is feeling the effect of the large growth in the export traffic at Galveston and New Orleans. The grain traffic which was formerly carried to the northern and eastern ports by this company's lines has lately been drawn towards the southern ports. The company seems, however, to be developing a fair local traffic and the losses in coal and grain were partly offset by a gain in merchandise and other high-class freight, resulting in an increase in the average receipts per ton-mile from .95 cent to 1.06 cents. Passenger earnings increased $641,747 and mail and express earnings $66,381.

Large additions were made to motive power and equipment during the year, the increases including 56 engines, 1,050 freight and miscellaneous cars and 44 coaches. Contracts have been let for the delivery in October of 27 engines and 1,825 miscellaneous cars. Payment for this equipment has been arranged for by a series of notes, the aggregate outstanding obligations of this kind now amounting to $4,315,896. To pay for new equipment bought during the year, an appropriation of $5,353,943 was made from the income account.

The report speaks of the plan of the directors for providing capital for future improvements and extensions, and also for the redemption of the various divisional mortgages now in existence, by the creation of a "refunding first mortgage" to the amount of $40,000,000. Action of this kind would release the surplus earnings (which in the past have been used for improvement purposes) for the payment of dividends on the preferred stock. In case this should be done, the surplus which now is $1,066,368, would suffice to pay 4 per cent. on the $13,000,000 outstanding preferred stock, and about 1 per cent. on the common stock of the company. The more important statistics of operation follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 2,884 | 2,601 |
| Gross earnings | $17,766,595 | $17,208,193 |
| Freight | 13,102,910 | 13,256,900 |
| Passenger | 3,892,202 | 3,160,453 |
| Operating expenses | 12,659,470 | 12,123,131 |
| Conducting transportat'n | 7,521,054 | 6,913,309 |
| Maint. of way and struc | 2,690,226 | 2,779,995 |
| Maint. of equipment | 1,613,969 | 1,681,076 |
| Net earnings | 5,107,126 | 5,085,062 |
| Surplus for the year | 1,066,369 | 1,099,916 |

## NEW PUBLICATIONS.

*Webster's International Dictionary*, Twentieth Century Edition, edited by W. T. Harris, Ph.D., LL.D., United States Commissioner of Education; 2,380 pages and 5,000 illustrations. G. & C. Merriam Co., Springfield, Mass.

A new and enlarged edition of Webster's International Dictionary has recently been published. It is called the Twentieth Century edition and contains a 234-page supplement in which are 25,000 additional words. The biographical dictionary has been thoroughly revised and contains the names, nationality, occupation, etc., of 10,000 noteworthy persons of ancient and modern times. The gazetteer has also been revised, and the figures for population and area are compiled from the census returns of 1900 and 1901. New plates have been made for the whole dictionary, so as to insure that the typographical excellence of the work shall not be impaired.

## TRADE CATALOGUES.

*The Franklin Institute*, Philadelphia, Pa., is distributing its announcement and programme of lectures for 1904-1905. A brief description of the Institute, including the library, the lectures, the schools, the exhibitors, etc., are given. It states that at the present time the library contains 57,534 volumes, some 42,274 pamphlets, 2,861 maps and charts, and 1,241 photographs. These are all classified and catalogued and are exclusively scientific and technical in character.

*The Lidgerwood Manufacturing Company*, New York, is distributing its new cableway catalogue. The book measures 9 in. x 12 in., and contains 160 pages. It is liberally illustrated throughout with both line and half-tone engravings, which show installations of the Lidgerwood cableways in all parts of the world. Details, performances, illustrations, etc., of cableways used in the construction of canals, dry docks, dams, locks, filter beds, piers, log handlings, fortifications, open pit mining, quarrying, etc., are given. Illustrations and descriptions of the Lidgerwood-Miller marine cableway for coaling vessels at sea are also shown.

*The Royal Blue* for September, published by the Baltimore & Ohio, is a special World's Fair issue. It contains a long article by Major Pangborn describing the interesting exhibit of historical locomotives representing every step in the advancement of engine building, which the B. & O. has placed in the Transportation Building. Another article by the same author gives some figures relating to the value, power and weight of the exhibit of modern locomotives at the Fair. Much useful information for visitors is given in the last few pages, including an itinerary for a three-days' visit to the grounds.

*American Blower Company*, Detroit, Mich., sends catalogues Nos. 162, 163 and 164. The first two are devoted to "A B C" vertical engines, Type F and Types B and C respectively, and the last to "A B C" horizontal engines, Type I. These various types are described in detail, and the different styles of each illustrated. A sheet and list of repair parts are given, also tables of dimensions. Another smaller pamphlet is devoted to "A B C" fans and blowers, giving illustrations, descriptions, price lists and dimensions.

*The Transit Finance Co.*, Philadelphia, has published a little book on the development of electric traction in the United States, in which are set forth the practical considerations involved in the building of electric railroads and some interesting facts about the

value of traction securities. The book contains in condensed form some interesting statistics of interurban electric railroads and is an attractive prospectus of the business of this company, which is to promote and build electric roads.

*The Wellman-Seaver-Morgan Company*, Cleveland, Ohio, is distributing an illustrated pamphlet descriptive of the "Akron Chilian Mill." This mill is used for the wet grinding of metalliferous rock. The mill is made in two sizes, 5 ft. and 6 ft. respectively; the 5 ft. size has a capacity for grinding 25 tons in 24 hrs. and the 6 ft. size will grind 50 tons in 24 hrs. Illustrations and full descriptions of the details of the mill are given.

*The Art Metal Construction Company*, Jamestown, N. Y., maker of incombustible furnishings and metal filling devices, issues an illustrated pamphlet descriptive of the fireproof offices of Hibbard, Spencer, Bartlett & Company, Chicago, Ill. These offices are completely equipped with metallic fixtures and furniture.

*The Allegheny Forging Company*, Pittsburg, Pa., issues price lists of its chain, hot pressed and cold punched nuts, plate and cast washers, and of rivets and burrs. These lists are published in separate folders and each folder contains useful information in regard to the subject dealt with.

## CONTRIBUTIONS

### Concrete Cross-Ties.

Joliet, Ill., Sept. 27, 1904.

To the Editor of the Railroad Gazette:

In your issue of Sept. 23d I notice an article describing some concrete cross-ties in use on the Ulster & Delaware. In the article you state that the cost of the tie is 42 cents exclusive of the cost of reinforcement. Is there not some mistake about this? I figure that the cement alone in one tie would very nearly cost 42 cents.

ARTHUR MONTZHEIMER,
Chief Engineer, Elgin, Joliet & Eastern.

[Our information came from the designer of the ties and we have no other means of verifying the cost.—Editor.]

### Block Signals Which Are Not Stop Signals.

The Lake Shore & Michigan Southern Ry.,
Cleveland, Ohio, Sept. 28, 1904.

To the Editor of the Railroad Gazette:

Permit me a word to supplement the quotation in your issue of Sept. 23, from my remarks at the Chicago meeting of the Railway Signal Association.* Most roads are using the following night signal indications:

*Home Interlocking Signals.*

Color—Red light.

Indication—Stop at or before reaching the signal.

Significance—If a train over-runs the signal (generally located 50 ft. in the rear of a derail) it will be derailed or will foul another track and quite possibly another train.

*Home Telegraph Block or Train-Order Signals.*

Color—Red light.

Indication—Stop.

Significance—This stop indication means that there are orders for the train or that the block is occupied, and simply requires the train to stop at the block station where the signal is displayed and not leave until the signal is cleared or proper order, or caution, or a clearance card is received.

In general practice a passenger train is permitted to pull past this signal, indicating stop, a sufficient distance to discharge and receive passengers and baggage, and freight trains commonly pass same at 20 miles an hour; 19 orders, caution or clearance cards being delivered by hoop on the fly.

On the Lake Shore, as on many double track roads handling trains of from 70 to 100 cars, to bring them to an absolute stop for every "pass the block" order or card would cause unbearable delay. While the engineman is held to strict responsibility for always knowing where he is, we cannot be blind to the cold fact that there are many moments, possibly vital ones, when from smoke, steam, snow, fog, distracted attention, a cinder in the eye, etc., he may lose his bearings, and that system of signal lights surely seems defective which gives him the same night indication at an open derail that it gives at a point past which he is permitted, by inference and by practice at least if not by definite rule, to pull a portion of his train before stopping, or at which he may not have to stop at all if the expected order, caution or clearance card is passed up to him on the hoop. This serious inconsistency may be obviated in two ways: First, by requiring trains to stop *at or before reaching all signals* indicating stop. Second, by providing a distinctive night indication for telegraph block and train order signals.

The first means may be used where these signals are put far enough in advance of the block stations to admit of station stops for passenger trains being made in rear of the signal, and where freight trains are so short and infrequent that the delay occasioned by stopping them dead before reaching any block or train order signal indicating stop, could be tolerated. The stopping of heavy trains is theoretically correct but on a great many roads entirely impracticable.

The second method is theoretically proper and easy, but little used. The writer has experimented with separate fixed purple lights placed about 18 in. below the lamp giving the "stop" and "proceed" indications; and results so far indicate: First, that the purple light can be seen under average weather conditions, about 1,200-ft. Second, it shows purple as far as it is visible as a light. He believes it will be a sufficient marker for the train order or telegraph block signal to permit of the air being released and the train permitted to drift by the signal, after speed has been reduced at sight of the more distantly visible red. If the purple marker light should be extinguished of course absolute stop would be made at or before reaching the signal.

On many lines it is of great advantage to have all orders to take siding at next block station given by a fixed signal instead of by written order; and where the arm displaying this latter indication is carried on the same mast with the home block or train order arm, it would probably have to show the same light at night as does a caution signal, and the combination of a red light or a white light over a green light (or yellow where that is the caution color) on the same mast would need the marker light (purple) to distinguish it from an automatic block. A differentiation of some kind is imperative, as any fixed signal indication directing a train to take siding at the next block station, would, of course, have to be acknowledged by proper whistle signal.

I shall be grateful for any suggestions on this matter.

AZEL AMES, JR.,
*Signal Engineer.*

*Mr. Ames said, at Chicago: "A red light is used for an open derail; and a man who goes by that light 50 ft. goes on to the ground. We also use the same on train-order signals, where it is not an absolute stop signal. There are roads where the train-order signal requires an absolute stop before reaching it, but not many; and with heavy freights you cannot afford to require it. . . . We are going to display on our train-order signal masts 18 in. to 20 in. below the regular light, a fixed purple light that cannot be seen more than about 1,200 to 1,500 ft. away."

### Rail Fastenings.

Mr. A. Morrison, of the Cambria Steel Company, presented a paper on this subject at the St. Louis meeting of the Roadmasters' and Maintenance of Way Association. Having referred to British and Continental practice he said:

Our experience is that when track is properly drained, ballasted and tied, almost any kind of rail fastening will do satisfactory work. It is not a question of providing material for the most favorable conditions, but it is a question of material that will give good results under moderately unfavorable conditions. In Great Britain tie renewals are made by special gangs. The work is so laborious, on account of the complex fastenings, that a section gang would never get through with the work.

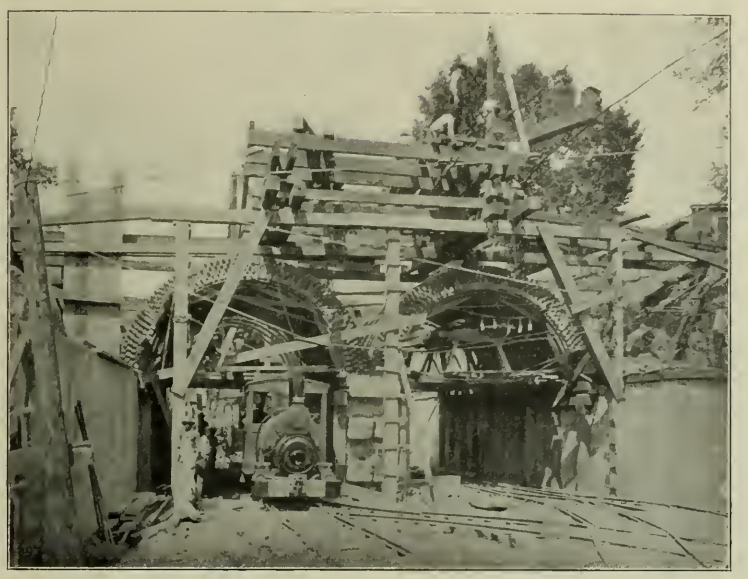
Fifteen years ago I used screw spikes, which had a projecting head on one side to engage the rail base. The idea was that when changing rails all that we had to do was to give the screw spike a quarter turn with the wrench, lift the rail out, then put in the new rail, and turn the head back to place again. That looked very attractive, but we found that when the wrench was applied to these screw spikes they were rusted fast to the tie, and to get the rails out we had to break the head off every one of them.

A general manager of an eastern road related his experience with screw spikes, when he was assistant engineer in charge of construction on a new road, as follows:

"The ties were bored with a boring machine, which put down the four holes with one operation. The screw spikes had clips on two sides. It seemed impossible to get the head to fit with exactly the right pressure on the rail base. The heads were either loose on the rail, or so tight that the head snapped off, and I have seen bushels of these heads along the line of the track. The screw spikes rusted badly, and after a while could not be turned. They were not a success and none were used after the first laying of track."

A test with lag screws, as a rail fastening, was made on a mountain grade on an eastern railroad a few years ago. The track was laid with large oak ties, and heavily stone ballasted. The pushing engines on this grade were exceptionally heavy, and as a natural consequence they created considerable wave movement of the rail, which meant a corresponding lifting of the heavy oak ties, where the screws were used. In many cases, however, instead of the ties responding at once to the rail movement, the heads of the screws would let go, and as a result several of the trackmen were more or less severely injured.

I have mentioned these cases to show that when lag screws or screw spikes are used, they hold the tie to the rail so firmly that the ties must either lift with the rail, or the heads fly off. No trackman would for a minute deem it proper for the ties to work up and down on the ballast. You all well know from hard experience what the result would be. (1) The tamping would be destroyed by displacement of the ballast. (2) Where the sub-grade was imperfectly drained the ties would pump mud. (3) Center bound track is more quickly formed



South Portal Showing Twin Brick Arches.

where the ties are working than under any other condition.

The ideal conditions require that the tie be solid on its bed, so that impact from the rail be received by the tie and distributed to the sub-grade by the ballast. With the use of screw spikes the impact is exerted by the tie on the ballast with a pounding action which disturbs, displaces and destroys the material which gives as well as receives the impacts by every passing wheel.

The use of lag screws requires the previous boring of holes, and where dowels are used, larger holes must be bored for them. If greater adhesion is wanted, why not do the same thing for the spike? A hole bored for a spike $^{1}/_{16}$ in. less in diameter than its thickness will materially increase its adhesion. If using cedar ties or other soft wood, drive the spike, then extract it, plug the hole with an elm tie plug, and finally drive the spike into the center of the plug. This will give 100 per cent. greater adhesion and lateral resistance, all of which is very much cheaper than using a lag screw; and when making renewals the spike can be pulled and the work proceed in the usual manner.

The cost of a lag screw is double that of a spike, and the cost of application about four times as much. Had the lag screw positive advantages, there would be some reason for incurring the extra expense, but instead there is absolutely no advantage, but a certain detriment, particularly when considered in connection with the conditions existing on the railroads in this country.

## Progress on the Washington Tunnel.

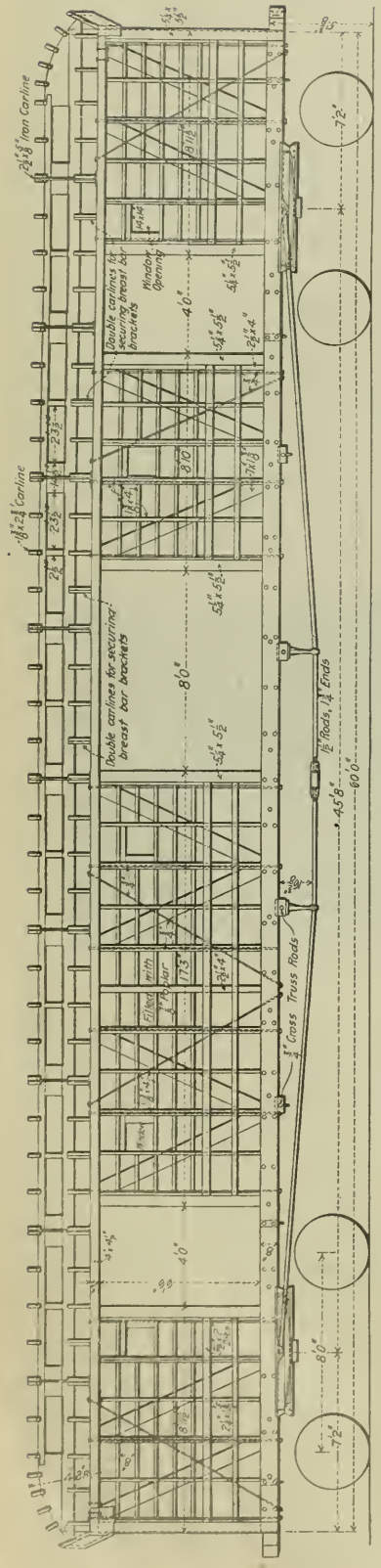
Good progress has been made during the summer on the Pennsylvania's tunnel under Capitol Hill, which will give that road an entrance from the South into the new Union station now building at Washington, D. C. The site of the new terminal is close by the present B. & O. station, and to give an entrance for trains of the Pennsylvania and all other roads coming in from the South this tunnel, 4,800 ft. long, is being built from a connection with the Pennsylvania's present line at Virginia avenue and Second street, under First street and Capitol Hill. There will be two parallel single-track tunnels 16 ft. wide and 18 ft. high, divided by a first class ashlar masonry wall and having concrete side walls. The arch rings consist of five courses of brick, the facing ring being of vitrified brick. The foundations for the side walls and center wall are concrete 6 ft. deep and 4 ft. wider than the thickness of the walls. For 1,200 ft. north of the south portal the work is being done by the "cut and cover" method with steam shovels. About 500 cubic yards are removed a day and about 500 ft. of the tunnel at the south end has been completed to date. Seventy-five feet of excavation, masonry work and back filling is being done a week.

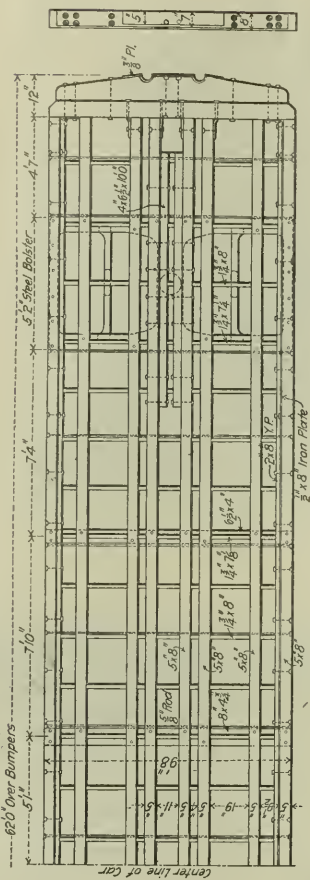
Excavation for Tunnel between the Capitol and the Congressional Library.

Timbering in Open Cut.

In molding the concrete side walls, the forms used are steel plates instead of boards, and the results are said to be superior to anything heretofore done in this class of work. The walls have a smooth and even surface when the forms are removed and do not require patching or finishing. All the concrete is mixed in one plant located near the work, and when delivered from the mixer is loaded into buckets and carried on flat cars to the point where needed. Portable cranes run by electric motors are used to lift and dump the buckets off the cars and into the molds.

Besides the concrete work in the side walls, the filling over the haunches of the arch rings above the central dividing wall

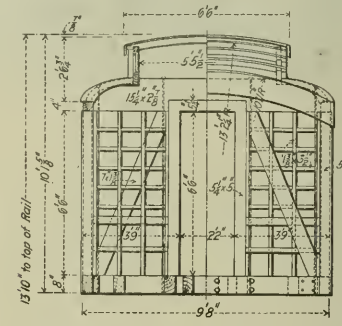

Double carlines for securing breast bar brackets
Window Opening
Double carlines for securing breast bar brackets
1/2" Rods, 4 Ends
1" Cross Truss Rods
Filled with Plaster
Side Elevation of Framing for 60-ft. Horse Car, Central Railroad of New Jersey.



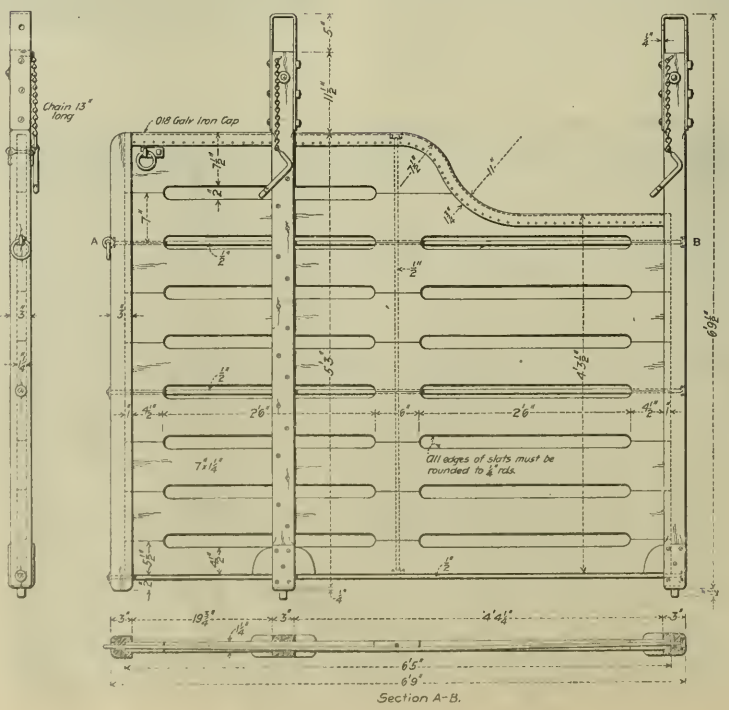

is also concrete. This is put in solid and is carried up in the center to a slightly higher level than the arch ring crown, giving a slope each way to the top of the twin tunnels. The whole top of the tunnel is covered with four layers of Hydrex felt laid in asphalt and covered with a thick coat of cement mortar. Along the side walls, gutters are run which are filled with broken stone. Water coming through the earth filling is drained from the roof of the tunnel into these gutters, and thence to perforated cap drains spaced at intervals of 50 ft. and connected with the city sewers. About 200 men in all are employed on the work.

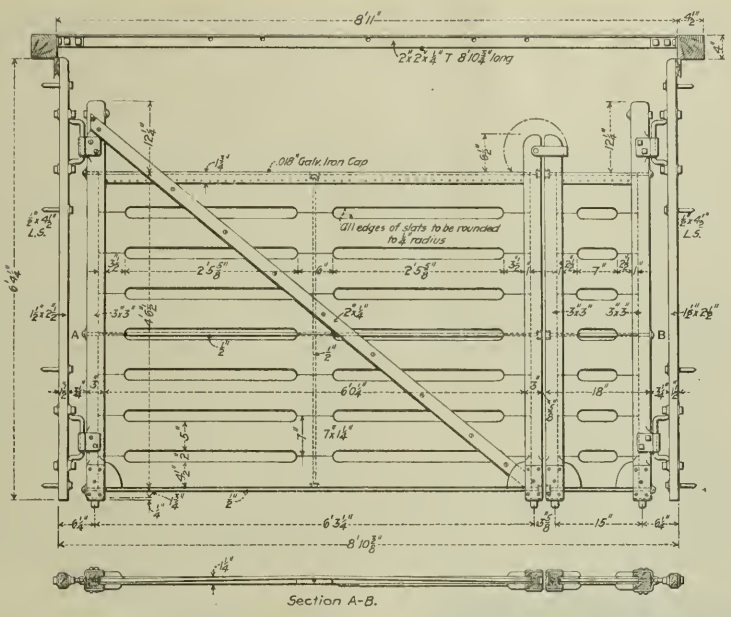
## Special Horse Car for the Central Railroad of New Jersey.

The Central Railroad of New Jersey has recently completed a special horse car, 60 ft. long, at its Elizabethport shops. It is intended for carrying fine horses and carriages in regular passenger trains and is mounted

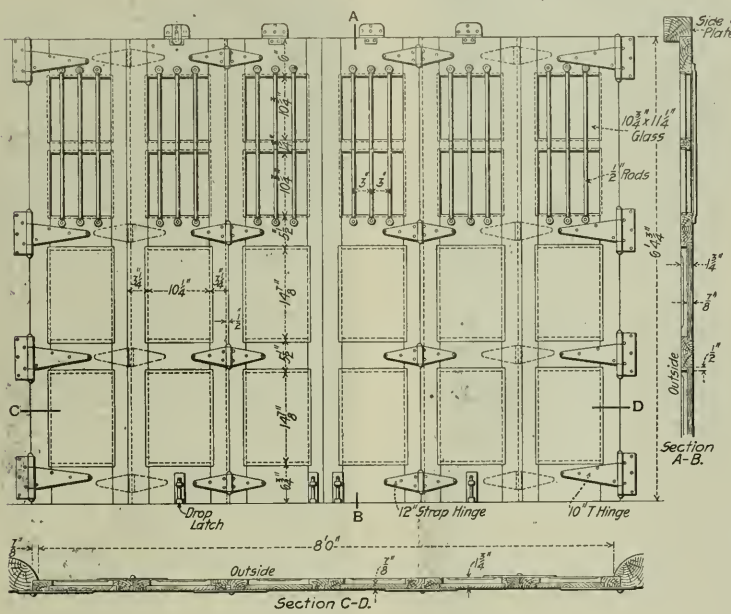



on standard four-wheel passenger trucks. It has stub ends and is fitted with Standard steel platforms and Buhoup three-stem couplers attached under the framing. The underframe is wood and consists of eight longitudinal sills, each 5 in. x 8 in., trussed with 1½-in. rods which are fastened at either end to the double cast-steel body bolsters. The






Transverse Partition for 60-ft. Horse Car.




Folding Side Door for 60-ft. Horse Car.

side framing is particularly heavy because of the wide door openings, of which there are three in each side, one being 8 ft. wide and the other two being each 4 ft. wide. The braces are 7 in. x 1⅜ in., and the door posts are 5¼ in. x 5½ in.

The interior of the car is divided into five compartments by movable cross partitions, and each of these compartments can be divided into three or four longitudinal stalls by stall partitions. There is room therefore for from 15 to 20 horses. The 8-ft. doors are near the center of the car and can be used for loading carriages into the large middle compartment. The cross partitions are hinged to the side of the car and are made in two parts, the narrow part serving as a gate in the passageway so that the attendant can go from one end of the car to the other. Iron strips, 2½ in. x ¼ in., are let into the floor under each cross partition and 1⅛-in. holes are drilled in them to take the pins in the bottom of the partition posts. Curved strips are also let into the floor to form a rail over which the partitions can be swung to the side without injuring the floor boards. A 2-in. x 2-in. x ¼-in. T iron runs across the car between the side plates above each cross partition, and the stall partitions are hung from these by the straps which extend up from the posts. Pins in the bottom of the posts fit in holes bored through the iron strips which are let into the floor. The holes in these cross strips are spaced for three and four-stall partitions. Breast boards across the front of each stall are supported in iron sockets fastened to the side of the car at the proper intervals, and when not in use these boards are lashed in wrought iron brackets over the side doors.

The narrow end doors slide open but the side doors are made folding in order to save the space inside the car which would be taken up by the door guard strips. The 8-ft. doors are made in two parts of three panels each, and the 4-ft. doors are made in a single part with three panels. They are fastened at the bottom with ordinary latch bolts. In addition to the doors, five small sliding windows are cut in each side, and these are protected with bar gratings on the inside. The car is lined with ⅛-in. steel plates on the sides and ends for a height of 5 ft. from the floor.

We are indebted to Mr. B. P. Flory, Mechanical Engineer, for the drawings.

## Mr. Wallace on the Panama Canal.

Mr. John F. Wallace, Chief Engineer of the Panama Canal, was the guest of honor at a dinner given in Chicago, September 30, by the Illinois Manufacturers' Association, at which 400 manufacturers of Chicago and vicinity were present. Mr. Wallace was the speaker of the evening and began his address by referring to the fact that for over 400 years a passage across the isthmus in the neighborhood of the proposed Panama Canal had been the dream of navigators. Ever since Bilboa first viewed the waters of the Pacific ocean from the crest of the divide at Panama, the advantages of a short passage between the two oceans has been manifest. It was President John Quincy Adams who first appointed, in 1826, a commission to investigate and report upon the feasibility of a canal across the isthmus at Panama. So that the first steps on this project were taken by the United States, and not by the French, as is generally supposed. In 1848 the Panama Railway Company obtained its charter, the remarkable feature of which was, that an absolute monopoly was created which controlled every means of transportation within the country of Panama. It has been said that so sweeping were the rights conferred on this company that no one might independently even make a bridle path through the forest, and so rigidly did the company enforce its rights that it refused to allow persons to walk across the isthmus. Consequently the De Lesseps' French Company had first to buy the Panama Railway Company, and the property and charter of this company were among the assets transferred to the United States in the recent purchase.

The work of the French Company, which has been so much criticised, has paved the way for what we may hope will be our own success. The plans, machinery, and tools, and the great mass of records turned over to us by the French Company make an important foundation for the present Commission to build upon. There has been rather too much disposition on the part of Americans to refer slightingly to what was accomplished by the French. One of the greatest surprises to Mr. Wallace, during his recent residence of three months on the isthmus, was to find how much had really been accomplished and how valuable are the machinery and tools they have left for us. The United States can gain at least one-third of the time required to complete the work because of what has been done. Even the failures of the French Company are valuable, as they point out what not to do. It is extremely fortunate that the French failed to carry out their first scheme, of a sea level canal, 70 ft. wide by 30 ft. deep, for to-day less than 20 per cent. of the modern vessels could pass through such a canal.

One machine shop was found in the jungle filled with machinery equal to that in any shop of the Illinois Central railroad, with the exception of the three newest shops of that company. This shop has been overhauled and is now in complete operation. Over 3,000 dump cars and 300 good locomo-

tives are included in the property acquired, besides rails enough for 250 to 300 miles of construction tracks; many steam shovels and dredges also are included. While generally the wooden portions of machines have been destroyed by the climate it is surprising how little the metal parts have corroded.

The first work of the present commission, which will occupy two years, is to determine upon the most practicable plan to adopt. Plans are to be considered for high level canals having six, four, or two locks, or for a sea level canal having one lock at the Pacific ocean end. The estimates for a canal having six locks have been placed at eight years for completion, and at a total cost, including the 50 millions already paid, of 200 million dollars. Recent borings have resulted in establishing the fact that it will be more feasible to build a sea level canal than was at first considered possible; and while Mr. Wallace is not ready to make any definite recommendation to the commission at this time he feels that it is reasonable to consider that a sea level canal with one lock can be built by spending 50 millions more money, and 50 per cent. more time than would be required for the high level, six-lock canal. By this plan 36 million dollars of the estimate of the former commission for locks would be released and be available for extra excavation and river diversion work, including a seven-mile tunnel for flood waters. He is satisfied that the high level plan can be carried out within the estimate of the Isthmian Commission both as to time and money. There is a difference of 10 ft. between the mean tide levels on the two sides of the isthmus, and while the fluctuation of tide is less than two feet on one side, it is ten times as great on the other side, hence the need of one lock for a sea level canal.

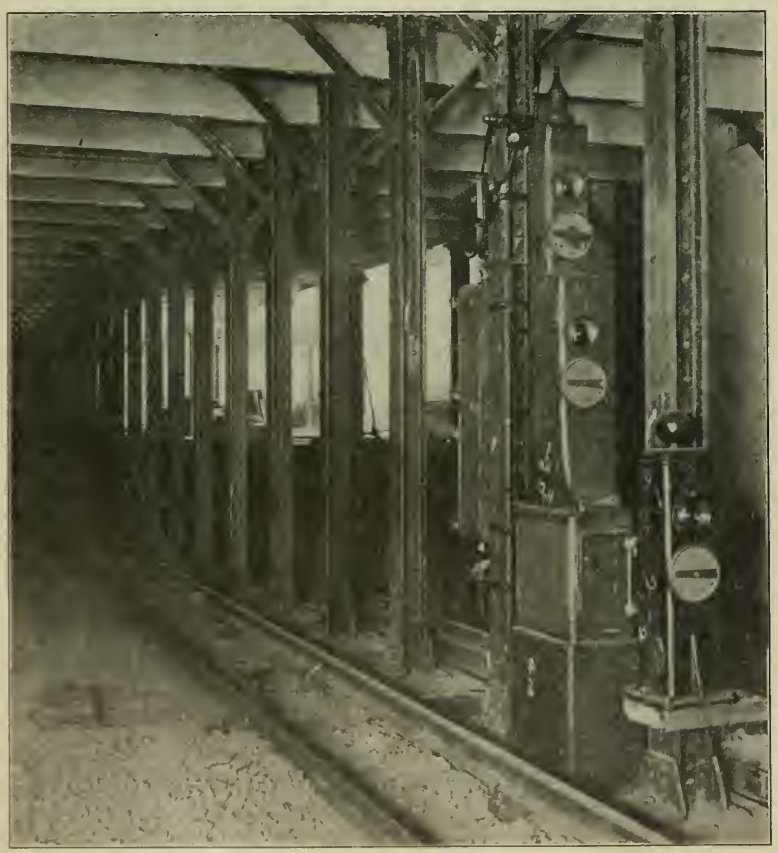
Mr. Wallace referred to the work now being carried on at Panama and Colon, including the building of water works, sewers and paving, all intended to make the sanitary conditions of the isthmus excellent. This work involves the expenditure of over half a million dollars. During the past three months he found the maximum temperature to be 86 deg. Fahr., and the nights cool. In concluding his address he paid a high tribute to Governor Davis, under whose administration conditions on the canal zone have been admirable. He denied that there had been any friction between Gov. Davis and himself, and incidentally stated that if there had been as many newspaper reporters on the isthmus as there are ties on the Panama railroad more misinformation could not have been published about conditions there than has been given to the reading public.

## Signals in the Subway.*

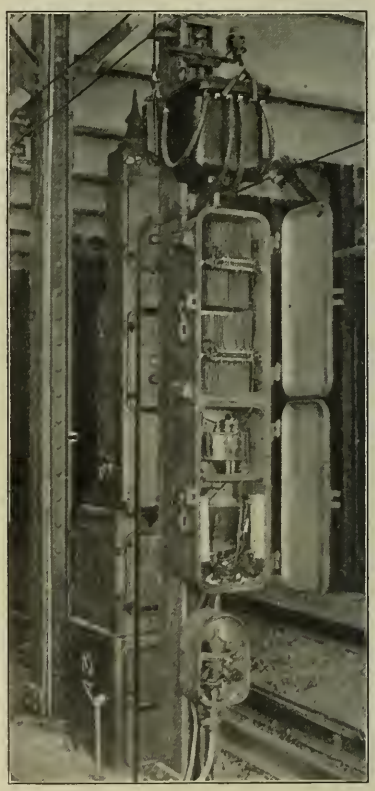
The installation of the block and interlocking signals in the New York subway involves at once the use of old and well-tried methods and appliances and also the application of some entirely new principles; and the provision of mechanical and electrical safeguards is more complete than anything that has been done before. The problem has been solved by a careful consideration of the local conditions and the location and connections of the signals are such as to give the greatest capacity to the line and the utmost flexibility in operation.

Between City Hall station and 96th street, a distance of 6½ miles, there are four tracks, the two middle tracks being intended for express trains. On these tracks the running conditions are quite similar to those on steam railroads and throughout their length they have automatic block signals controlled by track circuit. From 96th street to 145th street on the West Side division there are three tracks. Two of these are for local trains and the middle track is for express trains which will be run only in one direction at a time, running down in the morning and up at night. This express track is also to be worked by block signals. Above 145th street, where there are but two tracks, both tracks are block-signaled. The tracks for local trains between 145th street and City Hall have block signals only at the stations and on curves where the motorman's view ahead is obstructed. Conditions on these tracks are similar to those on the elevated roads where a complete block system has never been thought advisable or necessary owing to the frequency of the stops and comparatively low speed. Including the sections of local tracks at curves and stations, there are 24½ miles of track equipped with automatic signals.

All of the block signals as well as the interlocking signals are a modified form of the Westinghouse electro-pneumatic system adapted to the restrictions of clearance and lighting conditions in the tunnels. The distinguishing feature of the installation is the use of an alternating-current track-circuit for operating the relays controlling the electro-pneumatic valves on the signal posts. An electric track circuit for signals as used on the ordinary steam road is a comparatively simple problem compared to the one encountered here, in which the rails act as return feeders for a 500-volt direct current with amperage sufficient to propel a train requiring at times as high as 2,000 h.p. On the elevated and the subway lines of the Boston Elevated Railroad a direct current of low



Block Signal and Dwarf Signal with Automatic Stop.



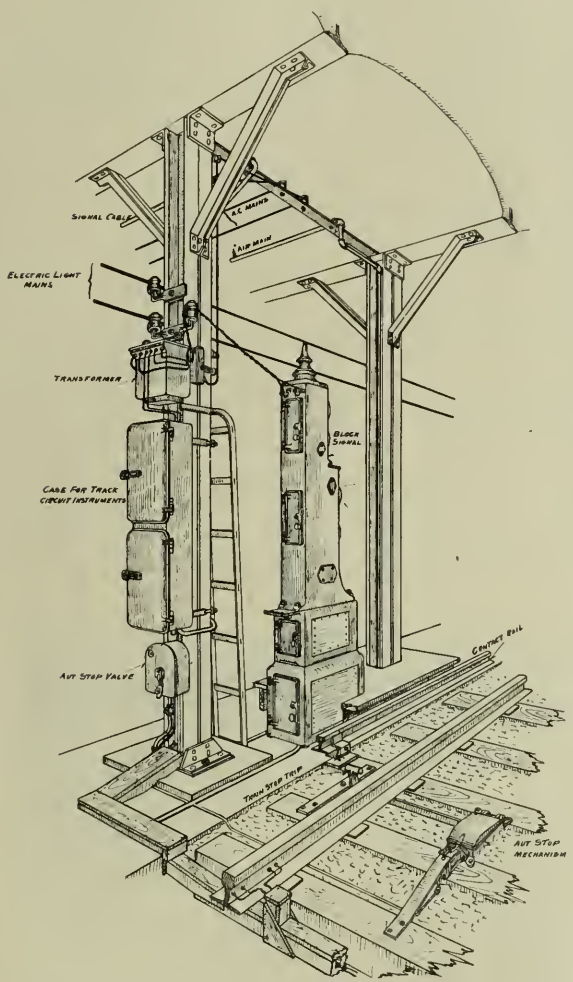
Rear of Signal Showing Auxiliary Apparatus.

*It is announced that the Subway will be opened for business from the present southern terminus (City Hall) to 145th St., on Oct. 27.

voltage is used, and with good results, but there the traffic is not so enormously heavy and the chances of derangement of the delicate mechanism of the signal relays by a sudden rush of current or drop of voltage in the return rail are not serious. Preliminary experiments made on the North Shore Railroad in California by the Union Switch & Signal Co., which installed all the signals, showed that an alternating current track circuit could be successfully used with a high-voltage direct-current return power circuit provided the return power circuit was carried through only one rail with the other rail insulated at the ends of the blocks and all of the automatic signals in the Subway were designed on that principle.

Current for the signal track circuits is supplied through 500 volt a.c. feed wires from the sub-stations, which run through the tunnel from end to end. Each signal post at the entrance of a block section carries a step-down transformer with two secondary coils, one of which delivers an alternating current of 10 volts for the track circuit and the other delivers an alternating current of 50 volts for the signal lamps. The low voltage secondary coils are connected across the rails at one end of a block section and the track relay is connected across at the other end of the block, with a choke coil interposed to keep out the direct current. The action of the relays is similar in every way to those used with continuous current circuits.

On account of the limited clearances in the tunnel and the conditions of night which prevail, the signals indicate by color and not by position. The appearance of the signal and its auxiliary apparatus is shown in the accompanying illustrations. The mechanism controlling the indications of the signal is enclosed in a cast-iron box about 9 ft. 9 in. high, and 10 in. square, mounted on a concrete base between the tracks. In the bottom of the box are the air cylinders and the electro-pneumatic valves which control the admission of air to them. The distant signal is below the home signal, in accordance with standard practice. For each of the two signals, the home and the distant, a bull's-eye lens of white glass is mounted in the front of the case and behind it are two 4-c.p. incandescent lamps connected in parallel and both lighted so that the light will be maintained even if one is out of order. The color indication is given by colored glasses mounted in slides or frames which are counterweighted and are pushed up between the lamp and the lens by rods from the air cylinders below. The color indications in the signals are: red for stop, green for proceed, and yellow for caution. Immediately below the lenses are white circular discs with small black semaphore arms on their faces which remain horizontal if the signal is at danger or caution and stand at an angle of 60 deg. when the signal is cleared. This gives the motorman a visual signal indication if the lamps are not burning and is a check on his color sense. The case has doors, front and back, for the ready inspection and repair of the mechanism inside.




Automatic Block Signal and Train Stop in the Subway.

Back of each signal box and mounted on the columns supporting the roof of the tunnel is the auxiliary apparatus, which is enclosed in separate boxes. The alternating current mains are carried along on the columns near the roof and these are tapped by the connections to the transformer before mentioned, which is mounted near the top of the column. Immediately below this is the box containing the "grid" resistance for preventing the short-circuiting of the alternating current relay which is enclosed in a separate box, with the choke coil. At the bottom of the post is the valve for the automatic stop. Current for operating the electro-pneumatic valves in the signals and interlocking plants is furnished from 16 sets of storage batteries situated at certain interlocking towers in the subway which are charged by small d.c. motor generators. These batteries are arranged in pairs so that one is being charged while the other is being discharged and they furnish current at 16 volts.

The dwarf signals used at interlocking plants in the tunnel are substantially the same in their construction as the block signals except that they show only one indication on each post. The posts are 3 ft. 4½ in. high and are capped with a sphere instead of a pointed cone as are the block signals. Red and green, for stop and proceed, are the only two colors shown. These signals, like those for fast movements, have an indicator dial. Where the movement of trains is always in one direction, the dwarf signals are replaced by dummy signals of similar external appearance, but showing a fixed purple light and having the disk below the lens painted purple also.

The length of the blocks and the location of every block signal on the entire line was carefully worked out from data relating to the grades and alinement of each section. Before locating the signals an exhaustive series of brake tests was carried out by the Westinghouse Air-Brake Company, under the direction of the consulting engineer of the Interborough, to determine the distance required for stopping a train with emergency applications of the air-brake at all speeds up to 50 miles an hour. These were plotted in the form of a speed-distance chart with a curve for level track and adjusted curves for trains on 1 per cent. and 2 per cent. ascending and descending grades. From this chart the theoretical minimum distances between signals for the maximum possible speed on any gradient could be easily found, thus establishing the proper length of each overlap separately. This method was a radical departure from standard railroad practice, but one which was deemed absolutely necessary in this case. With these conditions and data to work from it was not difficult to fix the position of signals in respect to stations, curves and junctions. Suppose the stopping distance for a train running at 30 miles an hour was 400 ft. Adding 50 per cent. for safety, the minimum length of block would be 600 ft. and the length of overlap would be 1,200 ft. The minimum distance between signals is, as a matter of fact, about 820 ft. on the express tracks. The lengths of blocks have been so fixed that the maximum working capacity of the express tracks is a train every two minutes and on the local tracks a train every minute.

To prevent the occurrence of collisions as a result of disobeying the signal indications, an automatic train stop has been put in under an agreement made by the contractor with the Kinsman Block System Company, of New York. This consists essentially of a rod or shaft extending across under the rails opposite the signal post and carrying on the end nearest the third rail an arm or trip. Between the rails is a cast iron box containing an air cylinder, an electro-pneumatic controlling valve and a counterweight on the end of another arm attached to the shaft. If the signal is set at "stop" the air in the cylinder is cut off by a circuit-breaker connected with the signal blade, and the counterweight drops, throwing the stop arm to an upright position above the level of the rail. All of the cars to be run in the subway are fitted with an arm, carried on the truck, which is connected to a valve in the air-brake train pipe; and if the train runs past a signal set at stop the stop-arm, which has assumed an upright position, engages with the trip or arm carried on the truck and opens the train pipe, thereby setting the brakes on all the cars in the train and bringing it to a stop before it enters the second block ahead, in which is the obstruction by which the signal has been set to stop. In order not to delay trains unreasonably in case of derangement of the automatic stop, the trainmen are supplied with a socket key with which to turn the air valve controlling the movement of the stop-arm so as to lower it while the train is passing. The trainman must hold the valve open with the key

until after the train has passed, after which the device will resume its stop position.

The accompanying diagrams show the track circuits and the operation of the automatic train stop on a typical section of one of the express tracks. The rail Y acts as a return feed main of the power circuit and is not insulated at the ends of the block sections. The rail X is insulated at the end of each block section just beyond the signal post. The current for the track circuit is supplied through the secondary coil of the transformer which is mounted at the end of each block. Current flows at all times through the rail X, through the signal relay at the beginning of the block and back through the rail Y to the transformer. The relays have two armatures, M and N, which are normally held up. If now a train enters the block ahead of signal 1 (lower diagram), the relay at 1 is de-energized and both armatures drop. When the circuit at N is broken, the electro-magnet of the pneumatic valve controlling the home signal at 1 is de-energized and this cuts off the supply of compressed air which allows the signal to move to the stop position by gravity. The movement of the home signal blade at 1 opens a circuit breaker in the circuit controlling the distant signal at 2. This throws the distant signal at 2 to caution. At the same time that the circuit is broken at N, the circuit in the armature at M is broken and this keeps the home signal at 2 at stop. The home signal at 2 being at stop, the circuit breaker at 2 which is connected through the distant signal at 3 is held open and the distant signal at 3 is held in the caution position. The automatic train stop is connected through the armature M, and when the circuit in this armature at signal 1 is broken, the train stop at 2 is thrown up. Immediately, therefore, after a train has passed signal 1, the home at 1 comes to stop and the home and distant at 2, already at stop and caution, are continued in that position. The automatic train stop at 2 is thrown up and the distant signal at 3, already at caution, is kept so. When the train has passed out of the block beyond signal 1, the relay at 1 picks up both the armatures M and N, closing the circuit for the home signal at 2 and for the train stop at 2. These then resume the clear position and the movement of the home signal at 2 closes the circuit breaker connected with the distant at 3, throwing it also to clear. A train in any block is thus protected by a distant signal two blocks in the rear and by the home and distant signal, together with the automatic stop, one block in the rear.

The interlocking equipment is the well-known Westinghouse electro-pneumatic system with some slight modifications in the design and arrangement of the parts in the machines and switches on account of the very limited space in the tunnels. The cabin shown in one of the illustrations is only 3[illegible] wide and the machine has been arranged so as to reduce the width, chiefly by changing the position of the bed-plate from a horizontal to a vertical position and changing the other parts to suit. The switches are all operated with motion plates instead of the usual bell-cranks. There are 23 interlocking machines with a total of 383 levers, situated as shown in the following table:

| | No. machines. | No. levers. |
|---|---|---|
| City Hall | 3 | 32 |
| 14th St. | 2 | 16 |
| 18th St. | 1 | 4 |
| Spring St. | 2 | 10 |
| 42d St. | 2 | 15 |
| 72d St. | 2 | 15 |
| 96th St. | 2 | 19 |
| 100th St. | 1 | 6 |
| 103d St. | 1 | 6 |
| 110th St. | 2 | 12 |
| 116th St. | 2 | 12 |
| Manhattan Viaduct | 1 | 12 |
| 137th St. | 2 | 17 |
| 145th St. | 2 | 19 |
| Dyckman St. | 3 | 26 |
| 135th St. | 1 | 6 |
| Lenox Junction | 1 | 7 |
| 145th St. | 1 | 9 |
| Lenox Yard | 1 | 35 |
| Westchester Ave | 1 | 13 |
| St. Ann's Ave. | 1 | 24 |
| Freeman St. | 1 | 12 |
| 176th St. | 1 | 56 |

The small machines controlling single crossovers are mounted in neat boxes on the station platforms and will not have a regular attendant. They are so arranged that they can be set and locked for clear main tracks in both directions. There are a total of 227 interlocked switches, 224 automatic train stops, 354 home signals, 187 distant signals, and 150 dwarf signals.

The compressed air for operating all of the block and interlocking signals is supplied from motor-driven compressors located in six sub-stations, one each at City Hall, 18th street, 54th street, 96th street, 143d street, and at Dyckman street and at 133d street on the Bronx division, being approximately two miles apart. Current for operating the motors is supplied from the main feed wires running from the central power plant at 59th street and Eleventh avenue. Three of the sets are sufficient to supply power for all the signals and the other three can be held in reserve for emergencies. The motor is a Westinghouse direct current machine taking 60 amperes at 600 volts and driving an Ingersoll-Sergeant, straight tandem compound, single-acting compressor through a Morse silent chain. The compressor has cylinders 19¼ in. and 12¼ in. x 12-in. stroke, and has a capacity of 239 cu. ft. of free air per minute when running at 120 r.p.m. The compressed air is transmitted from the sub-stations through 3½-in. mains which give sufficient storage capacity to the installation. An automatic rheostat and pressure regulator keeps the pressure between 80 lbs. and 90 lbs.

In connection with the signal system, there are a number of other safety devices of much interest. One of these is the emergency box, patented by Mr. Gibbs, which is located in each station, and into which all of the signal circuits adjacent to the station are led. In case of a sudden emergency, an employee or other person on the station platform can push the button in this box and immediately the signals for all tracks adjacent to the station are set to danger.

To prevent short circuits through the cars and motors when passing from one section of the third-rail to another, due to difference in voltage or grounding of one section, a balance coil relay controlling a dwarf signal in front of the break in the third-rail is introduced. When a decided difference in voltage exists between the two sections of third-rail, the signal stands at danger and continues to stand in that position until the voltage is equalized. Where the section break occurs near interlocking points, a modified arrangement is used. In this case small voltmeters are mounted over the machine. The operator can tell at a glance if the difference in pressure is great enough to be destructive, and can set the signals accordingly.

Not connected in any way, but, nevertheless, a very important adjunct to the signal system, is the installation of fire and emergency alarm signals throughout the tunnels. At every manhole on the West Side division are located a fire-alarm box and general emergency alarm box, which are connected with

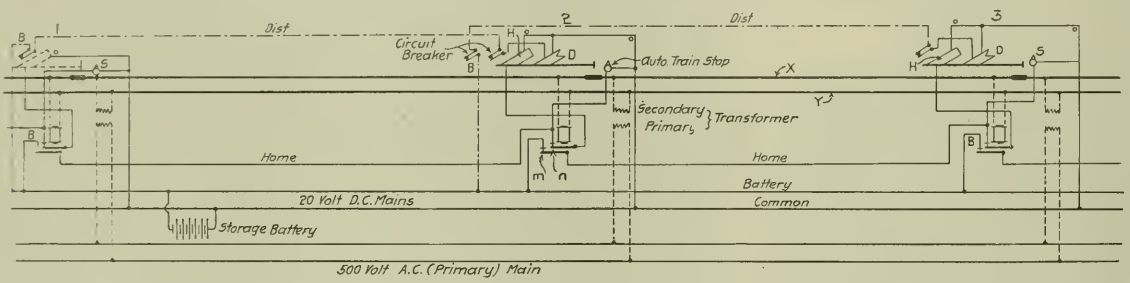



Diagram of Track Circuit and Signal Circuits for Typical Block Section.

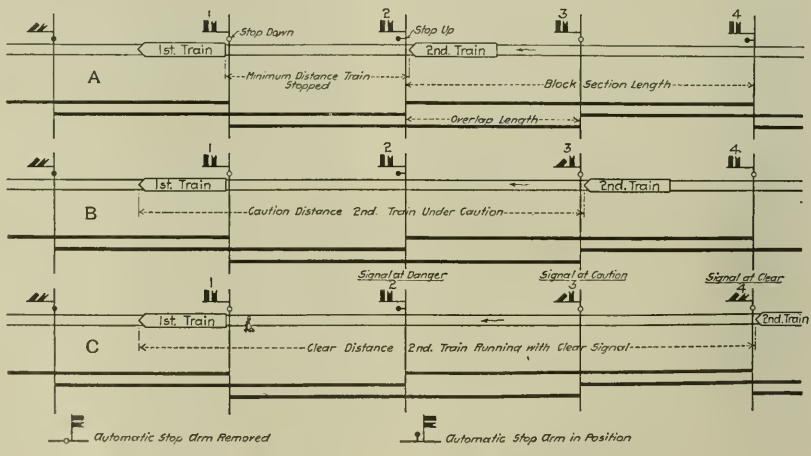
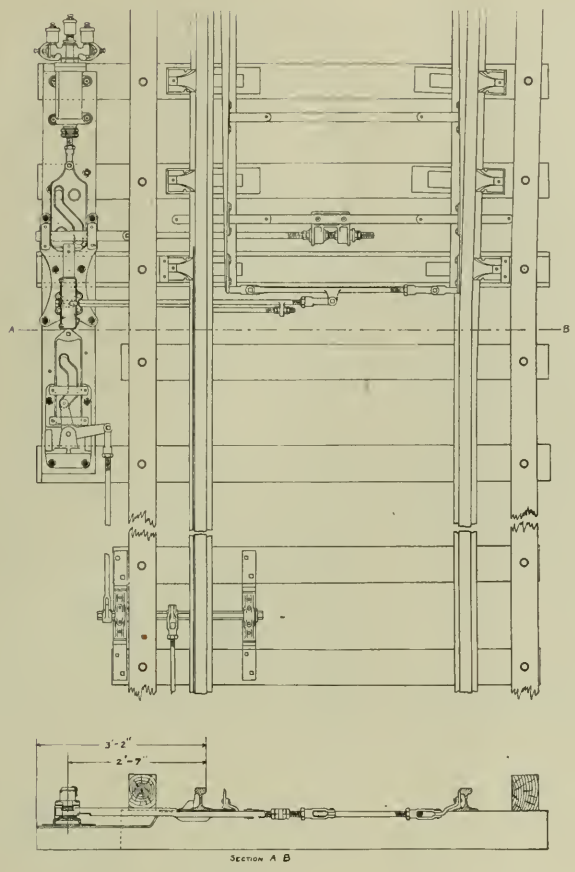
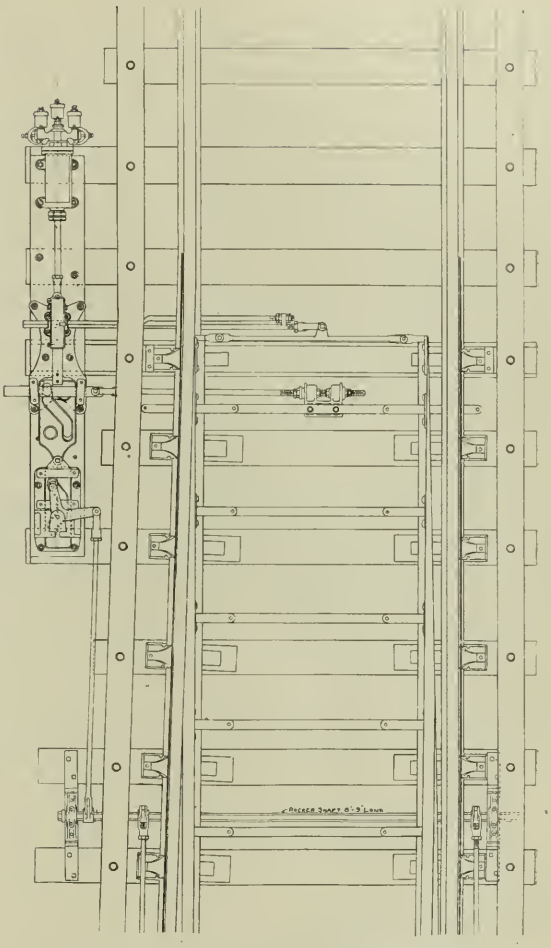



Diagram of Double Overlap Arrangement in the Subway.




Split Switch with One Detector Bar.



Split Switch with Two Detector Bars.

Interlocking Machine at Eighteenth Street Station.

Interlocking Cabin at City Hall Station.

recording gongs in every station and also in the train despatcher's office, general superintendent's office and all of the sub-stations and power houses. In case of fire in the tunnel, the station men are instructed to pull the city fire alarm located in the passenger station which is nearest the scene of trouble, every station having one of these. The men in the electrical sub-stations, on receipt of either a fire or an emergency alarm, immediately shut off the power from the third-rail in that station so that there will be no danger to passengers walking through the tunnel. This entire alarm equipment has been furnished by the Gamewell Company.

All of the general features of the installation of the safety devices and signals on the line were worked out under the direction of Mr. George Gibbs, Consulting Engineer for the Interborough. Mr. J. M. Waldron, Signal Engineer for the road, supervised the installation. The Union Switch & Signal Company made and installed all of the apparatus under the direction of its chief engineer, Mr. J. P. Coleman, and Mr. Sidney Johnson, who had entire charge of the actual work of construction. Mr. H. M. Sperry, general agent at New York for the Union Switch & Signal Co., suggested the arrangement of the double overlaps, which is one of the most novel and important features of the installation.

### All-Electric Interlocking at Oakdale, Tenn.

The Cincinnati, New Orleans & Texas Pacific has installed power interlocking at tunnels 25 and 26 near Oakdale, Tenn., in which one of the switches is 2,636 ft. from the cabin and one derailing switch 2,996 ft. From the north derails to the south is 3,951 ft. The apparatus is the Taylor all-electric, of the General Railway Signal Company, of Buffalo and Rochester.

A plan of the tracks embraced in this plant is given herewith. It will be observed that all of the switches and signals are out of sight of the signalman. The switches are locked automatically by track circuit locks controlled by the presence of a train at any point between A and B, and we are informed by Mr. Short, Superintendent of Signals, that trains are run through the single track section without either time-table or train orders, movements being governed entirely by the signals by means of the semaphores. The arrangement of the relays for actuating the locks is shown in the drawing. Either track circuit shunts lock the levers of derails 5 and 9 and of switches 6 and 8.

Signals 1, 2, 11 and 12 are cleared so as to afford intermediate reverse protection. There is an electric lock on Signal No. 9, which is cleared by a northbound train as it reaches a point 2,000 ft. in the rear of home signal No. 12, and an automatic annunciator in the cabin is rung from a point 1,600 ft. farther south. Trains from the north are announced by the agent at Oakdale station by an electric bell. The tower is connected by telephone and bells both with this and with the first station south, and the towermen are not operators, both being cripples, having been hurt in the service of the road.

The machine is a 12-lever frame, with ten working levers; and the power is derived from a 1 K.W. generator, operated by a 2 H.P. Fairbanks-Morse gasoline engine which stands in the first story of the tower. The storage battery is 52 cells, Willard 30-ampere-hour lead accumulator. The switch and signal motors are the standard Taylor motors. There are no distant signals for southbound movements as all trains stop at Oakdale station.

The cost of this plant was about $5,500, which, we suppose, does not include the cost of the tower. While this is a low figure for apparatus performing such important functions over so large a territory, the saving in running expenses is, obviously, a still larger item, as, without perfect control of the switches at the ends of the single track section, it would be necessary to employ a night and a day attendant at each end.

### The Application of Electricity to Steam Railroads.*

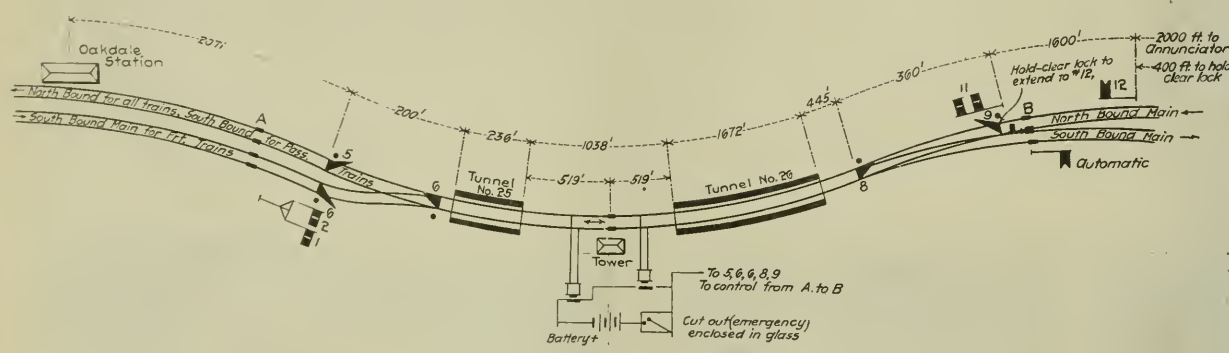
BY BION J. ARNOLD.

The last ten years has been a period of great activity and development in the field of interurban electric railways, which has brought into extensive use the alternating current, rotary converter sub-station system of operating direct current roads. With the introduction of the suburban railway, came an increased volume of passenger travel, induced by the increased facilities which may well be noted as an example by the steam roads of what may be expected in increased revenue when frequent and pleasant service is available to the public. Those engaged in electrical industries have thus far been absorbed in fields which seem to have been naturally theirs, and their success has been such that they now aspire to enter the field occupied by the steam locomotive as a legitimate field of competition. The question is, whether this field is one in which the advantages of electricity will be sufficient to overcome the obstacles which seem almost insurmountable.

Those who have given the subject little thought or who are unable to analyze it carefully on account of the lack of the technical knowledge necessary to appreciate the difficulties to be overcome, are most apt to predict the early supremacy of the electrically driven train over the steam locomotive.

That the obstacles encountered in the development of interurban railroads have been apparently formidable yet quickly overcome is not necessarily proof or even good evidence that the legitimate field of the steam locomotive can be entered and successfully achieved. Those most familiar with the subject are now prepared to admit that our great steam railroad terminals, where many switching locomotives are shunting back and forth continuously, and those portions of the steam roads entering our great cities, where suburban trains are numerous, frequent, and comparatively light, can be more economically operated by electricity than by steam. This is evident for the reason that it simply means duplicating, on a large scale, the systems which have proven successful on street railways, operating, as they do, numerous units running at frequent intervals. Proof that this field is recognized as a legitimate one for electricity is furnished in the examples of steam railroad terminals that are now being equipped electrically, such as the lines of the New York Central and Pennsylvania in the vicinity of New York, involving an expenditure of about $70,000,000, where not only suburban service will be operated electrically, but where in the case of the New York Central, the main line trains will be brought into the city from points 30 to 40 miles distant. While these are good examples of electrical operation on steam railroads, and instances of faith on the part of the railroad managers in the ability of electricity to successfully meet the conditions of steam railroad work, where the trains are sufficiently frequent, they are by no means conclusive evidence that electrically propelled trains can be made to successfully meet the conditions of trunk line passenger and freight service which is the field now so successfully held by the steam locomotive.

The best conditions for electrical success are a great number of units moving at a practically uniform schedule, at equal intervals, within a limited distance. The steam locomotive is the most economical where there are few but heavy units moving at uneven speeds over long distances at unequal intervals and at high maximum speeds. The amount of energy transmitted to any great distance and used by electric cars on the roads that have been built up to the present time is small when compared with the amount of energy that it takes to propel a steam railroad train weighing 500 or 600 tons at the speeds ordinarily made by such trains. When investment is taken into consideration, power cannot be produced in a steam central station, under conditions that exist to-day, and transmitted any great distance to a single electrically propelled train,




Taylor Interlocking at Oakdale, Tennessee; Cincinnati, New Orleans & Texas Pacific Railway.

*Extracts from the President's Address before the International Electrical Congress, St. Louis, Sept. 14.

requiring from 1,000 to 2,000 h.p., as cheaply as a steam locomotive, coupled directly in front of the train will produce the power necessary for its propulsion. Therefore, there must be other reasons than economy in power production, to warrant the adoption of electricity on a trunk line railroad unless it can be shown that the trains are frequent enough to make the saving in the cost of producing power greater than the increased fixed charges made necessary by the increased investment due to the adoption of electricity. There are undoubtedly in existence to-day conditions where water power in abundance is available along the right of way of existing roads, in which the substitution of electricity for steam could be made a paying one, with apparatus now available, even on roads having a comparatively infrequent service, but these are special cases and only tend to prove the correctness of the position, for in these special cases the cost of power would be but little over half the present cost of producing it by means of a central steam station.

The ideal conditions for any trunk line railroad having a traffic heavy enough to warrant the investment in a sufficient number of tracks to properly handle this traffic in such a manner as to get the most efficient service out of its rolling stock, would be to have four or more tracks between terminal points arranged in pairs upon which the trains for different classes of service could be run at uniform rates of speed. Thus, if six tracks were used, the through line, passenger and express service would be run on one pair of tracks; the local passenger, local express and local freight service upon another pair of tracks, while the through freight service would be run upon a third pair of tracks, and all the trains upon any pair of tracks would run at the same average speed and stop practically at the same places. If these conditions could prevail and the traffic were sufficient to warrant this investment in tracks, such a service could be operated more economically and more satisfactorily electrically than by steam. The difficulty is that few roads in existence have sufficient traffic to warrant such an investment in permanent way, and the result is that all of their traffic must be handled over one or two tracks, thus necessitating trains of all weights and all speeds running upon the same rails. This results in a tendency to bunch the cars into as few trains as practicable, in order not only to reduce the cost of train service to a minimum but to give the fast running trains greater headway to allow them to safely make their time. Such an arrangement of trains necessitates the concentration of large amounts of power in single units which is leading away from the ideal conditions for the application of electricity to the propulsion of trains, and it is this element, combined with the fact that the traffic on most roads is not great enough to warrant the investment necessary in electrical machinery to produce and transmit the power to the distances necessary to keep a few heavy trains in motion, that makes the trunk line railroad problem so difficult, as it is more economical to propel these heavy trains by steam driven locomotives, which are practically portable power houses.

Admitting that electricity becomes most economical when a sufficient number of trains are available, and that the steam locomotive is most economical when the trains have become few and heavy, the problem then resolves itself into one of the density of traffic, and the question then is: Where is the dividing line? No general law or formula can be laid down which will apply to all cases, for the reason that the elements entering into different cases vary so greatly that any formula would contain too many variables, dependent upon local conditions, to admit of a general application. I shall, therefore, only attempt to point out a way in which the dividing line between steam and electricity can be determined after the elements of each case are known.

It will readily be seen that with steam locomotive operation, the fixed charges, cost of fuel and engine labor increase almost directly in proportion to the increase in train miles, for in this case an additional locomotive means simply a given amount of increased investment, a given amount of increased fuel and labor, and this total investment is least when the number of locomotives is small. On the other hand, with electricity it is necessary to invest at once a large amount of capital in the power houses and transmission systems, which amount must be great enough to provide for handling the maximum number of trains required upon the line, and unless this number of trains is great enough so that the economy effected in the different methods of producing and applying the power is sufficient to offset the increased fixed charges, due to the additional invested capital, it will not pay to equip and operate electrically. Any problem, therefore, must be analyzed for the relative cost in operation. In case this does not show a saving, the advisability of equipping electrically will depend entirely upon the probable increased traffic to be derived from the adoption and operation of electrically propelled trains.

I am convinced that electricity will be generally used on our main railroad terminals, and ultimately on our main through lines for passenger and freight service, but it will not always be adopted on the grounds of economy in operation; neither will it come rapidly or through the voluntary acts of the owners of steam railroads, except in special instances. At first the terminals will be equipped for special reasons, due either to the voluntary act on the part of the Terminal Companies to effect economy in operation, or to public pressure brought to bear upon the owners through an increased demand on the part of the public for better service, on the grounds that the use of the steam locomotive is objectionable in great cities. Those roads which run through populous countries will either build new roads, or acquire, for their own protection, those electric railroads already built and operating in competition with them, and utilize them as feeders to their through line steam trains. Thus the steam railroad companies will gradually become interested in electric railways and eventually become practically the real owners of them. With these roads operating as feeders to the main line system and with the terminals thus equipped and the public educated to the advantages of riding in electrically equipped cars, the next step will logically be the electrical equipment of the trunk lines between the cities already having electrical terminals. Thus some favorably located trunk line having a sufficient density of population will feel warranted in equipping electrically, and when this is once done the other roads running between the same competing points must follow, sooner or later, in order to hold their passenger traffic. This may result in temporarily relegating some roads to freight service, so long as they operate exclusively by steam, but with the increased demand on the part of the public for better and cleaner service will come a corresponding increase in passenger revenue to the roads equipped for handling it until one road after another finds it advantageous to furnish an electric passenger service.

With the terminals and main lines equipped electrically and the desire on the part of the public for more prompt and effective freight service resembling that which is given by the steam roads in England and on the Continent, due to the great density of population, there will be developed a high class freight service conducted in light, swiftly moving electric trains which can be quickly divided and distributed over the surface tracks of the smaller cities, or through underground systems similar to that which is now being built in Chicago. Such a system would soon prove indispensable to the public and a source of great profit to the roads as it is now getting to be to many suburban railroads. This class of freight service would soon prove so large a part of the freight traffic of a road that the operation of the through freight traffic by steam locomotives, though at present cheaper, would in time, as the cost of coal increases, grow less until those roads operating an electric passenger service would ultimately use electricity exclusively.

The principal problem before the electric railway engineer to-day is how to make the most effective use of high pressure transmission, and high tension working conductors, and maintain safety of operation. Experiments conducted during the past year by engineers in this country and abroad have made this problem simpler than it seemed before and to-day we seem reasonably certain of the solution. Until recently the cost of electrically equipping a trunk line with the standard direct current rotary converter system, has been such as to practically prohibit its adoption, but recent improvements in the single-phase alternating current motor have made it possible to eliminate a large part of the investment heretofore necessary and the prospects for the application of electricity of long distance running are better than ever before. The rotary converter, which was the means of reducing the cost of long distance roads, was introduced in 1898; and within the six years from the time of its adoption through the development of the single phase, it has been practically rendered obsolete for heavy railroad work. The dividing lines between the steam locomotive and the electrically propelled train have thus moved several points nearer together, due to the reduction which can now be made in first cost and the saving in operating expenses.

With the single phase motor and the steam turbines in successful operation and the transmission problem almost solved, and with the rapid development of the internal combustion engines now taking place, we are warranted in believing that we can so combine them into a system which will ultimately supplant the steam locomotive in trunk line, passenger and freight service. The steam locomotive will hold its own in this country for many years to come, but I expect a remarkable development to soon begin in the electrical equipment of favorably located steam roads.

## Tie Plates.*

A tie plate is a rolled steel plate, having thin flanges or claws on the under side, which, when embedded in a tie under the rail seat, has sufficient adhesion to cause it to act with, and become practically an integral part of, the tie. It is used for the purpose of preventing the destruction of the tie by rail abrasion, and thereby prolongs the natural life of the wood used. While this is the prime requirement of tie plates, they per-

*Report of a committee, consisting of C. E. Jones, C., B. & Q.; J. A. Kerwin, M., K. & T.; and C. F. Blue, M. & O., presented to the Roadmasters' and Maintenance of Way Association, St. Louis, Sept. 13, 1904.

form many other functions as a result of that just named.

There are three distinct classes or kinds of tie plates—non-adhesive, longitudinal flange and cross-grain claw. Non-adhesive plates do not come within the definition of tie plates. for the reason that they have no adhesive qualities, and therefore cannot perform the first requirement essential to a tie plate; which is, to become a part of, and act with, the tie under passing loads. They are flat-bottom plates and depend on the track spike for holding them in position under the rails. As spikes automatically accommodate themselves to the vertical wave movement of the rail, there is necessarily a space between the base of the rail and the surface of the tie in amount depending on the condition of the track, weight of rail and rolling loads; hence, a plate placed between these separately moving bodies, without inherent adhesive qualities, must be and remain loose from the time it is first applied. The abrasive movement with such a plate still takes place between the bottom of the plate and the surface of the tie, much the same as before the insertion of the plate. This was the earliest type of tie plate used, and those who remember their use will recall the black eye they gave to further experimenting with tie plates, by reason of their general ineffectiveness in meeting the requirements of a tie protecting plate.

Longitudinal flange plates were the first form of tie plate to give the necessary adhesion to the tie. There are now many plates on the market of this design, varying in detail only. These plates are rolled with deep, thin flanges on the under side, running in the direction of the plate, and when embedded in the tie, unite so firmly that they become a part of it, and prevent the tie abrasion already explained. All movement takes place between the rail and plate, metal against metal, instead as formerly, with metal against wood fiber. This form of plate is used extensively in the western and southern States, where soft wood ties are in general use. The first plates used were much too thin and too narrow. The size of a tie plate should be determined by the density of the wood on which the tie plate is to be used, and the weight of rolling stock. The size of plate depends entirely upon the compressibility of the fiber—the softer the wood the greater area the plate should have. The plate should be thick enough to resist buckling during the life of the tie at least.

The claw tie plate has a shoulder on its upper surface to abut against the outer base of the rail, and has four 1-in. claws on the under side, which are finished with a spike point, giving sharp cutting edges. These claws enter the tie with a clean cut across the grain, and give not only great adhesion to the tie, but offer effective resistance to rail spreading. These plates are used on tangents and curves, but more particularly on curves. On curves they have replaced the old, and at one time much used, rail brace. Curves of maximum degree of curvature, and having the heaviest conditions of traffic, when equipped with claw plates, are held positively to gage, and the rails are maintained in a true and natural position. In hard wood ties this is the only form of plate that can be embedded with any degree of satisfaction. Its embedment is accomplished by either driving it home, striking the plate over the claws with a hammer, or allowing the traffic to do the work.

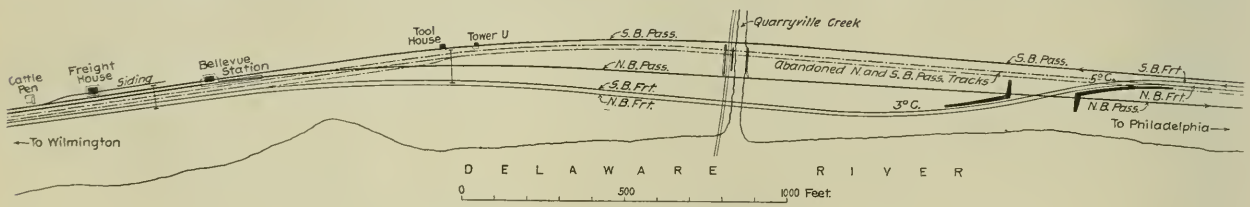
The safety to traffic from the use of tie plates is well known. Track equipped with the proper plates carefully applied, is always safe and spreading track can be made a thing of the past. It is hard to estimate the saving in cost effected by the use of tie plates, but it is large. The life of ties is extended several years because they are no longer spike killed. Adzing ties to roll the rails back into normal position is no longer necessary. Moving the section gang from one curve to another, spiking in places that seem to be more inclined to spread than to remain in proper position takes the time of the trackmen, and their time means money. Just how much this would amount to in dollars and cents over an entire railroad system would be hard to determine. However, we know that since such curves have been equipped with tie plates there is no longer such waste of labor, and consequently more time is now available for legitimate track work, which is showing from year to year in the vastly improved condition of our railroads.

## Improvements on the Philadelphia, Baltimore & Washington.

The extensive track elevation work and improvements which the Pennsylvania has been carrying out on its Washington-New York line has been described from time to time in the *Railroad Gazette* within the last three or four years as sections of the work have been completed. The work between Philadelphia and New York, which includes track elevation in Newark, Elizabeth, New Brunswick and Trenton, a new stone arch bridge across the Delaware at Trenton and the entire rearrangement of the passenger terminal facilities in Philadelphia, has now been completed, but south of Philadelphia on the line of the Philadelphia, Baltimore & Washington, the work is still in progress. It includes track elevation through Chester, Pa., and Wilmington, Del.; the enlargement of the Shellpot yard at Wilmington and a new steel truss bridge across the Susquehanna river at Havre de Grace, Md., to replace the present antiquated structure.

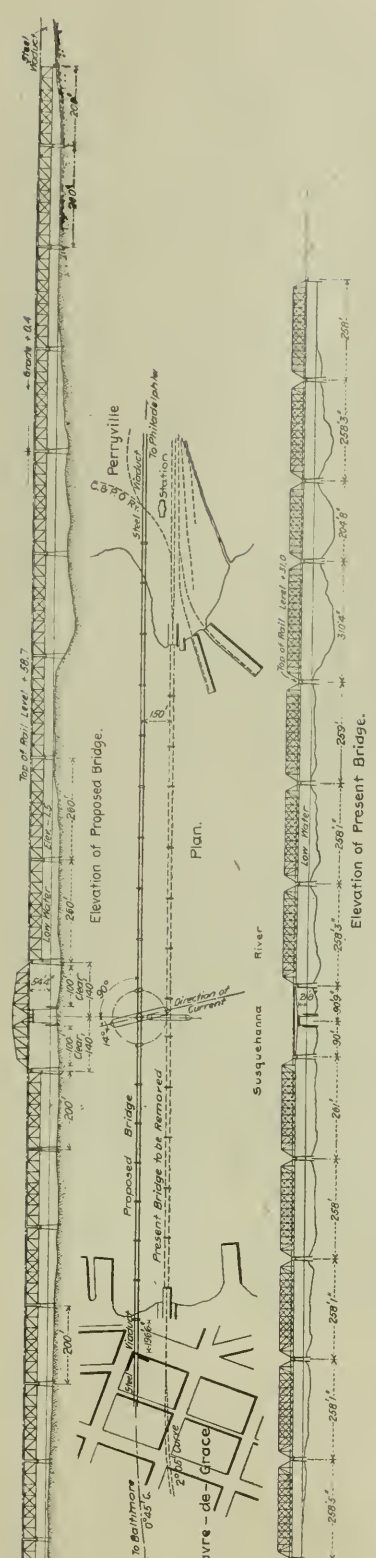
The track elevation through Chester begins at Crow creek, about two miles north of the station, and continues through Chester, Lamokin, Thurlow and Trainer, a distance of about 4.6 miles. At Lamokin the grade drops down for about 1,000 ft. to form a connection with the Central Division, which has not been elevated. The four tracks are carried on a solid fill held by broken rock range masonry retaining walls. The construction work has been carried on in the same way as the work in Newark, which was described in the *Railroad Gazette*, May 6. The wall on one side was built and a construction track carried on a trestle the height of the retaining was built. From this track the fill was dumped off to one side and when this was completed trains were diverted on to the construction track, the other retaining wall built and the fill completed. Two overhead and 27 underpass road crossings have been put in, and 14 crossings formerly at grade have been abandoned. The bridges over streets are all plate girder structures with solid floors. There has been but one change of alinement on this section of the work, at a point near Eddystone, where a 1 deg. 30 min. curve has been changed to a 50 min. curve.

About four miles south of Chester a detour has been built which is about 1½ miles long and which reduces a 3 deg. 6½ min. curve to one of 1 deg. At Bellevue, Del., eight miles south of Chester, the north and southbound freight tracks are carried under the northbound passenger track with a "jump-over," shown in plan in the accompanying drawings, and run to the east of the passenger tracks into the Shellpot yard. The grades of all four tracks have been adjusted at this point for about 6,300 ft. At the north end, the southbound passenger track begins to rise on a .25 per cent. grade, increasing to a .4 per cent. grade until it reaches a maximum elevation of 23 ft., or about 10 ft. above the old grade at that point. The station at Bellevue is located on the summit of the southbound track, which begins to fall on a .6 per cent. grade until it again reaches the old sub-grade about 1,300 ft. further south. The northbound passenger track starts from the present grade at the south end and rises with a .6 per cent. grade until it reaches an elevation of 37 ft., or 23 ft. above the level of the freight tracks which pass underneath. From there on it falls on a 1.3 per cent. grade to the old level at the north end. To make room for the fill the northbound passenger track is swung out to the east about 110 ft. away from the southbound track. The bridge over the freight tracks is 200 ft. long and is supported at each end on masonry abutments with long wing walls running back parallel to the freight tracks. The center line of the freight tracks is about 80 ft. to the east of the northbound passenger track after passing under the "jump-over," and at a point about opposite the Bellevue station they swing in again and run alongside of the passenger tracks, which also converge until the Shellpot yard is reached two miles below.




Plan of Jump-Over near Bellevue, Del., Philadelphia, Baltimore & Washington Railroad.

The track elevation through Wilmington starts at mile post 25, east of the city, and continues through to the junction of the Delaware division, about 3½ miles in all. For a part of the distance near the present passenger station the new line is deflected about 75 ft. north of the old right-of-way. This necessitates the abandonment of the old station and in its place a new and modern station and division office building will be erected. This work is similar in character to that being done at Chester and other points along the line, and includes underpasses at 25 streets. Two former grade crossings have been closed and vacated by the city. The Shellpot yard, which is just east of Wilmington, is a large old-fashioned yard operated entirely by switch engines and poling cars. It has recently




Plan and Elevation of Old and New Bridges at Havre de Grace, Md., P., B. & W.

been enlarged and changes made in the track arrangement to enable it to handle to better advantage the large volume of freight to and from the south.

At Havre de Grace an extended change in alinement will be made in connection with the new bridge which is to be built across the Susquehanna, and two sharp curves will be eliminated. The new location starts at mile post 57 in the town of Principio, and follows the old line over the river into Havre de Grace, but about 150 ft. north, joining the old line at mile post 63. The maximum curve in the new line is 45 min., whereas in the old line there are two 1 deg. curves and one of 2 deg. 5 min.

The old bridge which is to be removed consists of 12 through truss single track spans with an average length of 260 ft., and one deck swing span 181 ft. long, about in the middle of the bridge. The new bridge, which is 150 ft. upstream, will have 16 spans of deck trusses, wide enough for double track, and one through truss, swing span over the channel. The seven spans to the west of the swing span are each 200 ft. long, and the eight spans to the east of the draw will each be 260 ft. long, with one short inshore span 200 ft. long on the east bank. Steel viaduct approaches will lead on to the bridge from the embankment at both ends. The elevation of the top of rail above mean high water is 46.3 ft. on the new bridge and 31 ft. on the old bridge. This difference in level is to permit raising the tracks through Havre de Grace on an ordinary sloped bank. Four grade crossings will be carried under the tracks. At Perryville, on the east bank of the Susquehanna, a change will be made in the connection with the Columbia & Port Deposit on account of the change of grade on the new main line. Contracts for the grading of the new line have not yet been let as this work can be done any time before the completion of the bridge, which will take at least a year.

All of the improvements south of Philadelphia have been carried out under the direction of Mr. W. H. Brown, Chief Engineer of the Pennsylvania, to whom we are indebted for the drawings and information.

## Locomotives and Other Rolling Stock.*

### *Locomotives.*

The interest of French locomotive practice is centered in the development of the four-cylinder compound, which has permitted a marked increase in the weight and speed of the trains. In the majority of these engines, the high-pressure cylinders drive one axle, and the low-pressure cylinders another axle, but coupling rods have been preserved between these axles. The only exception is a unique locomotive (No. 701) built in 1885 for the Chemin de Fer du Nord, in which the two axles were not connected. This plan has not been continued. The use of coupling rods began in 1887 on the Paris, Lyons & Mediterranean locomotives. Since 1890 large numbers of such engines have been built or ordered by French railroad companies, and their aggregate number will soon exceed two thousand.

Mallet, four-cylinder engines are used on meter-gage lines. These are supported on two separate groups of coupled axles: One group, driven by the high-pressure cylinders, is connected to the locomotive frame in the ordinary way; the other group, driven by the low-pressure cylinders, forms a movable truck, so as to give great flexibility to the engine.

A few Vauclain locomotives, built in America, are in use on the State Railroads (also non-compound American locomotives on these and other railroads); and old engines have been converted into two-cylinder compounds, especially on the Midi lines. Steam pressures of from 14 to 16 kg. per sq. cm. (200 to 230 lbs. per sq. in.) are resorted to, the use of very high pressures being requisite, when it is necessary to combine power and lightness, as in locomotive engines.

The majority of the compound engines belong to two classes, which may be considered as standards in France: The express locomotive, with four large coupled wheels, of 2 m. (6 ft. 6¾ in.) diameter or a little more, and the six-coupled locomotive, with diameters of from 1.600 m. to 1.750 m. (5 ft. 2¹⁵/₁₆ in. to 5 ft. 8⅞ in.), both being fitted with a bogie in front. The six-coupled locomotives are equally fit for goods and for ordinary passenger trains. A tendency must be noticed to increase the diameter of the six-coupled wheels of these engines to about 2 m. (6 ft. 6¾ in.), for enabling them to work express trains. On the other hand, the "Atlantic" type is resorted to for increasing the power of express locomotives, the boiler, and particularly the fire-box, being enlarged.

The new "Atlantic" (Nos. 3,001-3,008), recently built for the Paris-Orléans by the Société Alsacienne de Constructions Mécaniques, is of special interest as being the most powerful express locomotive yet made for the French lines. The principal dimensions are given in Table No. 1. The adhesive weight is 36 *t** (18 *t* per axle), and it is expected that this weight will be increased to 40 *t*. Such a change is easy in locomotives of this type.

*TABLE No. 1.—Principal Dimensions of "Atlantic" Locomotives of the Paris-Orleans.*

| | |
|---|---|
| **Boiler:** | |
| Internal diameter | 1.513 m. (4 ft. 11½ in.) |
| Height, axis above rail | 2.700 m. (8 ft. 10⁵⁄₁₆ in.) |
| Working pressure | 16 kg. per sq. cm. (228 lb. per sq. in.) |
| **Tubes:** | |
| Length bet. plates | 4.400 m. (14 ft. 5⅜ in.) |
| External diameter | 70 mm. (2¾ in.) |
| No. (ribbed tubes) | 96 |
| Grate area | 3.1 sq. m. (33⅜ sq. ft.) |
| Heating surface | 239.4 sq. m. (2,577 sq. ft.) |
| **Cylinders:** | |
| H. p. diameter | 360 mm. (14³⁄₁₆ in.) |
| Stroke | 640 mm. (25⅛ in.) |
| **Cylinders:** | |
| L. p. diameter | 600 mm. (23⅝ in.) |
| Stroke | 640 mm. (25¼ in.) |
| Driving wheels, diameter | 2.040 m. 6 ft. 8⁵⁄₁₆ in.) |
| **Weight:** | |
| Total, working order | 72.900 kg. (71.75 tons). |

The following figures, extracted from the dynamometer car records and indicator cards taken during numerous runs of these engines with heavy express trains, give a fair idea of their power:

A length of 13 km. (eight miles) was traversed in 419 seconds, being at a rate of 112 km. an hour (70 miles). The cut-off was at 53 and 65 per cent. respectively, in the high and low-pressure cylinders. The mean drawbar pull, behind the tender, was 2,350 kg. (5,180 lbs.), from which results an average effective horse-power of 972†; the mean indicated horse-power was 1,830. The maximum indicated horse-power recorded on these engines was 1,900.

On the Nord, "Atlantic" locomotives, with somewhat smaller dimensions, maintain a very fine express service. Average speeds, from end to end, of 90 to 100 km. an hour (56 to 62 miles), are obtained with trains weighing (exclusive of locomotive and tender) 250 to 300 tons. The profile of the lines is generally easy, with somewhat prolonged inclines of 5 mm. per m. (1 in 200),

*Abstract of a paper by Edouard Sauvage, presented to the International Engineering Congress, St. Louis, October, 1904.

*This abbreviation *t* is used for the French "tonne."

†The unit of horse-power is here 75 kg. x 1 m. in a second, while the English unit is slightly greater. It might be advisable to express powers always in kilowatts, to do away with this cause of errors. In the present instances, the figures would be 715, 1,347 and 1,400 kw.

and, in a few places, of 8 mm. per m. (1 in 125). Some of these trains run in connection with boats from England, and, in many instances of bad weather, time lost by the boat has been made up by the train, although the schedule is calculated with a pretty fair speed.

For instance, the run from Calais to Paris (297.2 km. = 184.6 miles) has been made in 3 hr. 9 min. against a booked time of 3 hr. 30 min.; and, with a very light train, only 3 hr. 3 min. have been consumed from Paris to Calais. The run from Paris to St. Quentin (153.1 km. = 95.2 miles) has been made in 1 hr. 37 min. with a train weighing 365 *t* (359.2 English tons), and in 1 hr. 34 min. with a 300-*t* (295.2-ton) train.

The six-coupled compound of the Eastern may be mentioned as a typical express locomotive of this class. After comparative trials with "Atlantic" locomotives, these six-coupled engines have been selected as more suitable to the requirements of the lines of this system. The grate area is 2.857 m.² (30¾ sq. ft.), the heating surface, 223.94 m.² (2,410⁷/₁₆ sq. ft.); the diameters of the cylinders are 350 and 560 mm. (13¾ and 22 in.), with 660 mm. (26 in.) stroke; the diameter of the driving wheels is 2,090 m. (6 ft. 10⁵/₁₆ in.). The engine, in working order, weighs 71.8 *t* (70.66 tons), of which 51 *t* (50.19 tons) is adhesive weight.

Although in many cases the six-coupled four-cylinder compounds have replaced with advantage the old eight-coupled locomotives, which were largely used in France, the Paris, Lyons & Mediterranean system has a large number of such engines with four cylinders, and a new type of eight-coupled four-cylinder compound has been built by the Southern and by the Eastern.

In this last engine a pony truck is used in front of the cylinders. The four cylinders are placed on a line under the smoke-box. The high-pressure cylinders are inside, and drive the second coupled axle. The low-pressure cylinders are connected with the third axle. It is advisable, as far as possible, to put the low-pressure cylinders inside, under the smoke-box; but in this case their diameter was too large, and they could not be placed between the frames.

The consolidation locomotives haul trains of 800 to 900 *t* (exclusive of engine and tender) on lines with inclines of 1 cm. per m.; the same trains being taken by six-coupled engines on easy profiles. In the present state of things, the pull of these engines nearly comes up to what the car couplings can stand with safety, and could not be exceeded on that account.

Powerful tank-engines have been put in service recently, or are in course of construction, for working suburban trains, and even for general service, a rapid acceleration being of great importance in the first case. These tank-engines have six coupled wheels with a pony truck, and, in some instances, a bogie at both ends, or eight coupled wheels with one bogie in front; this last type is intended mainly for goods traffic. The four-cylinder compound system is also used for these engines.

The advantages of the four-cylinder compound system, as resulting from a prolonged practice in France, may be summed up as follows: Economy of coal resulting from the compound system in itself, or increase of power with the same consumption of coal; good utilization of steam at very high pressure, with the simple or piston valve and the old gears; good balance of pistons and other pieces with reciprocating motion; counter-weights applied only for revolving parts, thus doing away with vertical variations of pressure and pounding action on rails; ample bearing surfaces for all parts of mechanism, owing to the use of four cylinders with four separate gears and suppression of all undue strains.

It must be added that these compounds possess great elasticity in working, and are as well fitted for moderate as for high speeds, for light or for heavy trains. They remain economical within a wide range of power. In the Paris-Orléans experiments, an average steam consumption of 10.5 kg. (23 lbs.) per horse-power in an hour (the power being calculated from the action exerted by the driving wheels on the rail, to compare precisely with what is called the effective power of a stationary engine) has been measured with trains of heavy and also moderate weight.

As regards details of construction, the nearly exclusive use of Serve or ribbed tubes in all new constructions is well worth mentioning. Experiments have proved that the efficiency of a given surface of Serve tubes, taking into account the whole metallic area in contact with hot gases, was about the same as with the same surface of plain tubes; and in practice, these tubes have been found durable and free from leakage. They must be kept free from ashes and soot by frequent cleaning with a steam jet and, when necessary, with scrapers.

For valve gears, the Walschaerts system has been adopted in many of the French four-cylinder compounds, as well as for ordinary locomotives. This system is quite convenient when the valve is placed above or under the cylinder, and there is a distinct advantage in the use of one eccentric instead of two, for inside as well as for outside cylinders. The whole mechanism is simple, and easily kept in order. The distribution of steam effected by the Walschaerts system is particularly good, and quite uniform on both sides of the piston at different points of cut-off.

Piston valves are used in some of the latest designs. After the experience on the Eastern, they are preferable to flat valves, chiefly as giving larger ports and so reducing wire-drawing and compression of steam. An economy of coal, as high as 10 per cent., has resulted from their use in some cases.

From prolonged experience and from the unanimity of opinion of all having experience with these engines, it may be taken for granted that the four-cylinder compound system possesses marked advantages, at least under the conditions of service prevailing on main French lines. Thanks to their use, French railroads have been enabled to increase largely the weight and the speed of their trains, for goods as well as for passenger service, without any large increase of coal consumption per kilometer run. In fact, it is rather underestimating the merits of the compounds to say that by their use the weight of trains is increased by one-third with the same cost of fuel over what it was with the best simple engines used before; or, if not the weight, speed is increased, and in many cases both weight and speed.

In other words, the compounds would take a traffic equal to four, against a traffic equal to three, the number of engines and the expenses for fuel and wages remaining the same. The initial cost of the compounds is higher, the expenses for repairs may be somewhat greater, but the increase of traffic is such that the economy is obvious. As regards the cost of repairs, there is still some doubt as to their exact amount, as a very large proportion of the compounds have been running for a few years only, but it must be remarked that the increase of expenses will very likely be due to the boilers working at a high pressure, and it seems that the same pressures would be necessary for simple engines, if they were to compete with compounds.

To this must be added, especially for passenger service, the advantages of greater speed, of more punctuality, and of dispensing in many cases with pilot engines or with supplementary trains. In a mere practical point of view, the French administrations feel satisfied with the great extension they gave to the four-cylinder compound system, from which resulted economy as well as a large improvement in their services.

A complete solution of the problem would require a proof that the same results might not be obtained in some other way. Available data are not sufficient to give such a proof in an incontestable manner; still, it seems difficult to build an ordinary locomotive quite equal in every respect to the latest compounds.

It is clear that simple two-cylinder engines might be made with the same large boiler, and work with the same high-pressure, but it is nearly as clear that, with the ordinary valve gear of the locomotive, steam at such a high pressure cannot be utilized as well as by compounding; there is little doubt that the simple locomotive would require more steam for the same work or give less work for the same quantity of steam. In addition, there is a real difficulty in making all the parts of the simple engine strong enough to stand without undue wear the great stresses resulting from the increased pressure on large pistons, although this difficulty may be overcome.

An opinion, which seems to prevail, is that compound locomotives may be economical during long runs, but that their advantage is lost when they stop and start frequently, owing to the direct admission of steam to the low-pressure cylinders at starting. This opinion is rather too dogmatic, and the question requires some consideration. In many cases, with four-cylinder compounds, the tractive power necessary for starting from rest is obtained without this direct admission, or steam is admitted in that way only for the very first revolution of wheels. The engine is then worked compound, but in full gear for all cylinders. Of course, steam is not so well utilized as with a proper degree of expansion in each cylinder, but, even in that case, the compound compares favorably with a simple locomotive working in full gear.

In conclusion, opinions expressed by men placed at the head of locomotive departments of French railroads will be found of interest. Among others, M. Baudry, Locomotive Superintendent of the Paris, Lyons & Mediterranean, ended a communication to the Société des Ingénieurs Civils as follows:

"Some people may be of opinion that the importance of the coal saving due to compound locomotives is small, and even vanishes when the prices of coal are very low. That is a mistake, as the saving of coal means really an increased power of the locomotive. In fact there is no saving of coal for a certain work performed, but there is more work for the same coal consumption; thence result other important savings; less locomotives, less drivers, less firemen, less trains are necessary for a given traffic. These aggregate savings, which do not depend upon the price of coal, greatly exceed, in the majority of cases, the saving of coal proper. If the weight of trains is not increased, then an acceleration in speed is possible, and in that way the construction of more economical locomotives has resulted, during the last few years, in an increase of speed on all French lines."

M. Salomon, Locomotive Superintendent of the Eastern, writes that:

"Compared to the ordinary locomotive, the compound locomotive has the important advantage of a coal economy, which varies with the nature of the service, but which is, on an average, from 10 to 15 per cent. With

the use of four cylinders the symmetry of the engine is preserved, inertia forces are in better equilibrium, the turning force is more uniform, the total work is divided between two axles, and stresses are more evenly distributed on the frame. As a consequence, the mileages between two heavy repairs in the shops has been increased by 50 per cent.

"In my opinion, the use of these locomotives marks an important improvement, which has not been accompanied by any trouble in service; the only objections which have been often made to the use of compound locomotives are want of elasticity in their power, and excessive compression of steam at high speed. As regards the first objection, the use of independent gears for the high and for the low-pressure cylinders allows a satisfactory distribution of steam under very different rates of weight and speed. The second objection vanishes with large clearances and sufficient area of steam passages on the low-pressure cylinders. In this respect piston valves will be quite suitable if they remain sufficiently tight."

*Passenger Carriages.*

Normal passenger carriages are of three different classes; to these must be added sleeping and saloon carriages.

All recent constructions (for main line traffic) are of the lateral-corridor type with compartments. In the best types of rolling stock, vestibules with covered gangways from carriage to carriage are used. Such is the case for first and second class coaches intended for through trains, and these are frequently carried on four-wheeled bogies. In some other cases, especially for third class, the corridor extends only inside one carriage, without communication with its neighbor; side doors are preserved, and these carriages are usually carried on two or three axles. They are all fitted with lavatories.

Sleeping cars are also of the compartment system, with two and sometimes four berths in a compartment. For suburban traffic, the old system of compartments with side doors is still used; sometimes carriages with wide platforms at both ends are preferred.

*Goods Wagons.*

The standard wagons have two axles. The normal carrying capacity of 10 tons has been extended to 15 and even 20 tons in recent constructions. Steel bogie cars, carrying from 40 to 50 tons of coal or dense materials, such as stones or ores, have been built recently. Their use is, as yet, limited. Westinghouse brakes (and in some instances other compressed-air brakes) are used on the whole of the passenger stock and on certain goods wagons.

## New Locomotives and Motor Cars for the Paris-Orleans.

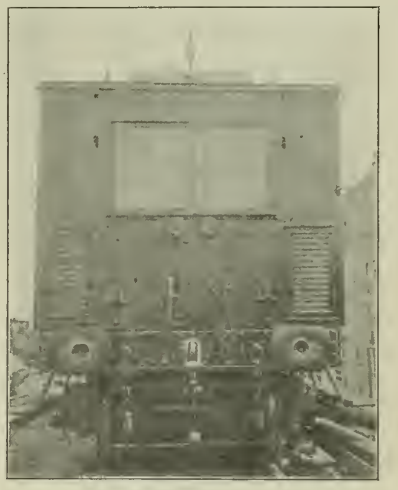
It will be remembered that the Paris-Orleans, the first French steam trunk road to make any important electric transformation of its lines, opened in May, 1900, an extension of its existing lines in Paris, creating a new terminus at Quai d'Orsay and operating the whole of the incoming and outgoing trains electrically. The generating station contains two 1,000 kw. groups, two 500 kw. substations, and two sets of storage batteries. The locomotives used were similar to the Baltimore & Ohio locomotives, having a central cab with sloping ends. Each locomotive has four GE-65 motors (225 h.p. each) and mounted on heavy trucks built by the Schenectady Works of the American Locomotive Company. The installation was made by the French Thomson-Houston Company, and the greater part of the machinery, especially the locomotives, is of American make, mostly from the General Electric Company, Schenectady.

The installation has given such satisfaction that an important extension was decided upon some time ago, and further additions have been made both to generating and substation equipment, but principally to the rolling stock. There has now been put into service, in addition to the original eight locomotives, a further lot of three, of the same powerful build, mounted on trucks similar to those on the old locomotives. The new locomotives are the baggage-car type, with a cabin at each end, and a compartment for baggage in the middle. The end cabin contains an L-7 controller and the usual circuit breaker and measuring instruments. The motor leads and the shoe-leads pass through brass flexible tubing, and connection boxes are provided for the motor leads. The motor armature coils are mica-insulated. The end cabins are lined with an Uralite insulating sheeting and the framework of the locomotive is fireproofed wood. The body is sheet steel. The gear ratio is 2.23 to 1.

Five motor cars all equipped with the Sprague-General Electric type M control, with type C-22 controllers, have been added to the present equipment. These motor cars have a cabin at each end, and the intermediate space is taken up with a baggage compartment and a space for third-class passengers, for which 34 seats are provided. The whole of the train control apparatus is mounted in these cabins, the rheostat equipment being of course properly insulated from the contractor groups. This is somewhat a

The Quai d'Orsay Station of the Paris-Orleans.

New Motor Car of the Paris-Orleans.



End View—Paris-Orleans Car.

departure from standard American practice. Similarly to the locomotives, the motor leads and the shoe-leads are passed through flexible tubing, and motor-connection boxes are used. GE-66 motors with one-turn armatures are used. The gear ratio is 3.08 to 1. The cabling used in both locomotives and motor-cars is covered with asbestos braid, slate-colored. Paint is used on the asbestos to avoid abrasion from chafing, etc.

These cars are mounted on bogie trucks of the Baldwin type. The wheel-base is 6 ft. 6 in., with 40 in. wheels. They weigh 6,250 lbs., and are calculated to carry 26,000 lbs., of which 15,000 lbs. is the weight of the empty car-body.

The following are the dimensions of the locomotives and motor cars just put into service:

| | Locomotive. | Motor-car. |
|---|---|---|
| Length | 10.2 meters. | 17.3 meters. |
| Width | 2.84 " | 2.8 " |
| Height | 3.87 " | 3.8 " |
| Weight | 55 tons. | 30 tons. |
| Distance between centers of trucks | 5.63 meters | 12.4 meters. |
| Wheel-base | 7 ft. 10 ins. | 6 ft. 6 ins. |
| Wheel-diameter | 49 ins. | 40 ins. |

The service which the old and new locomotives and motor-cars will have to perform is as follows: To haul from Juvisy (a suburb of Paris) a distance of 15 miles from Quai d'Orsay terminus, to Paris and vice versa, a total of over 200 trains daily, at speeds varying from 30 to 45 miles per hour. As a rule, all trains, except those proceeding south without a stop at the terminus of the electric line, will change engines at Juvisy and proceed to Paris or to Juvisy from Paris, as the case may be, in charge of electric machines. Times for express trains will be about 25 minutes or less, including one or two stops. The all-station or local service will take from 35 to 40 minutes. For this service, the motor cars will be used exclusively. There are two trains, comprising seven or eight trailers, fitted for use with the motor cars, one of which will be at each end of the train. A half-hourly service to Juvisy is maintained, together with supplementary trains at rush hours.

All the apparatus, especially the rolling stock, is of American pattern. The motors and train control apparatus are built by the General Electric Company. In connection with this plant, it is of interest to note that the Pennsylvania is using the Quai d'Orsay terminus as a model for their new station in New York.

The French winter time-table provides for a train from Paris to Nice, 675 miles, in 12 hours and 50 minutes, which it is claimed will be the fastest long-distance train in the world.

## New South Wales Government Railroads.

The annual report of the Railway Commissioners of New South Wales for the year ending June 30 last shows total receipts on the railroads of the Colony of $17,582,065 as compared with $16,574,4[illegible] for the preceding year. Operating expenses this year were $11,294,700, leaving net earnings of $5,088,000. The length of road open for traffic June 30 was 3,281 miles, an increase of 142 miles over the preceding year. The average number of miles operated during the year was 3,224. The amount of capital invested in the railroads is reported at $211,442,585, and, estimating the interest on this at $7,420,745 (the rate being 3.565, which is the average rate of interest paid on the State debt), the net earnings fall $1,533,380 short of the sum required to pay interest. The smallness of the increase in receipts is explained chiefly by the great falling off in freight traffic in consequence of the severe drought which has prevailed for two years. In spite of the adverse conditions, the percentage of working expenses to revenue has been reduced from 68.37 to 65.74.

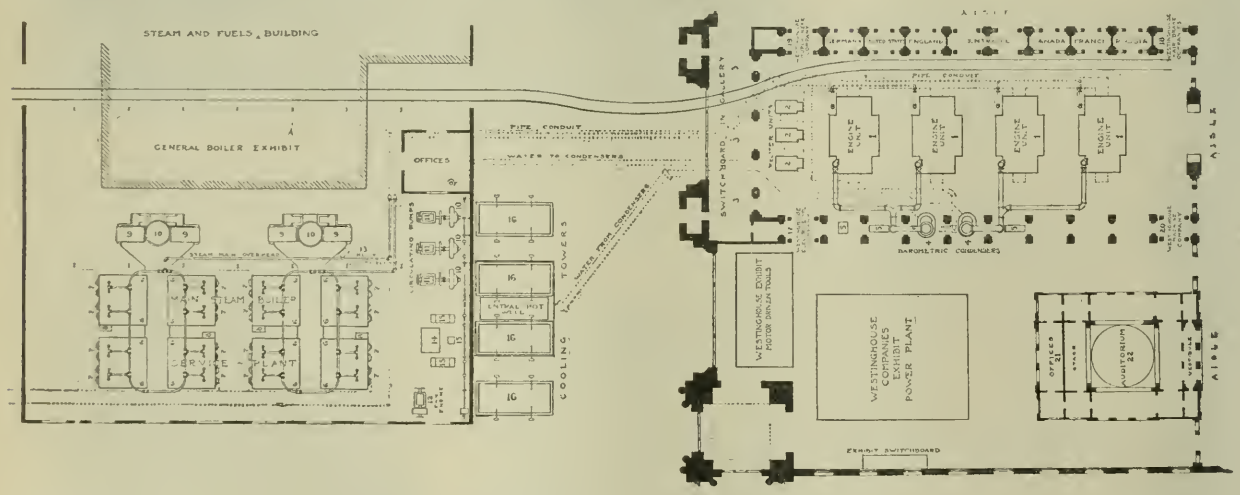
The average receipts per mile of road were $5,395 this year, as compared with $5,465 the year before; receipts per train mile $1.64 cents in 1904 and $1.43 cents in 1903. The Commissioners again call attention to the serious burden on their finances of the unprofitable railroads which have been built in the past. During the year now under review the loss on lines of this character amounted to $2,203,485, which is $333,265 greater than the loss in the year before. The people are warned that if the railroad finances are to be put into satisfactory position the construction of unprofitable lines must be suspended. There were no train accidents fatal to passengers during the year. About 240 miles of track was relaid with heavier rails and 400 miles were reballasted.

Additions to equipment included 24 freight locomotives, one passenger locomotive and 35 suburban tank locomotives; also three sleeping cars, 10 second class coaches, 66 hopper cars and six box cars.

The same report gives the statistics of the tramways of the Colony, the mileage of which on June 30 was 126. The net receipts of these lines amounted to $646,800, which was a little more than enough to pay the interest on the capital invested, calculating this at the rate above named, 3.565 per cent. In the preceding year the tramways showed a deficiency of nearly $100,000. The Commissioners are opposed to the extension of tramways except where favorable financial results are fully assured. The conversion of steam tramways to electric appears to be still unfinished, 47 steam cars, three steam motors and one cable car having been replaced by electric vehicles during the year.

## The Service Power Plant at the World's Fair, St. Louis.

The main service power plant for the Louisiana Purchase Exposition is a complete central station supplying electric power for general use throughout the grounds, for the night illumination of the buildings, for pumping the water for lagoons and court basins, cascades and fountains, and for operating exhibits and concessions in various parts of the grounds. The entire steam and electric station of 14,000 h.p. capacity was designed and installed by Westinghouse, Church, Kerr & Company. The four 3,500 h.p. Westinghouse-Corliss, vertical, cross-compound, reciprocating engines in the Westinghouse enclosure at the west of Machinery Hall, the smaller engines driving exciters in Machinery Hall, the engines driving the pumps, stokers and cooling tower fans in the service plant boiler house, just west of Machinery Hall, and the Roney mechanical stokers in the latter building were built by the Westinghouse Machine Company.




General Plan of Service Power Plant, World's Fair, St. Louis.

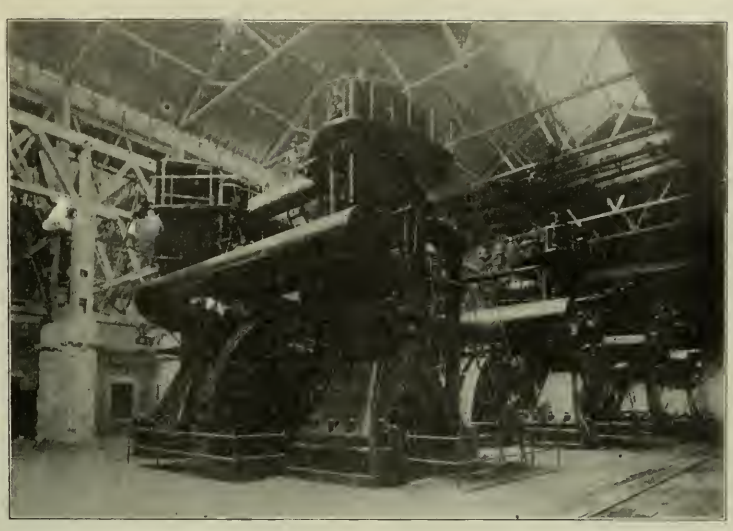
The central power station at the Chicago fair in 1893, which was also a Westinghouse installation, was of about the same total capacity as the present plant, but the 12 generators, although then the largest polyphase alternating current machines ever built, were each of only 750 k.w., or 1,000 h.p., capacity. The four 3,500 h.p. units of the Louisiana Purchase Exposition service plant, although three times as large as the largest at Chicago, are to-day regarded as of only medium size. The floor space occupied by the Westinghouse-Corliss engines and their direct connected generators is 15 ft. x 35 ft. each, being only about one-ninth of the space required at Chicago for six of the twelve 1,000 h.p. generating units which were belt driven. The plant resembles in general design such installations as the 40,000 h.p. station of the Metropolitan Street Railway Co., just completed at Kingsbridge, New York City, and the 75,000 h.p. station of the New York Edison Company, where 11 engines, rated at 6,500 h.p.

each, the largest engines in service, frequently carry a maximum load of 10,000 h.p. for short periods.

Electric current from the service plant and from exhibit power plants in Machinery Hall is transmitted at a potential of 6,600 volts, transformers being used only at distributing points. All power is controlled from the switchboard on the upper gallery over the west end of the main aisle, which has 29 panels. All main generator and feeder switches are installed in independent fireproof vaults, and are electrically operated from the main panel, indicators showing whether a switch is open or closed.

The four main units are alike in capacity and general design. The engines are of the vertical, "cross-compound" type, and run at a speed of 85 revolutions a minute. The main shaft is 3 ft. in diameter at the center and is forged hollow from open hearth steel, fluid compressed to insure homogeneity. On account of the length of the shaft the bearings are made self-alineing, having spherical instead of cylindrical seats. Both the bearing shells and the cross-head guides are arranged for water cooling.

The valve gear, which is a modified Corliss type, permits a maximum cut-off of three-quarter stroke, enabling each engine to sustain for short periods a load of 5,000 h.p. The speed of each unit is controlled by an enclosed type self-oiling centrifugal governor, adjustable while running for spring tension and sensitiveness. In order to operate the generators in multiple, a small motor is provided at the engine, which moves an adjustable weight on the governor mechanism. This motor is controlled from the switchboard, so that the engine speed may be adjusted until the incoming generator has been synchronized and connected to the system. An automatic speed limit is provided on the engines, which closes the throttle should the safe speed be exceeded because of a failure of the governor mechanism. This safety device may also be operated by the engineer from the main floor by means of an electric switch.

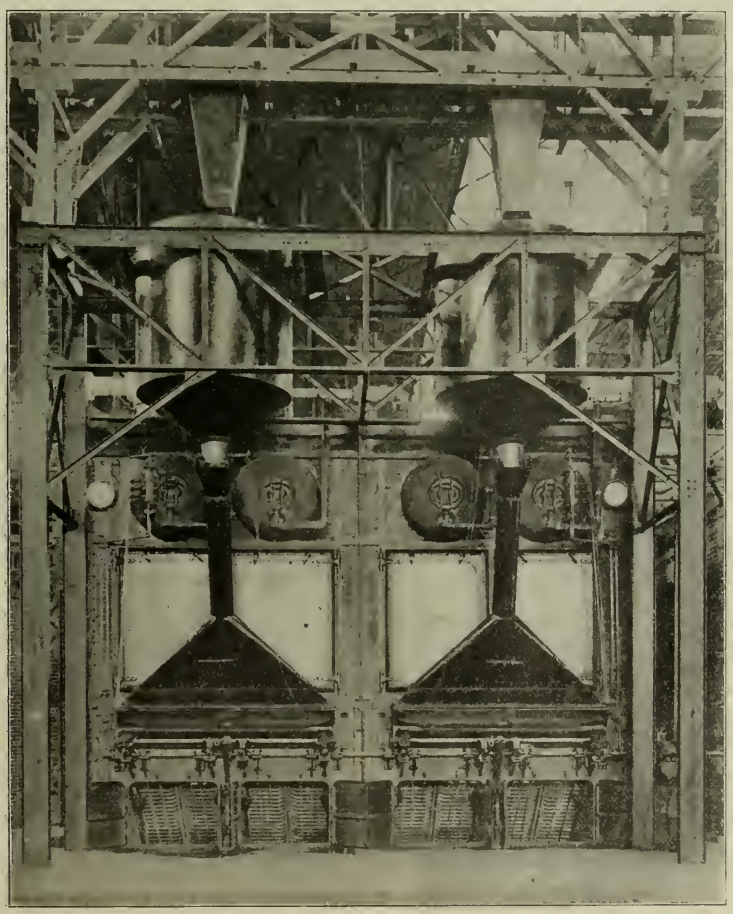


3,500-H. P. Westinghouse Units in Machinery Hall.

The generators, which are rated at 2,000 kilowatts at the usual temperature rise, are of the engine type, revolving field construction, with laminated armatures and fields. The armatures are strap wound in partially closed slots, and the fields are wound with copper strap on edge. In order to obtain access to the winding the entire generator frame may be moved out of position parallel to the shaft. Three 80 k.w., 125 volt, Westinghouse engine type units furnish exciting current for the generator fields.

All main and exciter engines, as well as auxiliaries in Machinery Hall, operate condensing, two complete central condensing equipments being installed, each of 7,000 h.p. capacity and serving one-half of the plant. They are of the Worthington elevated jet or "barometric" type, provided with entrainers and rotative "dry air" pumps for removing air from the condenser cones. Both horizontal and vertical types of pumps are in operation, one of the three being held in reserve. In case of loss of vacuum an automatic relief valve allows the exhaust steam from the engine to escape through the roof. A motor-driven valve operated from the floor below by a switch, controls the steam inlet to each condenser. Circulating water is supplied to the condensers by a centrifugal pump of the Worthington turbine pattern, direct driven by a Westinghouse compound engine. The hot water discharged into the condenser hot wells is not thrown away, but is cooled for further use in four specially designed cooling towers adjacent to the boiler room. A second turbine circulating pump elevates the hot water into the towers and, in falling, the temperature is reduced by evaporation, which process is further aided by forced draft from the fans located at the base of each tower and driven from the boiler room by a Westinghouse compound engine. A third turbine pump unit is held in reserve and may be employed on either condensers or cooling towers. Motor driven valves operated by a switch from the floor control the outlet of each pump.

Two complete systems of steam mains, 12 in. in diameter, convey steam to the main engines. The mains are carried beneath the floor in pipe galleries, anchored firmly to prevent creeping, and supported upon rollers to allow for expansion and contraction. Entrained water collecting in the boiler room piping is drained out and automatically returned to the boilers by a steam loop and "Holly" gravity return. A similar system



Boiler Battery in Boiler House Showing Roney Stokers.

of piping for the boiler room and pumping auxiliaries is connected to the boilers between the drums and main valves, so that steam is always available at the boiler house auxiliaries. These smaller engines operate non-condensing, exhausting into two Cochrane open feed-water heaters which reclaim the greater part of the heat from the exhaust. In the engine room all auxiliaries operate condensing upon the main condensing system.

Steam is furnished by 16 400 h.p., Babcock & Wilcox water-tube boilers of the forged header type, two boilers being set in a battery. The tubes and drums are carried by steel frames independent of the brick setting. Two 10-in. loop steam mains, each connecting four batteries of boilers, deliver steam to the two 12-in. mains which carry the steam to the main units in Machinery Hall. Each group of four batteries of boilers is served by an independent induced mechanical draft equipment consisting of two fans, each capable of operating the boilers at their full capacity. A damper, by means of which either fan may be cut in or out of service, is so arranged that, if desired, both fans may be run simultaneously.

The firing of the boiler plant is done by Roney mechanical stokers, each group of four stokers in line being driven by a small Westinghouse standard engine, through suitable gearing. The stoker has a narrow rocking grate, stepped at the proper angle to give a uniform descent of fuel from the coking arch at the top to the dumping gate at the bottom. Careful observations of the smoke from the stoker chimneys are made at intervals during the day's run, for purposes of comparative record.

The Niles electric traveling crane over the main engine units in Machinery Hall is of 40-tons carrying capacity and has a span of 80 ft. It is equipped with three Westinghouse motors—one, of 20 h.p., to drive the bridge, being located at about the center of the girder, one of 20 h.p. for hoisting, and one of 5 h.p. for moving the trolley, being secured to the trolley itself. The motors are controlled from the crane cab, and current at 110 volts is supplied from the exciters for the main engine units.

## Railroad Shop Tools.

(*Continued.*)

### RADIAL DRILLS.

The principle advantages of the radial drilling machine are the ease with which the tool can be moved to the various parts of the work to be drilled, and also the wide range of adjustment of the drill. This latter feature in many cases enables all of the holes in a piece of work to be drilled with but one setting on the table or bedplate. The accompanying illustration, Fig. 1, shows a new 5-ft. arm radial drill made by the American Tool Works Company, Cincinnati, Ohio. The feeding mechanism of this machine is in the head and it provides for eight distinct rates of feed ranging from .007 in. to .063 in. per rev. of the spindle, any of which may be obtained by simply turning the dial shown on the feed box until the desired feed, indexed thereon, comes opposite the fixed pointer. This method is an extremely simple one, as it requires no reference to index plates and subsequent handling of levers.

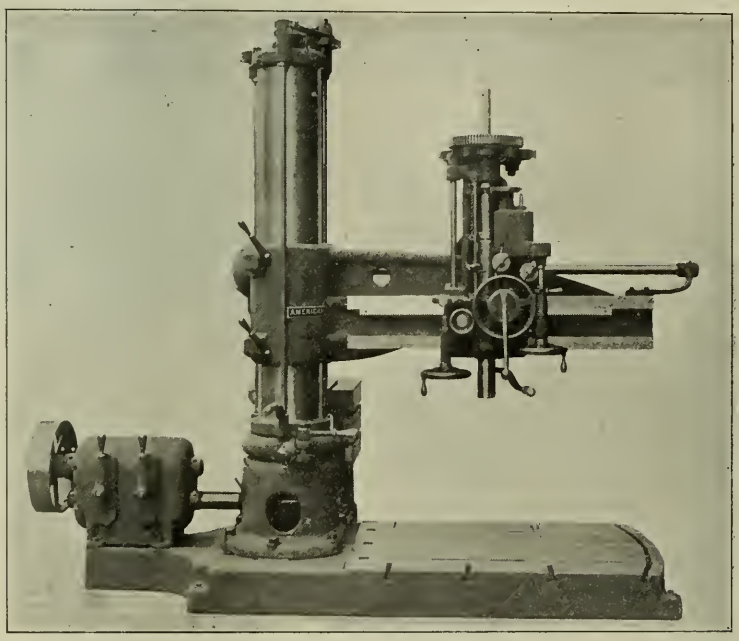


Fig. 1—The American Radial Drill.

The feeds operate through a friction which prevents the drill being crowded to such an extent that it might strain the feed mechanism. A plate attached to the machine gives a table indicating the proper feeds to be used with twist drills of all sizes from ½ in. to 3½ in., inclusive. The feeds can be automatically tripped at any position of the spindle by an adjustable trip dog and pointer acting on the worm clutch. Two or more dogs can be supplied, making it possible to counterbore any number of holes without resetting. The spindle is graduated to indicate the depth, giving all readings from zero. The trip acts automatically at the full depth of the spindle, thus preventing the breaking of the feed mechanism.

The speed box is of the geared friction type, providing four changes of speed, each being available by use of the two levers shown. The frictions are of the patent double band form and consist of few parts. When desired the speed box can be replaced by a cone by disconnecting at the coupling on the lower driving shaft of the machine. The spindle has 16 changes of speed, any one of which may be thrown in without stopping the machine. The column is of the double tubular type. The inner column extends the entire height of the outer column and provides a bearing for it at both top and bottom. This gives the equivalent of the double column and affords exceptional rigidity. The swinging arm is of parabolic beam and tube section. The lower side is parallel with the base, and the guides are extended so that holes can be drilled close up to the column. The arm is raised and lowered rapidly by a double thread, coarse pitch screw mounted on ball bearings and controlled by a convenient lever. Back gears are located on the head, thus making the greatest speed reduction at the spindle. They may be engaged or disengaged without shock or jar

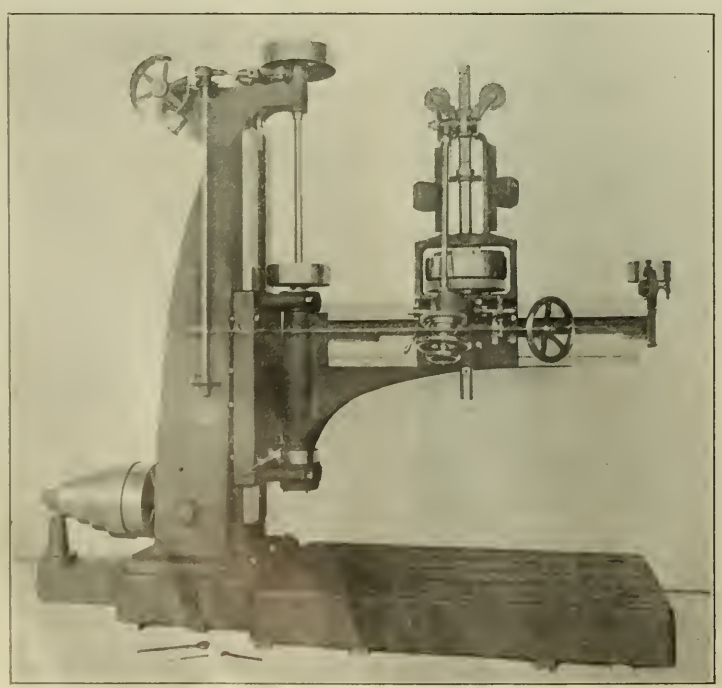


Fig. 2—The Baush Radial Drill.

while the machine is running. The drill spindle is counterbalanced and has a frictional quick advance and return. A tapping mechanism is carried on the head between the back gears and speed box where its frictions have the benefit of the back gear reduction, making it possible to perform unusually heavy tapping work. It also permits the taps to be backed at an accelerated speed. A lever for starting, stopping or reversing the spindle is controlled at the head from the front of the machine. The table has a top surface 20 in. x 20 in., and also side surfaces, which serve the purpose of an angle plate.

Fig. 2 shows a 5-ft. arm, belt-driven radial drill made by the Baush Machine Tool Company, Springfield, Mass. The tool will drill to the center of 146 in. The extreme height of the machine with arm and spindle up is 14 ft. 6 in. The bed is 146 in. long by 48 in. wide, and is 10 in. thick. The greatest distance from the spindle to the bed is 90 in., and from the spindle to the floor is 100 in. The maximum distance from the center of the spindle to the face of the post is 73 in., and the minimum distance is 27¾ in.

The arm is supported on roller and ball bearings, thus making it easy to swing around. It is provided with a friction binder for clamping it in any position. The spindle is made of tool steel and its largest diameter is $2^{15}/_{16}$ in. The spindle is counterbalanced and has a quick return motion and an adjustment of 18 in. The machine has six changes of feed which can be used with any of the spindle speeds which are provided. The countershaft is arranged for tapping, friction pulleys being furnished. This drill is made both in the belt and geared type.

A third machine, Fig. 3, is a 4-ft. radial drill made by the Mueller Machine Tool Company, Cincinnati, Ohio. The column of this machine is 9 in. in diameter and made in one piece, being bolted to the table. The arm is of pipe section and is supported on a top cap resting on roller bearings. A bronze plate is attached to the arm on which are given the correct speeds for drilling either cast-iron or steel. A ring graduated to 360 deg. turns with the arm, and in connection with a zero on the column provides a means for bringing the arm back to a definite position as often as desired.

The head can be locked to the arm in any desired position and it is adjusted by means of a double pitch screw which engages with a revolving dial on the outer end of the arm. This permits the operator to bring the head to within .001 of an in. of the required position. The spindle is made of crucible steel and is counterbalanced; it has quick advance and return and is provided with means for taking up wear. When used for tapping an adjustable gage screw causes the spindle to slip when the tap reaches the bottom of the hole, thus preventing the breaking of taps. The spindle has 16 changes of speed ranging from 18 to 370 r.p.m. The starting lever is within easy reach of the operator and controls the raising and lowering of the arm and the starting, stopping and reversing of the spindle. The automatic feed is driven by a friction plate and any feed from zero to .023 in. per revolution of the spindle can be obtained instantly and while the drill is at work.

A safety stop is attached to the automatic trip which prevents the feeding of the spindle after it has reached the limit of its travel. The dimensions of the machine are as follows:

| | |
|---|---|
| Drills to the center of a circle on table | 8 ft. |
| Drills to the center of a circle on base | 7 ft. 8 in. |
| Horizontal range of head | 3 ft. 5 in. |
| Vertical range of arm | 2 ft. 9 in. |
| Receives under spindle over base | 4 ft. 9 in. |
| Receives under spindle over floor | 5 ft. 2 in. |
| Least distance between column and spindle | 7½ in. |
| Traverse of spindle | 12 in. |
| Extreme height of drill | 8 ft. |
| Extreme height of spindle at greatest elevation | 8 ft. 7 in. |
| Size of table (plain or swiveling) | 15 x 25 in. |
| Size of base working surface | 31 x 48 in. |
| Floor space required | 96x120 in. |
| Weight of machine | 4,100 lbs. |

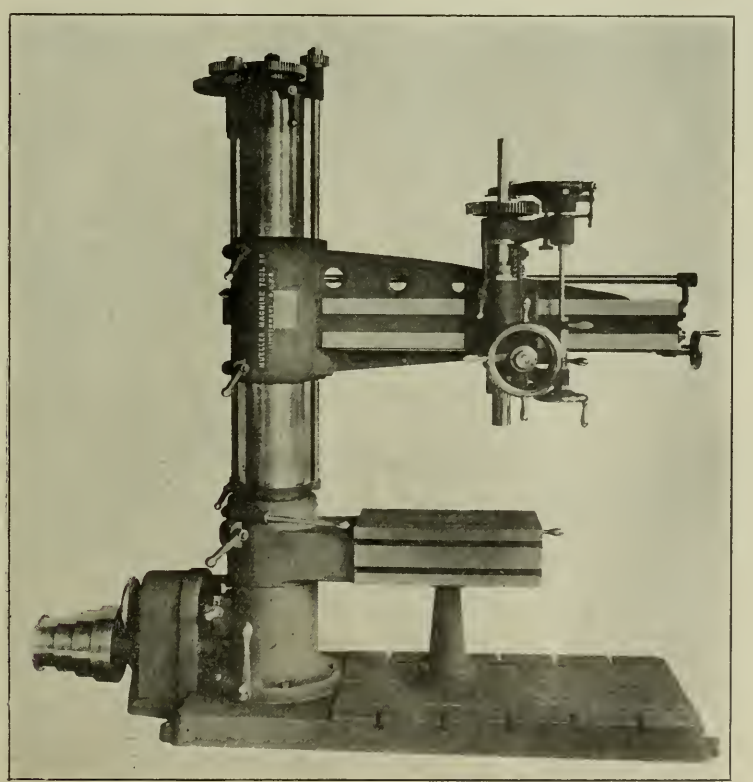


Fig. 3—The Mueller Radial Drill.

*(To be continued.)*

## Ventilation of Tunnels.*

BY FRANCIS FOX, M. INST. C. E.

It is desirable to ascertain, if possible, the standard of purity to be aimed at in ventilating:

1.—Tunnels worked by steam locomotives, in which the products of combustion of fuel constitute by far the largest source of impurity.

2.—Tunnels worked by electricity, in which the chief source of contamination is the human lung.

The general consensus of opinion is, that in tunnels worked by steam locomotives, provided the proportion of carbon dioxide ($CO_2$) does not exceed 20 parts in 10,000, no harm will be done, especially as the period during which passengers are exposed to this is but short.

The consumption of fuel in the fire-box of the locomotive depends upon the heating quality of the coal, the design of the fire-box, the load hauled, and the steepness of the gradient, etc.; consequently, it is impossible to lay down any definite and accurate rule. Each tunnel must be dealt with on its own merits, and the consumption of fuel per train-mile ascertained. Instances have been quoted where this has varied from 32 lbs. per mile up to as much as 268 lbs. in the case of a steep tunnel in Japan.

Allowing 29 cu. ft. of poisonous gas for each pound of coal consumed, the volume of fresh air required to maintain the atmosphere of the tunnel at the above-mentioned standard of purity is ascertained as follows: The number of pounds of fuel consumed per mile, multiplied by 29, multiplied by 500 (that is 20 parts in 10,000) and divided by the number of minutes interval between the trains, will give the volume of air in cubic feet which must be introduced into the tunnel per minute, either by blowing in fresh, or by exhausting the foul air, to keep it in a sufficiently pure state to avoid inconvenience.

As an illustration—assume a tunnel to be one mile long, a train passing through on the up and also on the down road every 10 minutes, the consumption of fuel being 40 lbs. per train-mile, the volume of air required per minute will be:

$$\frac{40 \text{ lb.} \times 29 \text{ cu. ft.} \times 500}{5 \text{ minutes (interval)}} = 116{,}000 \text{ cu. ft.}$$

The greatest disadvantages due to bad ventilation, are injury to employees, inconvenience to the passengers, danger of accident, slippery condition and rapid oxidation of the rails. On August 11, 1898, in the long tunnel of Ponte Decimo near Genoa, which is on a 2½ per cent. grade, a train which, in consequence of the greasiness of the rails, came to a stand (the men on the engine being rendered unconscious) ran back down the incline on the wrong road, and collided with a passenger train waiting its turn to pass through. The result was that 12 persons were killed and 40 injured; all the result of bad air.

The loss of weight in steel rails is also very serious, amounting in the case of the Box tunnel of the Great Western Railway to 2½ lbs. per yd. of rail per annum, as compared with ¼ lb. on the open-air portion of the railroad.

For tunnels worked by electricity, a different method of calculation must be adopted. No vitiation by combustion of fuel has to be provided for, but, on the other hand, the antiseptic properties of certain constituents

*Extracts from a paper read before the International Engineering Congress, at St. Louis, Oct. 6.

of coal, which are doubtless of value, are wanting.

Air which has been partially vitiated may not be very excessive in $CO_2$, nor give very bad results from a bacteriological point of view, yet it is very objectionable and injurious, producing languor and headache, and, if inhaled for too long a period, may cause the contraction of disease; but in crowded assemblies where it has been breathed, rebreathed, and breathed again, it is most pernicious.

The extent to which $CO_2$ may be added to pure air, without any very serious results for a short period, is remarkable; as high a proportion as 160 parts in 10,000 has been experimented with without injury, but, in combination with the products of respiration of a crowded audience, even 20 parts is excessive; it can only be regarded as an index of the toxic condition of the air. After long investigations by English and French chemists, the volume of air required by each person per minute has been fixed at 30 cu. ft.

Assuming that the standard of purity:

(1) for steam-worked tunnels, should be 20 parts in 10,000 of $CO_2$,

(2) for electrically-worked tunnels, 30 cu. ft. of air per minute per passenger,

the next step is to consider the best methods for effecting the desired results.

Two of the earliest instances of ventilated tunnels are those of:

*a.*—The Severn tunnel under the River Severn, on the main line to South Wales of the Great Western Railway.

*b.*—Of the Mersey Railway under the River Mersey, between Liverpool and Birkenhead.

The Severn Tunnel is 4 miles, 624 yds. long, the gradient varying between 1 in 90, and 1 in 100, and has one ventilating shaft, placed as near the middle as the river would allow, or 1 mile, 1,210 yds. from the southern entrance, being thus 862 yds. from the center. This is, of course, not an ideal position, as in certain directions of wind, the ventilating fan (which is a Guibal, 40 ft. in diameter with blades 12 ft. wide) is liable to draw its air mainly from one direction. In time as the traffic increases, a modification of this arrangement will have to be effected. The volume of air ejected from the tunnel by this fan is 400,000 cu ft. per minute.

The Mersey Tunnel was a much more complicated problem to solve, owing to there being three underground stations to be provided for. The plan at the outset was to allow fresh air to enter at the stations, so that the platforms should be kept fresh and pure. Consequently the vitiated air was drawn from points midway between the stations. By this arrangement, fresh air flowed into the tunnel at the stations, by means of the footways, staircases and lift shafts; it then traveled along the tunnel, getting more and more foul as it proceeded, until it reached the part of the tunnel equi-distant between stations, by which time it attained its maximum of impurity, when it was swept down, by the drag of the fans, into the ventilation headings, and ejected into the open air at the fan chamber. So long as these fans were kept running at their stipulated speed, and good coal was used on the locomotives, the ventilation results were excellent; but later, in consequence of financial difficulties, both these were modified, without improving the condition of the atmosphere. As, however, the tunnel is now worked electrically, the volume of air required is much reduced.

Table 2 gives the sizes and outputs of each fan. That at Hamilton street was found occasionally, when under a strong southwesterly gale, to be "drowned" in fresh air, consequently it had to be connected by drift with Hamilton Square Station, so as to be available when required to assist the other fans.

RESULTS OF EXPERIMENTS WITH VENTILATING FANS AT THE MERSEY TUNNEL.

| Fan at | In feet. Diameter of fan. | In feet. Width of blade. | No. of revolutions per min. | Area of drift-way. | Water gage, in in. | Velocity of air, in ft. per min. | Volume of air, in cu. ft. per min. |
|---|---|---|---|---|---|---|---|
| Hamilton St., Birkenhead... | 30 | 10 | 47 | 113 sq. ft. | 1.30 | 1,895 | 214,135 |
| Shore Road, Birkenhead.... | 40 | 12 | 45 | 41 " | 2.50 | 3,288 | 134,685 |
| James St., Liverpool ..... | 40 | 12 | 45 | 72 " | 2.45 | 2,465 | 178,880 |
| James St., Liverpool..... | 30 | 10 | 60 | 60 " | 2.30 | 2,062 | 123,720 |
| Bold St., Liverpool ..... | 12 | 5 | 240-300 | No. drift-way.* | .... | ..... | 300,000 |
| Total ..... | | | | | | | 951,420 |

*Air being drawn direct from the underground station.

The proper ventilation of electric tube railways similar to those in London is an especially difficult problem. These lines consist of parallel tunnels, each containing a single track, and at certain points these two tunnels merge into one to provide for cross-overs and switches. In addition to these places, there are, at the stations, numerous passages connecting the two tunnels, and consequently a well-regulated current of air traveling in a given direction cannot be secured. The train passing in one direction in one tube pushes the foul air at A, in front of it to the cross-over opening where it is sucked in behind the train B moving in the opposite direction in the other tube. Thus the air is simply churned round and round, and very little of the foul air is actually discharged or fresh air brought in. If fresh air is forced down from the surface through one shaft there is a tendency for it to ascend through an adjacent shaft. If, however, the well-known Saccardo injector system, which has been so successfully used in ventilating long steam railroad tunnels, is combined with shaft ventilation, very satisfactory results can be obtained.

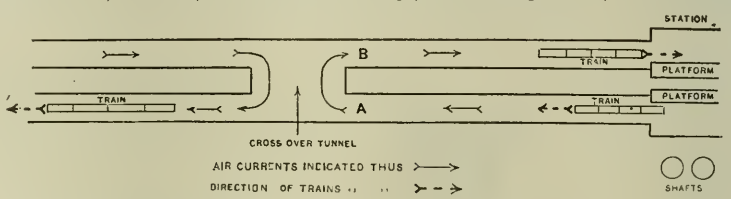
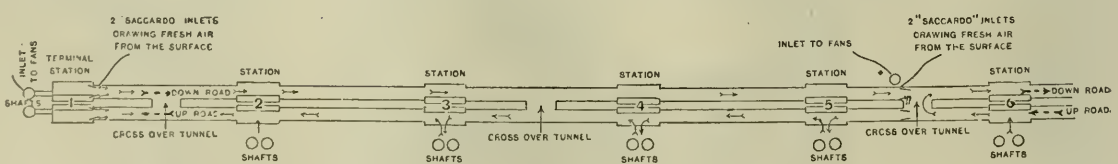



Diagram Showing Direction of Air Currents in Tube Railways.




Proposed Plan for Ventilating Tube Railways.

The accompanying diagram shows a proposed method of ventilating with such a combination of the two systems. The direction of the trains is shown by the dotted arrows and that of the air currents by full arrows; cross-over tunnels do not exist at most of the stations.

The direction of the air currents is to a great extent regulated by that of the trains, which fit the tube with but little clearance, and consequently act as pistons.

Starting from the terminal, Station 1, the first object is to keep the air at the platforms fresh, and this can be done by drawing air in from the outside by Saccardo fans, as shown, at the further end of platforms. Fresh air is drawn down the shafts at Station 2, by the suction of the trains, and this is returned along the parallel tunnel towards 2 and 3 by the combined effect of the trains and fans.

The air in shafts 3 and 4 will to a great extent be controlled by the piston action of the trains. The current will be constantly reversed, and this cannot be avoided unless the Saccardo system be more frequently introduced; this, however, is unnecessary, but at No. 5 it is again employed, and the same result for the next two or three stations will be repeated.

For every 100,000 cu. ft. of fresh air which is blown into the tunnel, or drawn in by the trains, an equivalent amount is ejected; the result being that, although this arrangement is far from ideal or perfect, it will maintain the air in a very fair condition.

As to the volume of air required, the following is the principle by which it is ascertained.

Assume holiday traffic, when the road is crowded to the maximum degree, trains running every 2½ minutes in each direction, that is 24 trains each way, or 48 in all, each train loaded to its full capacity, of say, 600 passengers, and traveling at a speed, including stops, of 18 miles per hour, three stations per mile, and each platform crowded with passengers.

For each mile of single tunnel, there will pass through in an hour 24 trains, each with 600 passengers, and requiring 30 cu. ft. of air per passenger per minute, but each train is on the one-mile length for a period of only $^{60}/_{18}$ minutes = 3⅓ minutes.

Therefore, for each tube, for each mile, the quantity of air required per minute is 69,000 cu. ft. When the trains and platforms are less crowded and the traffic assumes its normal volume the quantity of air required can be proportionately reduced. Arrangements should be made for the free passage of vitiated air from the carriages into the tunnel, otherwise the congested condition of the air on arriving at the terminus will be aggravated.

## ANOTHER DISASTROUS BUTTING COLLISION.

Before the newspapers have got through with their editorial discussions on the collision in Tennessee, Sept. 24, in which threescore passengers were killed, they are called upon to record a similar disaster in Missouri (Oct. 10), killing 28. Following closely the Colorado disaster, in which over 90 passengers were drowned, and lesser train wrecks at Pendleton, Mo., Tiskilwa, Ill., and Monroe, N. C., these horrors have aroused the press to unusual activity; but to what purpose? Two New York papers have interviewed such railroad presidents as they could induce to speak, and one has printed a lot of letters from life-insurance and accident-insurance experts; but not a word of instruction is to be found in any of these productions. Bridge disasters and butting collisions have never yet been successfully dealt with by the same remedy, and yet these and other classes of accidents are included in a single prescription by some of these journalistic doctors. The use of strong frames in all new cars hereafter built will afford no comfort to one who has to ride in an old car, and yet this is the only remedy suggested for preventing deaths in traveling egg-shells. The lessons of all these collisions and wrecks are as clear as daylight and have been repeated, frequently—at least every year—ever since Mr. Forney began to preach in the columns of this paper the gospel of safe railroading, more than 30 years ago; and *no one disputes this preaching.* Any one who finds the *Railroad Gazette* dull reading—we admit that on accidents it seems to us just a trifle monotonous—might turn to the last annual report of the Interstate Commerce Commission, a condensation of which was given in these columns Dec. 25, 1903, and January 1, 1904. There is no lack of knowledge; all that is needed is to apply it.

The *Railroad Gazette* has advocated the block system at all times as the one effectual preventive of collisions on main lines outside of yards (in which speeds can be regulated by fixed signals). The suggestion made by Mr. Forman recently in these columns, that telegraphic meeting orders be sent to meeting stations, as well as to the trains which are to meet each other, is excellent as far as it goes; but it provides against only one class of collisions, and only at stations where operators are on duty. The block system provides against all classes. When attention is concentrated on a butting collision of such magnitude as that at Hodges, Tenn., other dangers are liable to be forgotten; but when there is a single practicable remedy which provides against all possible causes, the only rational course is to apply that one.

On the question of forgetfulness in enginemen two things may be said. First, many persons seem to be confused by the fact that enginemen sometimes disregard block signals, as well as other signals, indicating that mental lapses cannot be wholly cured by the adoption of the block system. But the fact remains that the methodical procedure imposed by the block system affords the best known means of inculcating right mental habits in enginemen. This is confirmed by experience. Second, it is to be observed that the requirement, recently made somewhat general, that other men on the train shall read meeting orders, besides the conductor and enginemen, has not produced any marked improvement. So far as can be known without getting answers—honest answers—from all the enginemen of the country, there has been no improvement whatever. The principal trouble seems to be that the additional monitors are subordinates. A subordinate does not naturally assume responsibility. At Frankford, Pa., recently a brakeman called a conductor's attention to a forgotten meeting point, but too late to prevent the collision.

The danger of running weak cars in the same train with strong ones was strikingly exemplified at Hodges, but no more clearly than in numberless cases before. Sleeping cars must be run at the rear of trains because the day-cars, doing the way business and carrying the larger proportion of passengers, must be close to the baggage car and mail car, so that all can be stopped in convenient positions at small stations. Sleeping cars must be made heavy and strong in the lower part, in order to support the upper berths, to keep the center of gravity low and to insure smooth riding under varying loads. The only satisfactory rule for making up trains is to have all the cars of equal longitudinal strength. Putting light cars behind heavy ones would favor the light ones in a butting collision, but might harm them in a rear collision. In the majority of derailments probably the weak cars would fare better at the rear than in front. The reason why railroad managers continue to run strong and weak cars together in the same train, the weak at the mercy of the strong, is, no doubt, their feeling that the danger of such a smash as that at Hodges is remote. Possibly it is remote enough to warrant the practice, financially. When reasonable provision shall have been made against collisions, this danger will perhaps be made remote enough to make the passengers, as well as the stockholders, satisfied to have weak cars continued in service; but if the present state of the public mind continues, the legislatures may be expected to take action looking to a remedy.

## PER DIEM.

The great reform in settlements for interchange car service which was begun three years ago and which was put into operation a little later (July 1, 1902), is now a settled feature of American railroad practice, and may be regarded as irrevocable. The best man to review the history of the past two years in this field is Mr. Arthur Hale, chairman of the American Railway Association Committee that has been the guide of the railroads in making the change, and an article from him will be found in another column of this paper. Like some things that have been done in "world politics" in the last half dozen years, this grand movement, which can hardly be compared with anything smaller than National government affairs, is not without its dark features and unsettled problems; but the main results—that freight cars have been made more useful and that creditors and debtors can deal with each other rationally, and not be constantly in the dark—are accomplished. Even an expert, after all these months of experience, has to say, as does Mr. Hale, that comparisons between mileage and per diem are difficult to make; but the present general satisfaction is, fortunately, so well founded that its permanence does not depend on any comparison with the past.

Of course, Mr. Hale does not try to settle the thousand local or semi-local problems which burden the mind of the manager of an individual railroad, nor make any predictions for the future; but the records entertainingly a number of significant conclusions on the general subject. One of the most definite of these is that the short terminal roads have been proved able to stand a twenty-cent rate; to pay 20 cents a day for cars which formerly they got for 6 cents a day, more or less. There is no need to try to calculate how this has been brought about. Whether the road moves cars with less delay, or gets a larger share of the revenue on the freight, or stands a small loss, is immaterial from the outsider's point of view; the main thing is that enough roads have lived through the ordeal to insure the success of the whole broad scheme. All are agreed that, from an association standpoint, a per diem rate is right and a mileage rate is wrong; and that is enough to outweigh a great deal of local or temporary loss, or even injustice. Abstract right does have some weight now and then, even in business.

Of the grievances which do or may affect all alike, the most serious is the facility with which unprincipled managers can "break penalty" by moving a car on to another road to avoid paying 80 cents a day additional for unreasonably delaying it. Such second road is practically a confederate in a conspiracy, though unintentionally. While this may not be a serious question financially, it is an important one practically, for, like the suspicion of error or cheating under the mileage plan, it is always available as an argument to stir up discord. The only remedy in sight is to make a higher ordinary rate and abolish the penalty entirely. Whether this will ever be done remains to be seen. The penalty rule is a constant reminder that owners desire to have their cars at home; its abandonment, whatever the process by which that is accomplished, or whatever may be put in its place, will seem to indicate that that desire no longer exists; or at least will often be taken to so indicate when money can be made by adopting such view. Those car-service men who advocate pooling the ownership of freight cars, or the indiscriminate use of all cars on all roads, as the Pullman Company uses its sleeping cars, when necessary, would, presumably, be glad to see such a weakening of the home idea in car service. But whether the management of the freight cars of the country—or even a large section of the country—could be satisfactorily carried out by a clearing house is a point on which these advocates have not yet thrown much light. A million freight cars, used for a hundred kinds of traffic, would put

up to their manager a problem quite different from that involved in distributing two or three thousand sleeping cars, used for a single kind of traffic. Probably the whole question of penalty will have to wait until enough experience has been accumulated to give more courage to the men who advocate raising the 20-cent rate on general grounds, regardless of the penalty principle.

One difficulty, more troublesome than "breaking penalty," is hardly touched on by Mr. Hale; the attitude of the roads which have not joined in the per diem agreement and stick to the mileage plan. These roads are short and in some cases nothing more than switching roads; but they are sure that the adoption of per diem would increase their expenses, and so they persistently stick to their old methods. Unfortunately, the railroads most directly interested usually seem to think that it is for their interest to yield to these shipper-railroads, and uneconomical practice therefore continues. If the owner of the switching road be a big shipper he gets the better of the railroad in the same way that the "beef trust" is understood to vanquish the railroads in the matter of refrigerator cars. A high rate paid to the car owner by the railroad takes the place of a low freight rate on goods transported by the railroad. The short-railroad evil is not exactly the same as the private-car evil, but about the same remedy is needed. There is more need of applying a remedy, because the private-car evil sometimes is not an evil; sometimes it is good economy for a railroad to hire cars from a car company at a high price rather than build or buy cars for a service more or less temporary. But in both cases the per diem principle, if adopted, promotes good service, and therefore it ought to be applied. Moreover, a per diem rate comes much nearer to being just, in the abstract, than does a mileage rate.

As car-service rates, whether mileage or per diem, are largely arbitrary, it takes a powerful body to effect any change, and therefore association action is necessary. The larger roads two years ago used some coercion, or something very like it, in getting certain important railroads into the per diem agreement; and it looks as though they could do a public service now by exercising similar influence on some roads which are not important, measured by length, but which are important measured by their power to hinder the progress of a needed reform. For all practical purposes the argument is the same as when dealing with railroads proper; the per diem principle promotes economical use of cars and can be made to insure honest and accurate payments. Any injustice done to any road in the adjustment of the car service rate can and should be made up for by an adjustment in the rates for transportation.

In this connection it is to be observed that the enforcement of reasonable demurrage on freight cars detained to load or unload is a part of the same problem. The only thing necessary to insure the best practicable conduct of the demurrage matter would seem to be united action on the part of the railroads. Every few weeks the newspapers report a new decision from some court, upholding demurrage regulations; but no new law is thereby made; the successive decisions only repeat what has already been declared by other courts. It is good to have this reinforcement of just laws, but what is needed is not more decisions but more decision—on the part of the railroads. It would perhaps be pleasant if the courts could be called upon to do all of our unpleasant jobs for us; and still pleasanter if we could have statute laws compelling obstinate railroads to adopt enlightened methods. When two short railroads almost side by side, and doing business under almost identical conditions, take opposite positions, one adopting rational methods and the other keeping its attention fixed on a single page of its ledger, the temptation is strong to call for legislative regulation. But State legislatures oftener do harm than good in railroad management, and this matter of car regulation is one in which the railroads are peculiarly well situated to cure their own ills, if only they will act with vigor. It is cause for congratulation that we have available so effective a law-making body as the American Railway Association—albeit the Association makes no laws at all. A body which, like this, has only recommendatory power, even over its own constituents, ought, in a matter of this kind, to be just as useful and effective as the most powerful government in the world; for a recommendation depends for its force on its reasonableness; and the reasonableness of per diem for interchange, and of demurrage for detention, is universally acknowledged.

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An important western road recently undertook to build a large passenger car yard in connection with some extensive changes in one of its terminal stations. Before the plans were made a large number of existing yards in different parts of the country were inspected and studied in the hope of adopting their good features. The results of the investigations were disappointing, and in the end much original work had to be done in planning facilities in order to provide for present needs and prepare for further improvements in the future. Two prominent features were especially observed in the yards inspected. These were the facilities for making running repairs to cars and the arrangement of air, water and steam piping. In most of the yards the steam piping was carelessly laid and poorly protected. Apparently little thought had been given to economizing steam in heating the standing coaches; though it is quite likely that under similar circumstances steam pipes for supplying an engine situated at some distance from the boiler house would have been carefully protected to prevent waste. At first thought, the expense of a concrete-lined pipe-trench running through the coach yard might seem unwarranted, but it would probably pay for itself in one or two seasons out of the saving in coal alone, not to mention the other advantages of ease of repairs, good drainage, and general convenience. The amount of repairs made to cars standing in the coach yard depends largely, of course, on the remoteness of the car shops from the yard, though even where shops are close at hand there is always a certain amount of repair work that should properly be done in the yard, just as there is with locomotives standing in roundhouses, and a few simple facilities in the coach yard would relieve the shop of much work. The most important of these facilities is a drop pit for removing wheels from trucks. A convenient and inexpensive adjunct to the coach yard, especially in the northern States, is a "thawing-out" house. To thaw out the steam and water pipes in frozen cars by turning steam or hot water into them is tedious and wasteful; but if the whole car is run into an enclosed shed which is kept at a high temperature the pipes can be cleared with little expenditure of time or money. At all important points a 60-ft. turntable is a valuable addition to the coach yard. At such points there are always a number of observation cars, private and dining cars, etc., which must be turned, and, unless there is a convenient Y, it is necessary to use the roundhouse turn-table, which is usually kept busy by the engines; and delays and inconvenience are caused to both departments.

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If the stock market is a reliable barometer, as it often is if we do not take our readings too often, the business outlook has now been encouraging for some weeks; and confirmation of this is found in the business world in a number of different directions. The improvement of the past few months has not been so great as the similar change in 1902, but it appears to be substantial. Railroad earnings have increased as a whole, so that for the month of August we find fair gains over August of last year. The demand for cars and engines has also improved, and in the last week orders have been given for about 10,000 cars of various kinds. This does not include a large number of cars which are being built by the Pennsylvania, the Louisville & Nashville, the Nashville, Chattanooga & St. Louis, and the Central of New Jersey at their own shops. The severe retrenchment ordered on some railroads has also been somewhat modified in consequence of the large gains in receipts and the better prospects. Work has been begun or is about to be begun on several extensive improvements, including the Pennsylvania tunnel and terminal at New York, the Baltimore & Ohio improvements at Cleveland, the Pan Handle grade crossing abolition in Cincinnati, and the Wilmington improvements of the Philadelphia, Baltimore & Washington, which were stopped last year, half completed. Orders for rails, although mostly small, owing to the uncertainty as to the prices for 1905, show a good aggregate, and include an order from the Baltimore & Ohio for 14,000 tons, and several orders of quantities ranging between 2,000 and 3,000 tons from Chicago electric roads. Government contracts have helped the business improvement. The navy department, as announced in these columns a few weeks ago, is about to let contracts for one battleship and two armored cruisers and is also ordering important work on a number of large arsenals. Orders were given last week for five large new lake vessels, making a total of nine ordered, for which upwards of 30,000 tons of steel plates will be necessary. The United States Steel Corporation has also announced its intention of building four or five large vessels. All these instances of improved trade, coupled with the promising corn and cotton crops, with only a moderate loss in wheat, would seem to indicate that fair progress is being made towards satisfactory conditions.

### Education for the "Business" Side of Railroading.

The Philadelphia scheme for educating railroad men in a school of commerce—in vulgar parlance a "business college"—which was given in this paper Sept. 30, page 386, is the most ambitious project of the kind that has yet appeared. But the Wharton school has a reputation for common sense and conservatism, and useful work of this kind can be done there if in any school. We should feel a trifle dubious about the success of an attempt to effectively enlighten the youthful mind in the "practice and principles of rate making" unless a year were allowed to intervene between the two halves of the subject; but in the bright lexicon of the business college there is no such word as fail, so there is no room here for the pessimist. It is a sign of sagacity, certainly, to put practice first and principles second. The man who prepared the course evidently knows a thing or two about rate making. As in the case of schools of journalism, the visits to business institutions—taking a look at real work—must in any event be of the utmost importance. Taking a hand at it would be better. It is hard to see how the railroad course can be of great value unless this part of the teaching is done in the most thorough and systematic manner. Random half-day excursions will never fill the bill.

What may be called the literary side of this business training—the language, geography, law and science—will, of course, give full value to every young man who devotes himself to it. The education of men for business has long been a mooted question, but there can be no two sides to it if a young man has the strength and energy necessary to succeed. There has been a disposition to consider the educated man and the business man of so distinctly different type that the attainments of the one do not make for the fitness of the other. But it is idle to maintain at this late day that education does not have its place in every calling of life. In many cases the best combination on which to compromise with the extreme "practical" advocate is for the boy to be first placed in business for a period of about two years so that he can learn something of practical work and accustom himself to its drudgery. The wider outlook of the school will then be romantic to him in its reaches and rich in its illuminating explanation of the things with which he has already had familiar contact. If such a theoretically perfect combination of the apprenticeship and the instruction is impossible the next best thing is the school course in which, toward the end, the outlook is widened by contact with real life as is proposed at the Wharton school.

Circumstances as well as talent largely control the drift of men's lives towards that place where they come to do their life's work. These circumstances are fortuitous more often than prearranged or foreseen, so that it is impossible to determine in advance those things for which a boy ought to fit himself. This fact largely modifies the advantage of a highly specialized training. But the other fact that anything well learned contributes to a facility in other things most indirectly related, largely compensates for the direct inapplicability of much that is learned. In general it is fairly safe to say that the specific mechanical facility for any work must be acquired in the performance of the work itself and cannot be acquired in any school satisfactorily. Hence the reason why the practical man is disposed to look with some distrust upon too much specialization in the school.

There is another side to this question which should not be ignored. If we grant that time spent in school work is well applied towards ultimate efficiency then it must be made to account for credit to the man who has spent his time in such preparation, when he comes to compete with the man who has not spent any time in such a way. The things that he has learned are largely beyond the range of the work to which he will be immediately assigned, and this will continue to be the case for his first year or two. If his advance is held severely along the lines of those who do not have this larger ultimate fitness, he will be at a serious disadvantage.

This has discouraged many college graduates who have aspired to a railroad life, and they have gone elsewhere. We have no ready-made solution of this difficulty, but it needs to be solved, for there is no question that the railroads need educated men. It is a serious charge against railroad managers when a man of practical affairs and such eminence in his calling as President W. H. Baldwin, Jr., accounts for the small representation of college men in railroad employ on the ground that the railroad manager has not as yet arranged a plan for injecting the college man into the organization.

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The interesting tables of various items of maintenance expenses given for ten successive years in the annual reports of the Illinois Central and of the Yazoo & Mississippi Valley Railroad show in a striking way how certain renewals fluctuate. Thus the Illinois Central used 34,614 tons of rails for renewals in 1899-1900, when it had about 6,000 miles of track, or 5.77 tons per mile of track; in the year ending with June last, with an average of 6,480 miles of track, it put in 24,037 tons of rails, or 3.67 tons per mile of track. On a railroad like this, with abundant earnings and the best of credit, there can be no question of postponing renewals too long. Last year rail renewals were less than 1 per cent. of the total working expenses. The figures for tie renewals show even greater fluctuations: 1,987,356 ties were used in 1901 (about 320 per mile of track); 1,086,693 (172 per mile of track) in 1903, and 1,563,898 (241 per mile of track) last year. Tie renewals have cost more than rail renewals in every year of the ten except 1903, and for the entire ten years 50 per cent. more ($4,990,006 for ties against $3,288,406 for rails). The Yazoo & Mississippi Valley report shows the cost of rail renewals to have varied from *a credit* of $831 in 1901 to an expenditure of $140,919 last year, when it was more than the aggregate for the eight years from 1895 to 1902. The credit we may suppose to be due to sales of old rails much in excess of the 105 tons of new ones put in the track in 1901. Tie renewals have varied from 292,242 last year to 493,360 in 1898, that is, from 249 to 610 per mile of road (not track). When the road was built there must have been timber enough on the right of way to tie the track several times over. The cost per tie of tie renewals was only 24 cents in 1895, 30 cents in 1900, and a trifle less than 40 cents last year—figures which most railroads will envy.

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### Louisville & Nashville.

Louisville & Nashville for the year closing June 30 reported a net income of $6,688,000, which amounts to 11.15 per cent. upon the stock, but the directors charged expenses with $1,746,000 of betterments. If we restore to income the amount thus deducted we have a total net income of $8,434,000, or 14.06 per cent. on the stock. Last year the corresponding earnings were 13.69 per cent., therefore the results of the year are slightly better than a year ago.

There has been added to the operated mileage during the year 199 miles, of which a length of 86 miles is owned, and 113 miles operated, but not owned. The principal extension is the line known as the Knoxville, La Follette & Jellico Railroad. This is designed to give the Louisville & Nashville a short line from Cincinnati to Atlanta. Its completion, soon expected, will give the Louisville & Nashville advantages which it has long needed in the territory east of the iron district of northern Alabama.

The operated mileage consists of a large number of separate financial entities bound together by ownership of stock or control of stock. In the past year the company has consolidated some of these properties with the parent company. The Alabama Mineral Railroad and the Birmingham Mineral Railroad have been merged in this way. Both these roads have heretofore been operated as part of the system, but were controlled through ownership of the entire issues of capital stock and first mortgage bonds. The company has also acquired the entire capital stock of the Newport & Cincinnati Bridge Co., and has taken for itself the full title to the property, and has bought the Southern division of the Cumberland & Ohio, which was sold under foreclosure. All these properties are or will be deeded to the Central Trust Co. as pledges under the unified mortgage. The financing of the year is indicated by the table below.

| | |
|---|---|
| *Debit*: | |
| Increased liabilities— | |
| Funded debt | $9,055,179 |
| Contingent list | 3,254,000 |
| Profit and loss | 3,391,714 |
| Decreased assets— | |
| Investments | 6,528,319 |
| Materials and supplies | 1,818,556 |
| Total | $24,047,768 |
| *Credit*: | |
| Increased assets— | |
| Cost of road and real estate | $11,464,385 |
| Advanced to subordinate companies | 6,362,067 |
| Sundry accounts | 222,109 |
| Current assets | 4,010,973 |
| Contingent assets | 1,046,204 |
| Decreased liabilities— | |
| Reserve accounts | 15,288 |
| Sundry accounts | 926,742 |
| Total | $24,047,768 |

The increase by sale of collateral trust bonds and unified bonds yielded over $9,000,000, and the assumption of the guarantee of interest on properties taken over added $3,254,000 more to the increase of liabilities. The change in the form of ownership from investments to property merged into the general property of the Louisville & Nashville accounts for the decreased investments of $6,528,000, and for an equivalent amount in the cost of road among the increases in assets. The increased advances to sub-companies are incidental to the construction now in progress. The income account is not unfavorable:

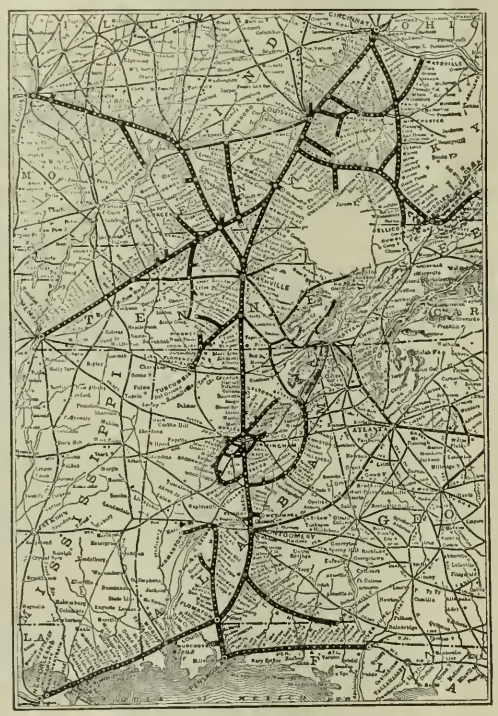
| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Earnings | $36,493,792 | $35,449,377 | $1,494,414 |
| Expenses | 25,141,548 | 23,970,812 | 1,170,735 |
| Net earnings | $11,802,244 | $11,478,565 | $323,679 |
| Other income | 1,635,154 | 1,122,493 | 512,661 |
| All income | $13,437,398 | $12,601,058 | $836,340 |
| Charges | 6,749,227 | 6,390,010 | 359,216 |
| Net income | $6,688,171 | $6,211,047 | $477,123 |

The net result is an increase of about half a million dollars, due partly to the increase in earnings on L. & N. proper and part to the profitableness of the other properties owned. Half of the increase in direct earnings was from freight and half of the increase in returns from freight was due to the higher average rate, the other half being due to new business. The average receipt per ton mile increased from .779c. to .790c., or 1.41 per cent. Expenses increased $1,171,-

000. This increase was about equally divided between maintenance and transportation expense.

The report this year contains a detailed table of expenses which is a decided improvement over the crude exhibits formerly given; but no comparisons are made with last year's operations. It is noticeable though at the outset that conducting transportation expense is not a large proportion of earnings, being only about 35 per cent. The increase for the year being only slightly over half a million, puts this among the few roads in which the increase of the transportation expense of the year is not all out of proportion to the increase in earnings.

The property evidently was well maintained; the betterment expenditures charged to earnings, amounted to $1,746,000 compared with $2,000,000 last year. Not a serious decrease. Over one-third of the total expenditure for improvements was for equipment and over $300,000 of it for sidings. while the remainder was principally spent for buildings, heavier rails and stronger bridges. The notable thing in operations this year is the shifting of the balance for car service from a debit balance of over $100,000 to a credit balance of $12,000. The aggregate saving is not large, but the significance of these figures is notable, reflecting as they do the increase in equipment and better disposition of cars, due no doubt largely to the influence of the reform in method of payment.



Louisville & Nashville.

The balance of traffic was well maintained, the local mileage being 68 per cent. of the whole, though this was slightly less than last year. The average train load has been pushed up from 180 to 185 tons, or nearly 3 per cent. By the purchase of the new equipment the first of the year, the rolling stock is apparently in very good condition. Of the locomotive equipment, 10 per cent. was bought within a year, nearly 7 per cent. of the passenger equipment and 12 per cent. of the freight equipment. Freight traffic cannot be examined as no tonnage tables are given. On the whole the report tells of a year of successful operation with no large expansion in the traffic or the operations. The new line which is in course of construction is not yet a considerable factor in the business of the road. Louisville & Nashville has a safe reserve in the standard of maintenance and in the physical condition of the property and equipment. Conservatism is plainly impressed upon every feature of the report.

### Chicago & Alton.

The fourth annual report of the Alton shows the same characteristic development of traffic which has been evident in the operations of the property since it was acquired by the "Harriman interest" in 1900. This growth in traffic is best illustrated by the following table comparing the gross receipts and the gross receipts per mile of road for the past six years.

| | Receipts, | |
|---|---|---|
| | Gross. | Per mile of road. |
| 1899 | $6,546,590 | $7,766 |
| 1900 | 7,796,456 | 9,119 |
| 1901 | 9,036,656 | 9,826 |
| 1902 | 9,225,739 | 10,032 |
| 1903 | 10,071,092 | 11,002 |
| 1904 | 11,425,853 | 12,484 |

The table shows an increase of about 75 per cent. in gross receipts and of 65 per cent. in gross receipts per mile of road since the reorganization in 1900. The company has built but little new road. The ton mileage increased .4 per cent. and the freight train mileage 6 per cent.; but the average receipt per ton mile increased 13 per cent., making the earnings per freight train-mile a little over 6 per cent. better. Passenger earnings per passenger train-mile increased over 15 per cent.

The report is not as complete as could be desired. The statement of improvement work does not show what work is charged to capital account or what to income account. Expenditures for betterments and equipment during the year amounted to $697,893 as compared with $1,879,410 in 1903. Of this, $595,904 was for improvements on roadbed and structures, as against $1,636,465 expended for the same purpose last year.

Gross earnings from all sources amounted to $11,425,853, as against $10,071,092 last year. Freight earnings contributed $7,445,877, an increase of $835,240. It is in live stock, grain, flour and mill products that the chief traffic gains of the year are found, the increase in flour and mill products amounting to 85 per cent. over last year and the gain in live stock to nearly $200,000, or 40 per cent. more. Receipts from passenger traffic amounted to $3,351,943, an increase of $443,360, or 15 per cent., and passenger receipts are now equal to nearly 50 per cent. of the freight. Ninety per cent. of the passenger traffic is classed as local.

Operating expenses for the year were $7,524,600, or $899,404 more than last year, leaving a gain in net earnings for the year of $454,357. Maintenance of way charges increased $232,645 and conducting transportation increased $576,664, heavy renewals of rails having been made. During the past five years ties and rails have been renewed on over 60 per cent. of the track, and renewals of ballast during the same period average about 35 per cent. Maintenance of equipment charges remained about the same, as in 1903, increasing only $39,930. During the year 17 locomotives and 50 passenger coaches were added to the equipment. In the past five years, the total tractive power of the locomotives in service has been increased from 2,874,520 lbs. to 5,460,445 lbs., or 89.9 per cent. At the same time, the average capacity per freight car has increased from 21.52 tons to 31.72 tons.

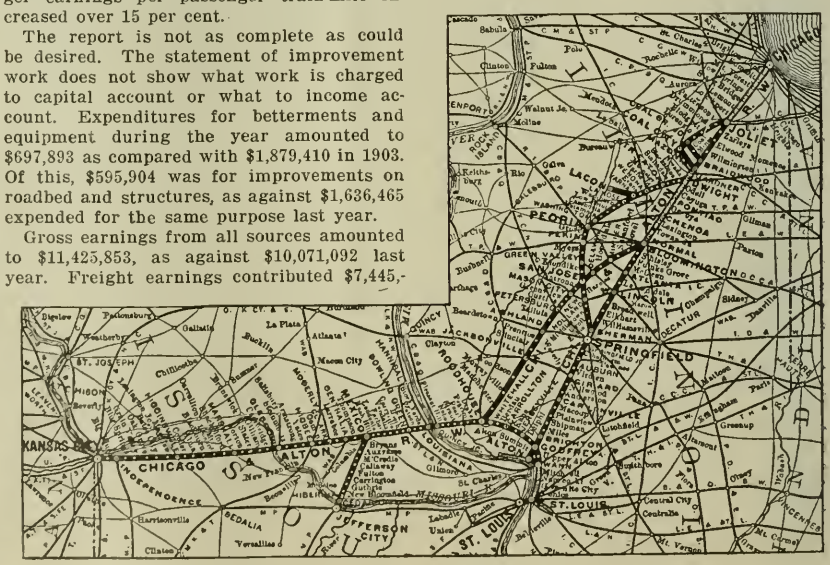
The more important statistics of operation follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 915.2 | 915.4 |
| Gross earnings | $11,425,853 | $10,071,092 |
| Freight earnings | 7,445,877 | 6,610,637 |
| Passenger earnings | 3,351,943 | 2,908,583 |
| Mail | 259,899 | 241,112 |
| Express | 253,921 | 218,039 |
| Operating expenses | 7,524,600 | 6,625,196 |
| Maint.-of-way | 1,446,010 | 1,213,365 |
| Maint. of equipment | 1,230,762 | 1,190,832 |
| Conducting transportat'n | 4,559,731 | 3,983,068 |
| General expenses | 288,094 | 237,931 |
| Net earnings | 3,901,253 | 3,445,897 |
| Net income | 3,561,253 | 3,100,897 |
| Surplus, June 30 | 693,346 | 569,438 |

## NEW PUBLICATIONS.

*Mechanical Railway Signaling.* By H. Raynar Wilson. London: Published by *The Railway Engineer*, 3 Ludgate Circus Buildings. Price 18 shillings, net.

The first edition of this work was issued four years ago and was noticed in the *Railroad Gazette* of Oct. 5, 1900; and now the publisher has issued a second edition. It is an elaborate work of 200 pages, describing in much detail the principal kinds of mechanical (manual) interlocking machines in use in England. A considerable number of new illustrations have been added and the index has been amplified. Mr. Wilson, who some years since dissolved his connection with the Lancashire & Yorkshire Railway, has written a book on "Power Railway Signaling," which, it is announced, will be pub-



Chicago & Alton.

lished at an early day; and to this new work has been transferred some of the matter from the older book on electric train staffs and tablets for single track working. This forthcoming book describes controlled manual and automatic block signaling, and pneumatic interlocking.

*State Demurrage Rules;* by John B. Daish. Published by *Grain Dealers Journal*, Chicago. Price $1.

This is a reprint, evidently made by a careful lawyer, of the laws relating to demurrage on freight cars in the States of Connecticut, Florida, Georgia, Louisiana, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, South Carolina, Texas and Virginia. Following the laws themselves is a digest showing in tabular form the main features of the laws in each State. For example, the free time in Connecticut is four days; in one State 72 hours; in eight States 48 hours; in one State the time allowed on grain is only 24 hours; one State does not specify the free time.

*Loci in Mechanical Drawing.* Part III. Piston Acceleration, by Alex. MacLay. The Technical Publishing Company, Limited, Manchester, England. (D. Van Nostrand Co., New York). 120 pages, 5 in. x 8 in. Cloth. Price 2s. 6d.

The aim of this book is to introduce to the student a class of loci which are neither geometrical nor mechanical. Curves of velocity and acceleration are discussed and worked out in connection with examples of piston motion in engine mechanisms of the slider crank order. The book is especially valuable inasmuch as it embodies a number of notes which heretofore have not been available to students of this subject.

## TRADE CATALOGUES.

*The Buckeye Jack Manufacturing Co.*, Louisville, Ohio, has issued a new catalogue, its third. The first pages show the four different styles of jacks that the company has been making since its establishment in 1902. The construction is fully described, and views of the assembled jack and of the detail parts shown; also the chief characteristics of each style are enumerated. Three new jacks have been added to the previous line, and four more styles are to be added in a very short time. The three new jacks are described and illustrated in the same manner as those preceding. For the four styles soon to be added, the capacities and the purposes to which they are adapted are given. On the last two pages are printed a number of testimonials relative to "Buckeye" jacks.

*The Under-Feed Stoker Company of America.*—The September number of "The Publicity Magazine," published by this company in the interests of the Jones stoker, contains a number of half-tone illustrations of boiler rooms in which these stokers have been installed as well as a number of interesting facts in regard to stoker equipments. A table of standard steam boiler measurements is given, and the results of a boiler trial made at the University of Chicago are also shown. The boiler in this trial was equipped with a Jones stoker. Aside from its mechanical features the magazine contains a considerable amount of light reading.

*The Crocker-Wheeler Company*, Ampere, N. J., sends a pamphlet bearing the title "Railway Generators at the Louisiana Purchase Exposition." It contains illustrations and descriptions of the engines and generators used in the Intramural power plant. This plant consists of six steam-driven units, each driven by a different make of engine, and one generator driven by a water-wheel. The capacities of the generators range from 100 k.w. to 900 k.w. They are of the Crocker-Wheeler standard railway type and are compound wound for 550 volts.

*The Rand Drill Company*, New York, issues its circular No. 14. It contains illustrations of the latest pneumatic hand tools such as are used for chipping, calking, flue beading, riveting, drilling, etc. Short descriptions and tables showing the capacities of the tools are given, as well as a number of half-tone illustrations which show the tools in actual use. These photographs cannot help but impress one with the wide range of usefulness of the pneumatic hand tool.

*Bulletin No. 171* of the American Blower Company, Detroit, Mich., describes its newest engine, Type A, which is a vertical, enclosed self-oiling design. Considerable space is given to the method of lubrication, which is illustrated by a phantom perspective, and the details of which are fully illustrated and carefully described. Other details are also described, and illustrations of the most important parts shown.

*The Niles-Bement-Pond Company*, New York, is distributing its September number of the Progress Reporter. A full detailed description and illustrations of the improved Pond car wheel lathe are given, as well as a short article which gives in detail the method of operation recommended for attaining the highest rate of production. The company claims that with this lathe an average of six pairs of car wheels can be turned out in 10 hours.

*Joseph T. Ryerson & Son*, Chicago, Ill., issue a booklet bearing the title The Path the Calf Made. The tale is in verse and tells about the historic calf, wabbly of legs, which left a crooked trail, which became a path, a lane, and finally, after many years, a city street. The moral is applied to flue welding; the only straight road is by way of the Ferguson flue-welding machine, which is described and illustrated.

*The Richmond Electric Company*, Richmond, Virginia, maker of electrical machinery, is distributing its bulletin No. 3. It contains a full detailed description and illustrations of the R. E. type direct-current generators. These generators are made in 18 sizes varying from 0.75 k.w. to 37½ k.w. A table shown in connection with a diagram gives the dimensions and weights of the machines.

*Dean Bros. Steam Pump Works*, Indianapolis, Ind., is distributing an interesting booklet descriptive of its condensing machinery. It opens with a short, but comprehensive article, which explains the duties of the air pump and condenser. This is followed by detailed descriptions and line and half-tone illustrations of different types of air-pumps, jet and surface condensers, cooling towers, etc.

*Chapman Valve Manufacturing Company*, Indian Orchard, Mass., issues a pamphlet containing a partial list of customers who use its valves for high and low-pressure and superheated steam service. This company makes valves from ¼ in. to 72 in. in diameter, operated by hand, air, electric, or hydraulic power. Line and half-tone illustrations of various types of valves are shown.

*Something Pneumatic*, or the September number of the monthly magazine of the Chicago Pneumatic Tool Company, contains the usual number of interesting articles on pneumatic devices and their applications; also a reprint of a paper on "River Wells and Horizontal Delivery of Water," read by C. H. Friederick before the Ohio Society of Mechanical, Electrical and Steam Engineers.

*The Crane Company*, Chicago, Ill., sends a leaflet descriptive of its renewable seat and disk, globe and angle valves, and of its renewable seats and wedge, straight-way valve, for high pressure service. Illustrations, sizes and prices of the valves are given. The company is also distributing an illustrated pamphlet descriptive of its exhibit at the St. Louis Exposition.

*The Obermayer Bulletin* for October, published by The S. Obermayer Company, is designed primarily to show the various goods made by that company and their adaptability to foundry practice. There is also an article on "Brass Melting," and other articles on new foundry materials that have previously not been advertised.

*The Little Blue Flag*, a magazine published by The Lowe Brothers Company, Dayton, Ohio, contains in the September number a statement regarding the outlook for fall business, which it pronounces most encouraging. There are also other articles of interest to paint sellers and paint users, and some good advice for both.

*The Garvin Machine Company*, New York, issues a pamphlet in which brief descriptions and illustrations of about 135 modern special machine tools are given. This is being distributed among the various manufacturing companies with a view of interesting them in an economic method of making duplicate machine parts.

# CONTRIBUTIONS

### Multiple Unit Control for the Subway Cars.

The new cars for the Interborough Rapid Transit Company to be used in the New York Subway are equipped with the Sprague-General Electric system of multiple unit control. It was erroneously stated in the article on "Power Equipment for the New York Subway" in the *Railroad Gazette*, September 16, that these cars were equipped with the Westinghouse electro-pneumatic system of control.

### Unions vs. Individual Progress.

To the Editor of the Railroad Gazette:

The editorial on "Unions vs. Individual Progress" in your issue of September 2 and the comment of G. S. M. in your issue of September 9 suggest some other reasons for the apparent lack of interest taken in the welfare of the railroad companies by the employees in the train service.

Should an engineer running a "pooled"

engine be expected to make repairs? Charles Paine in his "Elements of Railroading" pointed out the economy of "pooling" engines and the resulting competition among the enginemen, the fair apportionment of labor and the readiness of any engine or any crew for an emergency. The old idea that an engineman was wedded to one particular engine for life has been superseded by the modern ideas of getting all possible work out of an engine all the time and thus to save the investment of large amounts of capital. Few if any railroad officers will support the old argument that the sentimental regard of the engineer for his own pet engine will keep it in more perfect condition than could be attained in any other way. This is not an age of sentiment.

Many roads are practicing strict economies in doling out oil, coal, waste and other engine supplies, and it improves an engineman's record to use just as little of these as possible, regardless of the damage to bearings or failure to make steam and the consequent delays on the road. As for the train crews the one sin which they can commit is to run behind schedule time. Cars are coupled with more certainty when they are run together hard and time in switching is saved at the expense of damage to rolling stock. The train crews are urged on by the operating department and the motive power department repairs the damage. If a record was kept of O. S. & D. freight charged against the train crews and a car damage record was kept against the engineer and conductors, together with a record of delays to trains due to hot bearings, possibly it would point out ways of curing some of the most pernicious practices of present day railroading.

OBSERVER.

## Comments on the Per Diem Rules.

BY ARTHUR HALE.

1.—"The rate for the use of freight cars shall be twenty cents per car per day, which shall be paid for every calendar day, and shall be known as the per diem rate."

This rate was the result of a series of compromises and was attacked before its adoption by the advocates both of higher and lower rates. The high rate men claimed, with justice, that 20 cents a day does not represent the worth of a modern freight car, or even its cost to the owners. The low rate men claimed it would increase their payments for car hire so materially as to amount to a confiscation of their net earnings. These two arguments practically neutralized each other. Under the mileage system car owners were getting about 12 cents a day for their cars, so that the new rate gave them an increase of over 60 per cent. More than this would have been an undue hardship to the railroads which had been encouraged during the existence of the mileage system to increase their business by the use of foreign cars. It has been proved that these railroads can stand the 20 cent rate. Whether they could have stood a higher rate at the beginning is a question. Some of the railroads which were anxious for a high rate have found that 20 cents was high enough to begin with, but there is still a persistent demand from certain influential railroads for a 30 cent rate.

It is very difficult to make a lucid comparison of performance under the per diem and the mileage system, but it is perfectly clear that 20 cents represents 33 miles at six mills, and there are a great many railroads that do not make 33 miles a day with foreign cars. Such roads are paying more than they used to pay for such foreign cars. Most of them make this up from increased receipts for their own cars on foreign roads, but some do not, and such roads are not anxious for an increase. There are other roads which have made a general improvement in their methods of distributing and handling cars and thus have increased their mileage per day enough to warrant their joining the ranks of the high-rate railroads.

2.—"Days shall be reckoned by subtracting the date of receipt from the date of delivery. The day of receipt shall be disregarded and payment made for the day of delivery."

This rule, like Rule 1, follows very closely the language of what we may call the original per diem rules, which were formulated by the trunk lines during the per diem experiment of 1888. These original rules were adopted by the Committee on Car Service of the American Railway Association and were reported by the committee to the association with slightly varying language a number of times between 1888 and 1901.

At the autumn meeting of the association in the latter year, these rules were taken from the table of the association and referred back to the committee with instructions to report an elaborated set of per diem rules. This action was taken without opposition and put the committee, at the next meeting, at a great advantage over the opponents of per diem.

A few words are added to the original rule, making it perfectly clear that a road which holds a car at 12.01 a.m. of any day, is responsible for the per diem for that day. As a result, there is no confusion in closing the per diem accounts of one month and opening those of another month.

When the system was first adopted there was a good deal of loss to car owners at interchange points where there was no man in charge at night. At such points the delivering road invariably claimed delivery as of the evening before, and the receiving road claimed receipt as of the morning after, and between the two roads there was a difference of one day in their per diem accounts. By systematic checking on the part of car owners, such differences are gradually becoming eliminated. This may be a good place to say that many railroads are employing more clerks to check up the per diem on their own cars on foreign lines than they do to check up the per diem made by foreign cars on their own lines, finding that the cost of such checking is amply repaid by corrections in the car accounts of their neighbors. This checking of another road's accounts is something that has only been possible since the adoption of the per diem system. If the per diem accounts, which can be checked, are so inaccurate, what must have been the inaccuracy of the accounts under the mileage system, which could not be checked?

3.—"A road shall have the right to demand the return of its car after it has been twenty days consecutively on any road. If the car is held by that road more than ten days after date of such notice on the prescribed form (L), making thirty days in all, thereafter a penalty rate of 80 cents per day in addition to the per diem rate, shall be paid by such road for the further use of that car."

This rule was new when originally adopted by the A. R. A. in the spring of 1902, and like all new rules it has caused some trouble. There have been a good many attempts to repeal it, chiefly in connection with the proposed increase in rate, as noted above. In general the short roads prefer a low rate and penalty and the long roads prefer a high rate and no penalty. It was at first urged that the penalty rate should apply automatically after a car had been on a foreign road more than 30 days, but there seems to be a general acquiescence in the present plan, especially since the adoption by the American Railway Association of a prescribed form for penalty notices and a method of transmitting them.

At present the chief difficulty in connection with the penalty rule is what appears to be its evasion in certain quarters. These evasions are thought to occur, first where two or more roads are under one General Manager, and it is in the power of their general officers to move foreign cars back and forth between these roads forming the same system, breaking penalty with such interchange. Second, when cars are interchanged between a per diem and a non-per diem road. In such cases the per diem road is usually responsible for the per diem rate, while the cars are on the non-per diem road, but it is not responsible for a continuous penalty.

These cases would not appear so aggravating if it were not for the fact that many industrial roads, which in the eye of the car owner would appear to have no standing as railroads at all, are considered by their connections as genuine railroads, even though they do not pay per diem. The American Railway Association has not taken final action on any of these questions, the feeling being that it would be better to allow the situation to develop rather than to take a step in the dark. The indications are, however, that a serious effort will be made at the next meeting to draw a line which will exclude from the per diem rules agreement many of the so-called "industrial roads," putting them in the category of "sidings." When this question is settled, there should be a general acquiescence in a rule whereby interchanges between a per diem road and a non-per diem road will not break penalty.

The question of divided systems is complicated by the fact that many of these systems were divided for accounting purposes long before the per diem system was adopted. It hardly seems fair to give any one man such power over foreign cars that he can move them indefinitely between different portions of one system, so as to be able to forever avoid the payment of penalty.

4.—"All railroads, including ferry lines, shall be responsible to the car owner for amounts accruing for the use of a car at the established rates, whether such a car is in road service or in switching service, until the car has been delivered to the owner or to another road."

This is one of the old rules with slightly changed language, a very important rule at first and now considered as an absolute matter of course. Under the mileage system no mileage was paid on cars in switching service, either on belt or trunk lines, and no mileage was paid on cars ferried long distances; and if the road holding the car was so arbitrary as to make no report as to whether or not the car was in switching service, this arrangement subjected the mileage accounts of many railroads to a suspicion which it is to be hoped was unjust.

As noted under Rule No. 2, it has proved practicable to check per diem, and all such suspicions are disappearing rapidly.

5.—"An arbitrary amount for each car in switching service may be reclaimed by the switching line from the road for which the service was performed. This amount shall be based on the average number of days actually required, and be determined by the roads directly interested for each local territory."

This was another new rule designed to make it practicable for the belt railroads to enter the per diem agreement. While the rules were in process of formation, the traffic departments of a number of railroads were consulted as to the practicability of so

increasing the switching rates as to make it possible for the switching roads to enter the per diem agreement without further provision for their relief. That something had to be done was evident, for in a number of cases the net earnings per car per day of the switching roads was less than the per diem rate proposed.

The traffic officials so consulted decided that as, in many States, the maximum switching rate was prescribed by law, and as at other points the switching tariffs were the gradual result of many years' experience and involved many interests, it would be impracticable to make any general change. A very difficult problem was therefore presented to the committee, and as a solution they presented the association the present Rule 5, which has so far stood without change. It is a very elastic rule and is based centrally on the idea that adjustments of switching rates in so vast a territory as North America must be settled by local bodies. The only restriction, therefore, that the association prescribed, was that the rate of reclaim should be arbitrary, this being the only evident method by which the per diem incentive for prompt movement of cars could be maintained.

Upon the passage of these rules, the railroads of the country promptly responded and meetings of transportation men were held in June, 1902, at which rules were formulated covering these switching reclaims at practically all points in the country. The first set of rules was formulated at St. Louis, which prescribed a reclaim amounting to the per diem paid on a certain number of days, which was supposed to represent the average for the round trip of a car in terminal switching service, while a smaller amount was prescribed for cars switched between one railroad and another without loading and unloading.

There has been singularly little change in the agreements so made. At Chicago the rate has been shifted up and down, and at certain other points experiments have been made and are making with a basis of the actual time consumed by each car in switching, with a maximum allowance; but in general, the original rules have stood very well.

The only point on which there has been any general change is on what has been called "Double Reclaim." Under the original rules the same allowance was made on cars switched either for loading or unloading as was made for cars loaded both ways. Now, cars loaded both ways in switching service take more time and involve the payment of more per diem, and it is gradually becoming understood and accepted as a principle that it is better to make a lower rate of reclaim and apply it on every loaded movement of a car in switching service, than it is to make exactly the same allowance on cars loaded one way and on cars loaded both ways. Considering the fact that this was practically a new question to the transportation men in the country—for switching rates have always been considered a traffic question—it is very gratifying that the question was solved so fully and so promptly.

> 6.—"In case a road delivers an empty foreign car without the consent of the owner to a road which does not pay per diem; or, if a road permits the loading or reconsignment of a foreign car, without the consent of the owner, to such a road, it shall be responsible to the owner for the payment of an amount equal to the per diem accruing on the car while on such road."

This rule, which holds a trunk line responsible for the per diem of a car on its connection, is a new rule. It probably did more to make the per diem system a success than almost any other. By Rule 5 it is made practicable for the belt lines and terminal railroads to enter the per diem agreement without undue loss, and by this rule it is made very much to the interest of the trunk lines to have the belt lines, terminal railroads and other small railroads with which they connect, sign the per diem rules agreement.

As noted under Rule 3, the pressure of the trunk lines to get some of the smaller railroads into the agreement has been so great that some of them appear to have pushed in so-called "industrial roads," which had never been counted as railroads at all. To this extent, the rule may be said to have worked too well, but this is something which can be readily adjusted, once the facts are ascertained.

> 7.—"When home route cards have been requested under the Master Car Builders' Rules, the per diem shall cease from date of request to owner. When a car has been destroyed and reported under Master Car Builders' Rules, the per diem shall cease from the date of notice to owner."
>
> 8.—"When a car is detained awaiting the receipt of repair material from its owner, the per diem shall cease from the date the necessary material is ordered from the owner until the date on which it is received by the road holding the car."

These rules have worked fairly well. They are designed to protect the owner of a foreign car against undue delay in shops and at the same time protect the road repairing the car against any delay caused by antiquated car design. There has been some difficulty in checking up the performance under the rules on roads where the motive power and the transportation departments were not close together, but this is something which usually has worked itself out.

An effort has been made to change Rule 8 so that when the owner was obliged to supply the repair parts, the per diem would not begin until these parts had actually reached the shop where they were needed, but it was recognized that the railroad where the shops were located was responsible for the movement from junction point to the shop. The rule was therefore allowed to stand.

> 9.—"The interchange reports shall close at midnight and shall include all cars interchanged upon the date named, unless otherwise noted thereon. The reports must be sent to the Car Record office each day, whether cars are exchanged or not. In cases where there are different standards of time at junction points, the time of the more easterly reckoning shall be used. The interchange reports to the Car Record office from junction points must be signed by the agents or other authorized representatives of both roads on the prescribed form, the receipt of cars delivered being thereby acknowledged. Car service rule No. 5 governs the delivery of cars. The time of delivery of cars upon interchange tracks of connecting lines shall *prima facie* be the time given by the delivering road."

This rule and car service Rule 5 are with some slight changes the original rules of 1888. It is to be noted that the last sentence of Rule No. 9 is practically the only change made by the association when it adopted the original rules as presented by the committee in the spring of 1902, and this change was proposed by the leading opponent of the per diem system. It is a very good provision, has worked very well, and has assisted greatly in the checking of per diem reports mentioned under Rule No. 2.

*(To be concluded next week.)*

## Overtime of Freight Trainmen.*

I do not find that our men are at all inclined to loaf or drag with their work to make overtime. A little education and caution, together with frequent words of approbation for good work, constitute a great incentive for men to do their best, and thereby put themselves in a position to ask favors now and then. If I find a trainman inclined to shirk, and showing a disposition not to aid in making time, I take him off his regular run and put him on the extra list for a while. This immediately sets him to thinking in the right direction. I am pleased to say, however, that I have seldom had occasion to do this.

When there is a rush of freight, a trainmaster must quickly anticipate what the volume of traffic is likely to call for in the way of train service, and make up additional crews accordingly, so that ample rest, say from six to eight hours, can be had at terminals. On some lines, when a rush of business sets in, delays on the road increase because trains are held for meeting. This leads to additional overtime. Under such conditions an advantage can be gained by reducing the load, so as to enable the engines to make a better run. With such treatment the engines can be got around for return trips in less time than if they are continually burdened with a drag of cars that can barely be kept in motion.

You ask what I mean by "excessive overtime." I mean cases where crews are on the road on a continuous trip of from 18 to 22 and 24 hours, making about as much overtime in hours as their regular trip time amounts to. I have been told, by men who have come west from eastern lines, that the larger part of their pay has been from overtime work. The only chance for sleep they had was on the road, when waiting on sidings or when held at blocked terminals.

A man (a fireman) came to my office one day last winter from a connecting road and applied for a position as brakeman; he was in his working clothes, and looked as though he had not been washed for 48 hours; and he said he had just quit the other line, as they wanted him to go out on an engine when he had just come in, and had been on the road without sleep, by doubling, for 42 hours; and he came near dropping asleep in the chair while he was telling me his experience.

There has been more than one wreck recorded in the past year caused by men who had been overworked being kept out on the road on excessive overtime hours, beyond all reason. These collision records are a sharp commentary on the course of the officials who allow such things to come to pass. In our State (Indiana) the Legislature has passed a law limiting the hours of labor of trainmen and enginemen to 16 hours, and requiring eight hours rest thereafter, excepting in emergencies such as wrecks and washouts. Our train despatchers are cautioned to look out for trains that have been badly delayed, and arrange for their proper movement by setting out cars, if necessary, so as to get them into a terminal within the prescribed time, if possible. Our freight conductors are also instructed to call the despatcher's attention to their situation when nearing the 16 hour limit, so that they may not be overlooked. Our men know that when they get in from a hard and long run they are sure of eight hours' rest.

We do not make allowance for rest that may be obtained in cabooses on the line, except, perhaps, in connection with circus trains or freights that are on sidings, waiting, perhaps, for a wreck to be cleared. Then we advise the men to go to sleep in the caboose, and we have them called by the station agent when wanted.

*Notes by a Trainmaster.

## Some Notes on the Early History of the Hudson River Tunnel.*

BY S. D. V. BURR.

In the early work upon the tunnel two operations were marked by bold originality, and are at the present time of historical value, one as a disastrous failure and the other as a successful solution of a most difficult proposition. But neither will ever be attempted again by any engineer at all familiar with the history of tunneling or with modern methods of prosecuting underground work. Since both of these jobs were performed over 20 years ago it may be of interest to briefly recall the facts about each.

Fig. 3—View at Foot of Shaft Showing Entrances to the Two Tunnels.
(*The circular opening above the men shows the location of the original air-lock.*)

Mr. D. C. Haskin, the originator and projector of the work, was not an engineer, nor was he intimately acquainted with the methods of tunneling then in vogue. He had a vague and general idea of what had been done, but no knowledge of essential details. His only engineering experience was gained as a contractor on Western railroads. He was his own chief engineer, in fact if not in name. This may explain why he permitted the work which resulted in the fatal accident of 1880. The shield method of tunneling was then well known, as it had been thoroughly tested in England, and had been successfully employed in the Beach tunnel under Broadway at Warren street, New York. But Mr. Haskin was of the opinion that his own method of an unprotected heading possessed advantages in the lines of economy and rapidity. One point cannot be too strongly emphasized—no serious accident ever occurred in those headings, either in the one in silt at the New Jersey end or the one in sand at the New York end. While blowouts were more or less frequent, the time element was present in every case, so that the men always reached the locks before complete flooding took place. The fatal accident about to be described was due to causes widely different from those obtaining in the heading, and in no way affected the principle under which the work was carried forward.

The first work connected with the actual building of the tunnels was the sinking of a brick shaft on the western or Jersey shore of the river. This was circular in section, 30 ft. inside diameter, and the shoe was carried to a depth of 54 ft. below mean high water, or 60 ft. below the ground surface. It first passed through a loose filling of cinders 15 or 20 ft. thick and then entered silt. While the shaft was being lowered the water was kept out by two pumps.

The vibrations set up by the pumps and the friction of the side of the shaft disturbed the ground, especially on the side next to the river. This, working in connection with the water drawn under the shoe by the pumps, caused the ash filling to flow down the side to the pumps. It was therefore known that the material to be passed through was not in an undisturbed and compact condition; it was treacherous, and it afterwards proved its treachery.

Twenty-nine feet below the top of the shaft an opening was cut in the side next the river and an air-lock put in. This projected a few inches beyond the wall and was at a higher elevation than the crown of the tunnels. It was not the intention to start the tunnels at the shaft, but to begin them about 30 ft. from the shaft and afterwards connect them with the shaft. The connecting, or "temporary entrance," as it was called, was shaped like a funnel and was composed of rings 2 ft. wide and each 18 in. larger than the one just behind. The upper edge of the funnel was in a practically horizontal line. The outer ring was 20 ft. in diameter. After the completion of this chamber, excavation was begun at the outer ring, downward and sideways, to permit of the starting of the masonry of the two tunnels. This work was in silt which had not been disturbed, and was prosecuted in the same way as the heading described in our issue of June 3 last.

After the air-lock had been put in one of the first jobs was to provide sufficient protection for the inner door in case of a cave-in at this point. The projecting end of the lock was enclosed in a tube 6 ft. 4 in. in diameter, 8 ft. long, built of ½-in. plates well braced. So serious had become the trouble at this point that a large hole was dug immediately above it, the bottom covered with canvas and the earth replaced. The condition of things at this time is shown by the sectional elevation and plan, Figs. 1 and 2, which are modified somewhat from Burr's "Tunneling Under the Hudson."

It was now time to remove the temporary entrance and make a permanent connection between the shaft and tunnels—this was to be one large chamber embracing both tunnels. The four largest rings were widened and deepened and the masonry built. Of the remainder the upper third had been extended and the plate composing this carried down the shaft and fitted as closely as possible to it. While this work was going on the protecting tube over the end of the lock was removed.

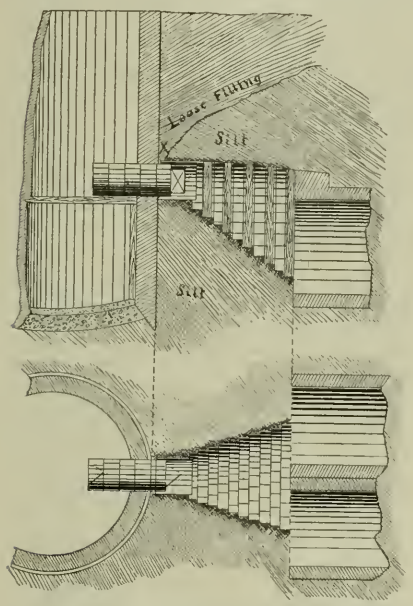
During a change of shifts a blowout occurred at this spot, marked x in Fig. 1. Eight men had entered the lock and 20 were in the chamber. The falling débris blocked the lock door so that it could be neither opened nor shut. When it was found impossible to move the door the glass bull's-eye in the other end of the lock was smashed, and as soon as the air pressure had fallen the

Fig. 4—End of North Tunnel Looking toward the Shaft.

*A previous article on the early history of the Hudson River tunnel by the same author was published in the *Railroad Gazette*, June 3, 1904.

outer door was opened and the men in the lock escaped, all the others being drowned.

Concerning this work several facts stand out with great prominence. It had been found possible to build the tunnel by depending largely upon an equilibrium maintained between the air and water pressures. But that work had been done in silt, which had never been disturbed. In this case the material was known to be of such a loose character that it could not be relied upon to serve as a barrier between the water and air. The bottom of the tunnel was a slope on which, or in which, it was difficult to obtain a firm foundation upon which to rest the struts supporting the plates, so that an unusual reduction of air pressure would be almost sure to result in the giving way of the roof plates. The removing of the protecting tube was a piece of criminal carelessness. When needed most it was not on duty. It had been designed to guard against just such an accident as did happen, and it served no purpose whatever



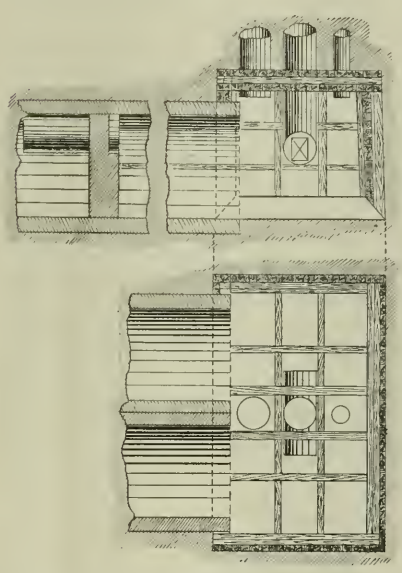

Figs. 1 and 2—Plan and Section of Shaft, Temporary Entrance and Completed Tunnels, New Jersey End.

except to protect the inner lock door, and yet for some reason, never satisfactorily explained, it was removed before the end of its usefulness. From this time forward engineers viewed the tunnel with suspicion.

To reopen the work a large caisson was sunk just over the temporary entrance. One working chamber covered both tunnels, and was joined to the shaft by two openings, as shown in Fig. 3, in which the circular opening directly above the men indicates the location of the original air-lock. The next engraving shows the working chamber after completion. Both pictures were taken by the writer in 1887, and are now used by permission of Harper & Bros.

In starting the north tunnel all the material had been removed before laying the masonry. A different method was tried with the south tunnel, and as it brought out the peculiar qualities of silt it may be well to describe it. An excavation about 3 ft. in height was begun at the crown and extended down each side and along the invert. In this way a ring was formed about 3 ft. wide, 5 ft. long and entirely surrounding a core of silt 15 ft. in diameter. This core was absolutely without support except at the two ends where it joined the parent mass. The superintendent was convinced that his bridge of silt had tenacity enough to hold its position until he could complete the circle of masonry. His experience in the heading had proved that silt, in its original state, settles very slowly, and it was this characteristic he took advantage of. The brickwork was started at the invert, the superintendent himself placing the first bricks in order to prove his confidence in the stability of the core. The masonry had been finished several days before the core had settled to the bottom.

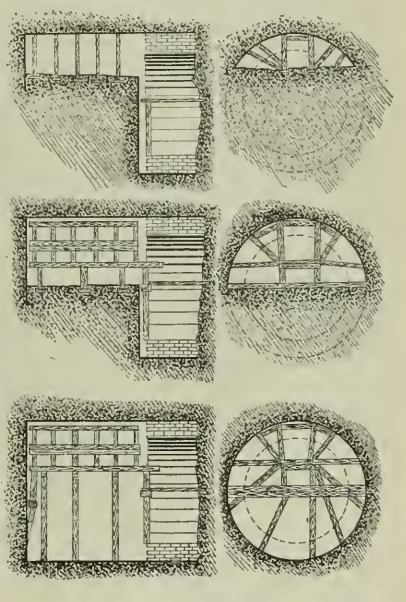
During the latter part of 1882, when the heading at the New York end was being successfully built through water-bearing sand, the writer said, in an article published in *Engineering News:* "The fact that the caisson was embedded in sand led to the belief among many engineers of high standing that an outlet could not be obtained and the tunnel started by the system of working by compressed air. Indeed, it has become unsafe to pronounce an unfavorable opinion in regard to any particular piece of work connected with the tunnel; in more than one instance obstacles which seemed to present an insurmountable barrier to all future progress have been met, conquered, and the work has gone forward. New devices and plans have kept pace with new difficulties. At first glance the sand above mentioned seemed to contain all the characteristics requisite for a first-class insurmountable obstacle. Upon the least reduction of the air pressure this material would follow the water into the caisson; the smallest opening afforded a ready passage. The water and sand could be kept quiet as far down as the air pressure was carried, and no further; and if a trench were dug, or undertaken, the upward pressure, due to the difference between the air pressure and head of water, or depth of excavation, would fill the trench with sand and water about as fast as it could be taken out, and the adjacent material would then be in no better condition than at first."



Figs. 5 and 6—Plan and Section of New York Caisson, Tunnels, Bulkhead and Air-Lock.

It was decided to reach grade and begin the permanent work upon the two tunnels by means of a caisson. This was designed by S. H. Finch, then chief engineer of the work, and under his direction it was sunk and the heading extended through sand and through the dock piles, many of which entered more than half way through the tunnel. The caisson was of wood, of the usual rectangular form, and furnished with three independent air-locks, one for men, one for material and one for long timbers. It was large enough to span both tunnels and was sunk to the invert. The caissons, tunnels and first bulkhead, with its air-lock, are shown in Figs. 5 and 6.

To begin work, an opening conforming with the exterior of the north tunnel was cut through the side of the caisson. Beginning at the top, flanged iron plates were inserted and made fast to the caisson. This work was pushed forward and down each side, and resembled the method pursued at the Jersey end, but was much more difficult because of the nature of the material. The plates were braced as securely as possible as soon as they were inserted, but settling could not be prevented, as there was no adequate foundation upon which to place braces. In addition, this unequal settling threw the plates out of line and opened the joints, so that the packing of silt, brought for this purpose from the other side, blew out. As the chamber was enlarged this trouble increased, and it finally became imperative to provide some means for holding the plates in position. A 12-in. timber was placed with one end resting against the side of the caisson and the other extending to the heading. Two tie-rods having turnbuckles reached from the outer end of this boom to the top of the caisson. In this way a firm support was obtained for the braces. After the lining of plates had been finished the section was cleaned out and the masonry laid.



Figs. 7, 8 and 9—Methods of Advancing New York Heading Through Sand.

The sketches, Figs. 7 to 9, show the method of building a section, which was about 10 ft. in length. The plates composing the forward end of the section, or in other words, the new heading, were always kept in advance of the heading, which had already served its purpose in the section just finished. In other words, the lower edge of the forward heading was always kept at a lower level than the upper edge of the heading being taken down, as is indicated very clearly in Figs. 7 and 8. This construction provided a seal against the entrance of water as long as the air pressure was maintained, and resembled in principle the compartments of the ordinary shield.

The hard work necessary in putting in the

roof plates can be imagined. It was impossible to leave the sand exposed even for the short length of time required for inserting a plate. In cases of this kind neither silt nor sand would prevent the rapid escape of air and the falling down of the uncovered surface. So a simple and effective expedient was adopted which provided such protection that the sand was never exposed at all. Light wooden poling strips ½ in. thick, 2 in. wide and about 3 ft. long were driven into the sand parallel with and ahead of the plates already in place. The rear ends of these strips were then pushed up and pulled back until they rested upon the finished ring. In this way a false lining was prepared which, with the assistance of the air pressure, held the sand long enough for the insertion of the plates.

A short distance from the shaft a masonry bulkhead was built in the north tunnel and an air-lock put in, as shown in Fig. 5.

More than once the work was flooded by the air escaping; but, as stated above, no one was ever injured by a blowout. While working upon the fifth section from the shaft a blowout occurred in the fifth row of plates composing the bulkhead. The men all got out and the work was flooded. A diver was sent in to examine the condition of things. The simple fact of sending in a diver to ascertain the extent and location of the damage yielded results that were of the greatest importance afterwards. The air from his helmet collected at the crown of the tunnel, and this suggested the starting of the compressors. In a short time the air filled the top of the tunnel down to the upper edge of the air-lock doors. This provided a headroom of air when the men were in an upright position, the water then being about breast high. Men entering the tunnel would wade down to the first lock door, dive through it, pass through the lock and dive through the inner door into the heading.

The tunnel was filled with air to the upper edge of the blowout. This provided a breathing space for the men, but compelled them to perform all the work of repairing under water. Their troubles can better be imagined than described. In addition the job was a slow one, as the water could only be lowered as the repairs progressed and the bulkhead was carried down.

Afterwards, other blowouts took place, but beyond flooding the work they were not of a serious nature. In these instances it was always easy to free the heading of water because the trick had been learned. The attempt was never made to pump the water out of the tunnel. The sand was perfectly porous and water found a ready passage through it. If this had been tried the water would have flowed in through the largest opening—naturally the blowout—and the extent of the damage would only have been increased. Again the pumping capacity at the command of the engineers was not sufficient for handling the Hudson River and its tributary, the Atlantic ocean even if a spillway had been convenient.

But by forcing air into the heading the displacement of water began at the point of least resistance, was in a direction most favorable for preventing any further entrance of sand, and the escaping air worked on the intermittent flow, which is present during every blowout. If these simple facts had been known and appreciated by engineers subsequently in charge of the work, thousands of dollars and months of time would not have been expended in vain attempts to reopen the New York end of the tunnel.

The Simplon Tunnel about the middle of September encountered a hot spring at the south end (where alone work is prosecuted). The hot springs heretofore have been in the other end of the tunnel. The south end, however, was long ago provided with a capacious drainage channel on account of a veritable river of cold water which delayed the work there some weeks, and the new hot spring was expected to cause little delay, so that a passage through was still expected about the middle of October.

## American Locomotives.*

Since 1893 the types of passenger locomotives, as distinguished by their wheel arrangement, have completely changed, and the eight-wheel American type, 4-4-0, is no longer built for fast express service. In passenger service, the competition of the different roads advertised itself by offering greater luxury and magnificence in sleeping cars, parlor, buffet and dining cars, of elaborate finish, greater length and greater weight. The length of these cars of modern construction is 70 ft., and their weight 120,000 lbs. The number of passengers hauled in a solid vestibuled train made up of such cars is comparatively small, and the weight of train per passenger very great. Such service is necessarily expensive. It is not profitable, and it is probably the most luxurious and most inefficient of any passenger service in the world. Trains of eight to ten of such cars weigh from 400 to 500 tons, and to haul them at average speeds approaching 50 miles per hour required a large increase in the weight and power of the locomotives. It was not possible to arrange a boiler of sufficient capacity on the 4-4-0 American eight-wheel type, and the Columbia, or 2-4-2, was first substituted, as any arrangement with trailing wheels allows a wider fire-box to be carried entirely behind the drivers, and also admits of a longer boiler barrel. For high speeds it was considered safer to use a four-wheel leading truck, and the best experts on track are of the opinion that the four-wheel truck causes less irregular deflection in the track and roadbed in advance of the drivers than a two-wheel truck, and therefore results in smoother riding and less injury to track. The Atlantic type, 4-4-2, therefore, has become a favorite type of passenger locomotive for express service. It has been built in large numbers in the United States, and is being introduced gradually in England, France and Germany. When still greater power is demanded for passenger service, and a larger boiler is necessary, the Pacific type, 4-6-2, is used, this having six drivers, with the same arrangement of leading and trailing wheels. Locomotives for burning anthracite coal have quite a different appearance from those for bituminous coal, as the wide fire-box in the former requires the cab to be placed well forward about the middle of the boiler, and the arrangement of the cab fixtures, the dome and the bell, are not such as to result in a handsome machine.

### FOUR-CYLINDER BALANCED COMPOUNDS.

For medium-weight trains and high speeds, it was desirable to retain the Atlantic type, with only four drivers, but when this type was developed to an extreme size the total weight on the drivers was as great as 100,000 lbs., and the weights of the reciprocating parts with simple cylinders were so great that the centrifugal force of the extra weight in the counterbalance increased the pressure on the rail at high speeds to 20 or 30 per cent. in excess of the static load. In order to overcome these difficulties, the four-cylinder balanced compound was introduced by the Baldwin Locomotive Works, and first used in regular passenger service by the Santa Fe in 1903. Four engines of this kind were used on the Santa Fe in 1903, and, during 1904, forty additional engines were ordered. In this engine, the four cylinders are placed in line laterally, and they are all connected to the front axle, which is cranked. The arrangements of the cranks are such that the reciprocating parts balance each other, and the pressure on the rails is increased very slightly at high speeds. The engines ride very smoothly, and their success is indicated by the large additional order which has been given. In this type, as the force of all four cylinders is transmitted through the crank axle, the stress in that axle must be great, and two of them have cracked in the main rod bearings. In repairing these axles, a 4-in. hole has been bored through the crank portion at the bearing, and a steel pin driven through and riveted. In future work, the cranks will be constructed in this way. A modification of this type, in which the outside cylinders are connected to the rear drivers, has been built by the Baldwin Locomotive Works for the Burlington. In this way the stresses from the cylinders are divided between the two axles. The cylinders are all placed in line laterally, but the piston rod and main rod of the outside cylinder are longer, so as to reach the rear driver.

Another four-cylinder balanced compound passenger engine of the Atlantic type has been designed by Mr. Francis Cole at the Schenectady Works of the American Locomotive Company for the New York Central. In this engine, the high and low-pressure cylinders are connected to different drivers. The high-pressure cylinders on the inside are placed in advance of the low-pressure cylinders, and they are connected to the front axle, which is cranked. The low-pressure cylinders on the outside are connected to the rear drivers. The four-cylinder engines, by both the Baldwin and the American locomotive companies, are operated by the Stephenson link motion, with one link for each pair of cylinders. In the Baldwin (Vauclain) engine, a single valve controls the steam for the high and low-pressure cylinders. In the American Locomotive Company (Cole) four-cylinder engine, there is a piston valve for each cylinder, but the valves for the high and low-pressure cylinder on one side are operated from one valve stem. It may be interesting to compare these arrangements of cylinders, valves, rods and links, with the Von Borries and de Glehn four-cylinder compounds.

*Cole.*—High-pressure cylinders inside, but in advance of the smoke-box, driving front driving axle. Low-pressure outside, in line with the smoke-box, driving rear driving axle. Two piston valves on a single stem serve for each pair of cylinders, and each valve stem is worked from an ordinary link motion.

*Vauclain.*—High-pressure cylinders inside and low-pressure outside, all in the same horizontal plane, in line with the smoke-box, and all driving the front driving axle. This is as in the Von Borries, but a single piston valve worked from a single link motion effects the steam distribution for the pair of cylinders on each side.

*De Glehn.*—High-pressure cylinders outside and behind smoke-box, driving the rear drivers. Low-pressure cylinders inside, under smoke-box, driving crank axle of front drivers. Four separate slide valves and four Walschaert valve gears, allowing independent regulation of the high and low-pressure valves.

*Von Borries.*—High-pressure cylinders inside and low-pressure outside, all in the same horizontal plane, in line with the smoke-box, and all driving the front driving axle. Each cylinder has its own valve, but the

*Abstract of a paper by Wm. Forsyth presented before the International Engineering Congress, St. Louis, October, 1904.

two valves of each pair of cylinders are worked from a single valve motion of a modified Walschaert type. This arrangement allows of varying the cut-off of the two cylinders, giving different ratios of expansion, which, however, cannot be varied by the engineman.

FREIGHT LOCOMOTIVES.

The demand for greater power in freight engines was the result of the introduction of the steel car, which increased the lading of freight cars from the ordinary capacity of 25 and 30 tons to 40 and 50 tons. The draft gear of these cars being entirely of steel and the automatic couplers of cast steel, made it possible to haul large trains without danger of breaking in two. The rating of locomotive capacity by the ton tended constantly to increase the trainload to the maximum, and the economy of this method of transportation, as compared with the old method, which gaged the train simply by a given number of cars, resulted in a demand for larger engines and greater tractive power. The consolidation type of freight engine, 2-8-0, which was first used in the United States in 1866, is still the prevailing type, as it can be built with a boiler large enough for the heaviest through freight service. For mountain grades, when pushing engines are required, the Decapod and Mastodon types are often used, and a 12-wheel Mallet articulated compound engine has been built during 1904 at the Schenectady Works for pushing on heavy grades.

BOILERS.

The changes in locomotive design, in order to obtain greater power, it will be observed, have been largely due to the use of a larger boiler. The barrel was not only greatly increased in diameter to accommodate a larger number of tubes, but its length was made greater, so that tubes 20 ft. long are frequently used. In 1893 the outside sheet of the fire-box in most locomotives was flush with the frame, and the width inside was 42 in. The larger express engines on fast schedules burned such a large quantity of coal per hour that the rate of combustion was often forced to 150 and 200 lbs. of coal per sq. ft. of grate per hour. The same was true of freight engines when hauling maximum trains, even at comparatively slow speeds. The strong blast required for such high rates of combustion was sufficient to pull unconsumed fuel through the tubes to the extent of 10 or 15 per cent. of the total coal fired, and throw it out of the stack, and the rate of evaporation was thus reduced. Even with such high rates of combustion, it was not possible to burn sufficient coal on a grate 42 in. wide to supply large engines with steam. A fast passenger engine, with cylinders 19 in. x 24 in., burned three tons of coal per hour, and since that time passenger engines with 45 per cent. greater cylinder volume have been built. It was found necessary to increase the width of the fire-box to 5, 6 and 7 ft., and such boxes are known as "medium-wide" fire-boxes, to distinguish them from those 8 ft. wide, used on anthracite boilers. The wide fire-box was easily applied to types of passenger engines having trailing wheels, such as the Columbia, Atlantic and Pacific, and in the consolidation type the diameter of drivers is so small that the wide box could be easily extended over the rear pair of that type. In placing the fire-box entirely back of the drivers on passenger engines, the throat sheet has been inclined forward, so that the front water leg conforms somewhat to a line parallel with the circumference of the rear driver, and the tube sheet is thus somewhat ahead of the water leg in that region. This is done for the purpose of retaining a proper proportion of weight on the drivers, to avoid tubes of too great length, and to improve the circulation of water along the lower side sheets. The front tube sheet is often placed some distance back of the cylinder saddle for the purpose of avoiding excessive tube length.

*The Spacing of Tubes.*—The development of the locomotive in America has been based upon a desire for increased tractive power, this power being the maximum to be obtained when using steam at nearly full stroke, and a mean pressure equal to 85 per cent. of the boiler pressure. With an average coefficient of adhesion of 25 per cent., the weight on the drivers is determined, and, in order to obtain it, a large boiler diameter was found necessary. Having a large shell it was thought desirable to fill it as full of tubes as possible, with bridges of only 5/8 in. between the tubes, and when the tubes are coated with scale the space is reduced to 3/8 in. at least. At the same time, the height of the evaporating surface above the lower tubes was greatly increased, and, with it, the length of travel of steam bubbles. Under such conditions, the tubes are not constantly covered with water, and they become overheated, resulting in leaks at the tube sheets. This has been one of the most serious troubles in the operation of large locomotives, and in locomotives built in 1904 there is a marked tendency to use a less number of tubes in a shell of the same size, and to increase the space between tubes from 5/8 to 3/4 or 7/8 in.

It was found that the maximum efficiency of the tube-heating surface could not be obtained by such close spacing, and it is believed that a higher rate of evaporation per square foot of heating surface will be obtained when the tubes are spaced further apart, and that, therefore, an equivalent or larger boiler capacity will be obtained with a less number of tubes with the wider spacing. An illustration of this is found in two lots of Pacific type passenger engines, built by the same works for the same road, those in 1903 having the close tube spaces and those in 1904 the wider spaces. The diameter of the boiler is the same, and the tubes are 20 ft. long in each case. Those built in 1903 had 328 tubes and those in 1904 245 tubes, a difference of 83. The total heating surface is reduced from 4,078 to 3,053 sq. ft., a difference of 1,025 sq. ft., or 25 per cent. The width of the mud ring and water space at the bottom is increased to 5 in. With such proportions for the water space between the tubes and in the water leg, the circulation of the water is greatly improved and the efficiency of the heating surface is increased.

LOCOMOTIVE OPERATION, AS AFFECTED BY THE FIREMAN.

In the operation of large locomotives with wide fire-boxes it is found that the fuel economy, the hauling capacity and the boiler repairs (especially fire-box sheets and tubes) are all materially affected by the limitations of the strength of the fireman, and by his lack of skill in keeping the grate covered uniformly with coal. From the facts contained in recent reports to the Master Mechanics' Association, the following conclusions may be drawn:

First, that in recent years poor material has often been employed for firemen. Second, that poor firemen are most extravagant in coal consumption when working wide fire-boxes. Third, that the irregular firing of wide fire-boxes has resulted in leaky tubes and cracked sheets. Fourth, that the capacity of a large locomotive is easily limited by the endurance of the fireman, whether good or bad. Fifth, that the economic size of locomotives may in some instances have been exceeded on account of the limitations of the fireman's strength.

The care with which wide fire-boxes should be fired is not generally appreciated by the men, and is largely the cause of the numerous troubles due to leaking, which are experienced with this type of boiler. It is more difficult to maintain an even fire on a large grate than on a small one, and as there is a greater tendency to irregular temperature in the former, it is the direct cause of leakage. The admission of larger amounts of cold air to the furnace than is necessary for combustion has a tendency to lower the average temperature of the fire-box gases, and thus to reduce the rate of evaporation.

It is, for this reason, easily possible for the fireman to effect unfavorably the coal performance with wide fire-boxes, even when he is endeavoring to do his best work. The rules relating to the privileges due to priority of service of firemen have had a tendency to place the youngest and most unskilled men on the large engines with wide fire-boxes, because the older men prefer the lighter work on the smaller locomotives. Although the rate of wages paid firemen is higher than that received by skilled mechanics, who have spent several years in learning a trade, or of clerks who are perhaps better educated, yet the fireman's service is no longer attractive to a good grade of men, on account of the laborious work required in handling the large amount of coal consumed per trip by large locomotives.

It has been shown in the reports referred to, that, as now operated, the wide fire-box is not superior to the narrow one in economy of fuel, and coal consumption must be nearly proportional to the horse-power developed with either type of boiler. As the large locomotives have a horse-power capacity nearly double that of the medium-sized engines used a few years ago, the amount of coal to be handled per hour when these engines are working at normal capacity must be twice as great. While the fireman may be able to handle this amount of coal for the first few hours, he cannot keep up the work uniformly for the whole trip. The Master Mechanics' report on automatic stokers emphasized this fact in explaining the conditions under which the machine stoker will prove most valuable:

"When the engine is loaded to maximum capacity the automatic stoker will not tire, and consequently it will enable the engine to carry maximum pressure all of the time and get the full benefit of the tractive power of the engine over a long, continuous trip; this cannot be done by hand-firing."

The power of the large locomotive is thus limited by the fireman in his failure to maintain uniformly full boiler pressure, due to the limitations of his physical endurance. So far as irregular firing results in failures of the boiler and fire-box, to that extent does the fireman determine the mileage service of the engine, for such failures require it to be laid up in the roundhouse or shop, and there is a loss, due not only to cost of repairs, but to the limited service obtained on the road.

If the above statements be considered with relation to the size of locomotives as measured by their coal consumption per hour, it would appear quite possible that a given tonnage could be handled by a locomotive of medium size, which would burn economically the same amount of coal used by a large locomotive on the same trip. Having reached the limit of the capacity of the fireman to shovel coal enough to maintain uniform boiler pressure, is it a profitable move to build locomotives still larger, and in some instances has not the economical size of hand-fired locomotives been more than reached? With oil fuel or with a machine stoker it is possible to force steam production and maintain uniform pressure beyond the maximum of present consumption, and it is only by the use of such measures that the

continued growth of the locomotive in America may be justified.

AUTOMATIC STOKERS FOR LOCOMOTIVES.

The necessity for an automatic stoker for the large locomotive, either passenger or freight, is quite generally recognized, and the requirements have been met in a very satisfactory manner by at least one form of stoker. It is strange, therefore, that a stoker which has been upon the market for several years, and which works so successfully, does not become regularly adopted by the railroads, which seem to need some such appliance to assist the fireman in his arduous work. The testimony as to the success of this device is the most convincing of any relating to locomotive improvements (containing such radical changes in methods of operation) which have been introduced in many years. The reports of the laboratory tests at Purdue show it to have given a very satisfactory performance. The testimony of motive power men who have had quite a number of stokers in use is entirely favorable to the device, and the opinion of the superintendent of our largest locomotive works is that the stoker is the coming device.

PISTON VALVES.

The flat slide valve is almost always provided with balancing strips, but, on account of imperfect lubrication, its excessive friction makes it difficult for the engine driver to change the cut-off, and the want of sufficient rigidity in the ordinary design has led to the use of a very heavy valve gear on modern locomotives. The piston valve was introduced for the purpose of securing a balanced valve, thus reducing valve friction. It has been designed in various forms, and much experimental work has been done with packing rings of different shapes. Although many objections have been made to the piston valve on account of broken packing rings and leakage, yet it has been gradually developed and successfully applied, so that it may be regarded as well established practice in America.

The use of the piston valve has modified materially the design of the cylinder and saddle, as well as the front frames, and in such designs there is opportunity to make a stronger construction of both cylinder and frame than with the flat valve. The packing rings used by the Baldwin Locomotive Works are rectangular and nearly square. The construction used by the American Locomotive Company for packing rings includes a bushing, with L-shaped rings on each side of it, and a large number of locomotives are now running with this form of packing ring.

The principal objection which has been urged against the piston valve is the loss due to leakage, and it was supposed that this was much greater than with flat valves. The subject was carefully investigated by a committee of the Master Mechanics' Association, and the following figures are taken from a report presented at the convention of that association in June, 1904. The amount of leakage per hour was measured with each type of valve, one series with valves at rest and another with valves in motion. The best results obtained from piston valves show a leakage of 268 lbs. per hour, and from flat valves, 348 lbs. The worst cases of leakage were 2,880 lbs. with piston valves and 2,610 lbs. with flat valves.

Incidentally, it was found that the principal cause of leakage was poor fitting of the rings, and the conclusion was reached that if equal attention is given to each kind of valve, the piston valve would show less leakage. Flat valves are free to lift from the seat, and thus relieve the cylinders from water and undue compression, but piston valves cannot lift, and provision must be made for the rapid removal of water from the cylinder; therefore it is essential that relief valves and well-designed by-pass valves be used in connection with piston valves.

The question of the lubrication of piston valves while drifting is one which is still in the experimental stage, but it is also one to which proper attention must be given, in order to make the use of such valves entirely satisfactory.

VALVE GEAR.

The use of the Walschaert valve motion on the Baltimore & Ohio, Mallet articulated locomotive, and on the Pennsylvania de Glehn four-cylinder compound, which are now on exhibition at St. Louis, has again brought the merits of this gear to the attention of American designers. These two locomotives represent extreme conditions as to the speeds for which they are intended. The one is for slow speed on heavy grades, the other for high-speed passenger work. This would indicate that the Walschaert gear is well adapted to any kind of service—freight or passenger. It is fortunate that a well-designed gear of this type will soon be seen in operation in the United States, and its performance on these locomotives will be watched with interest.

This gear has been used for many years on the State Railways of Belgium, and it is also used extensively in Germany and France. In the latter country it has been given preference over all others for the high-speed balanced compounds, which have made such remarkable records, and, on this account, it is found on the French locomotive which was built for the Pennsylvania.

The chief difference between the Walschaert and the Stephenson motions is the constant lead with the former when the valve travel is changed. This is due to the fact that at the end of the stroke the cross-head alone determines the position of the valve, and as the cross-head always has the same position at the end of the stroke the valve will also have a definite location, and the travel may be decreased but the lead remains constant. For high-speed locomotives, of the ordinary simple two-cylinder type, the constant lead may not be regarded as desirable, as early cut-offs are then used, and it is necessary to have greater pre-admission, when the cut-off is so short, in order to permit the steam to enter the cylinder without excessive wire-drawing. With the four-cylinder balanced compound, which is the most promising type for high-speed work, the cut-off need not be short. The record of the indicator cards taken from a locomotive of this kind on the Northern of France, as given in Mr. Sauvage's paper, shows that at 77 miles per hour the cut-off was 45 per cent. in the high-pressure cylinder and 67 per cent. in the low-pressure cylinder. The Joy valve gear has a constant lead, and it is used quite generally in England in connection with inside cylinders, and it has not been found objectionable on account of this peculiarity. As far as the distribution of steam is concerned, the Walschaert valve motion will produce results as good as, if not better than, the Stephenson shifting link, and it has some mechanical advantages which should recommend it as well adapted to modern locomotive practice in the United States.

A valve gear outside of the frames is conveniently inspected and repaired, while one inside of the frames is certainly in an awkward position for either operation. With inside cylinders and crank axles there is little room for eccentrics and links, and if all this be removed it allows ample length for main pin bearings, and it is then possible to have an inside bearing for the crank axle. The Walschaert gear, as ordinarily designed, is not symmetrical in a vertical plane, and there is a tendency to lateral bending and unequal wear when so constructed. In the engine referred to, Mr. de Glehn has taken special care to avoid these objections, and his design shows well-balanced wearing surfaces of ample proportions, which should be quite durable.

The point to which the writer wishes to call particular attention is the great contrast in the weight of the moving parts and the size of the bearings when this Walschaert outside gear is compared with similar parts of a Stephenson link motion driven by eccentrics. A prominent superintendent of motive power, who has made a special study of indicator cards, and who has given much attention to valve gears, in a recent discussion on "Modern Tendencies in Locomotive Design in America," made this statement:

"I consider that the increased complication and weight of the valve motion is an exceedingly serious matter in giving distorted steam distribution, due to the destructive effect of the valve motion in causing wear and tear."

The reports on "Weights of Detail Parts of Locomotives"* give the weights of parts of the Stephenson valve gear for large locomotives, as follows, in pounds: Eccentric 212, eccentric strap 225, eccentric rod 125, link 148, rocker arm 248, transmission bar 128, valve rod 66, valve yoke 90, valve 211. These figures indicate that the Stephenson valve gear, including the eccentrics and straps, as found on modern locomotives, has become a very ponderous affair. Some attention has been given to the valve pattern, in the effort to make it as light as possible, but the same care has not been taken with the moving details connected with it, and which easily become a disturbing factor at high speeds if made too heavy.

The principal load which comes on the eccentrics and straps, causing them to heat, is not the friction of the valve, but it is that due to the inertia of the reciprocating parts of the valve gear, the motion of which is reversed twice for every revolution. If the rocker arm is included, the weight, as found above, of the moving parts from valve to eccentric strap for one cylinder is 1,052 lbs., and at high speeds the energy of this moving mass must impose a heavy load on the eccentrics.

The eccentrics and straps are the most difficult details in the locomotive machinery to keep lubricated properly, and it requires constant vigilance to prevent them from heating. When they do heat and cut, and the straps are taken down, their location inside the frames is the most inconvenient possible, and with the increasing weight of the machinery this part of the locomotive repairs has become very laborious and expensive. More attention should be given to the reduction of the weight of the moving parts of the Stephenson valve gear, or some other type should be used. The Walschaert gear, located outsided the frames, is easily accessible, and very convenient for inspection, lubrication and repairs. The main driving bearings are two small pins with bushed bearings, and the contrast with the heavy and cumbersome eccentrics and straps, which are their equivalent in a valve gear system, is very striking. This gear is simple and light throughout, and it has much in it to be recommended for overcoming the objectionable features of the shifting link motion driven by eccentrics.

LOCOMOTIVE FRAMES.

In the design of locomotive frames the bar frame is still the general practice, and, for the pedestal portion, it does not seem feasible to adapt any other form to the gen-

*Proceedings Master Mechanics' Association, 1903, p. 187.

eral design of American locomotives. With trailing wheels, double-plate frames are frequently used, the plates being 13 in. deep, the inner one 1¾ in. thick and the outside one 1¼ in. In one design, a deep plate, 2 by 32 in., is used between the cylinder and the saddle, but this portion is either forged or cast with the usual bar extending to the pedestals. In a double-bar front frame, the top bar extends back over the front pedestal. A great deal of study has been given to frame design, but broken frames are as frequent as ever, and their repairs, due to such fractures, are expensive. No satisfactory explanation or remedy for broken frames has been found, but the following have been suggested: First, poor design; second, imperfect welds or faulty material; third, the inertia of the boiler with reference to frames when the bumpers strike an obstruction or when brakes are applied suddenly, where high cylinder saddles are used; fourth, the presence of water in the cylinders, with piston valves and inefficient relief valves. While any one of these may not cause broken frames, yet they are contributory, and when several are acting at once they produce stresses greater than the resistance of the material. The cracks in frames are not confined to any definite locality, but appear at all pedestals, and as many back of the leading axle as in front of it. The fractures are also found as frequently in the full section as at bolt holes.

More locomotive frames are now made of cast steel than of forged iron, and steel is regarded as the better material for this purpose. The tensile strength is 75,000 lbs. per sq. in., as compared with 50,000 lbs. per sq. in. for hammered iron. The cast-steel frame contains no welds, and is uniform in quality throughout its length. The projections required for driver-brake details, bearings, etc., for the valve motion are conveniently cast in steel, but they complicate the forging when made of iron.

While steel is 50 per cent. stronger than iron, yet almost as many cast-steel as wrought-iron frames have broken, where similar conditions, as to design and service, have prevailed. The reason of this is probably due to a lack of annealing, or improper annealing, or overheating of the casting. It is evident that the proper heat treatment of cast-steel frames is not well understood, or it is not usually applied. The quality of steel which should be used for locomotive frames is indicated by the following specification: Tensile strength, from 65,000 to 75,000 lbs. per sq. in.; elongation in 2 in., not less than 15 per cent.; to be annealed thoroughly. Chemical composition desired:

| | Acid. | Basic. |
|---|---|---|
| Carbon | 0.28 | 0.35 |
| Phosphorus | 0.05 | 0.06 |
| Sulphur | 0.05 | 0.06 |
| Manganese | 0.60 | 0.70 |

One advantage of cast-steel frames is the rapidity with which they can be manufactured; and they are also convenient for railroads which do not possess heavy hammers suitable for forgings of this size. Cast-steel frames require some work in straightening in the smith shop before they are ready for the planer. The cost of machining is also high, on account of the rough and hard surface, but the total cost finished is not more than two-thirds that of forged-iron frames. The foregoing information on frames is obtained partly from a report of a committee of the American Railway Master Mechanics' Association, June, 1904. This committee recommended as remedies for broken frames the following: 1.—Rational design; 2.—Cast steel to proper specification and good annealing; 3.—Provide such bracing as will prevent "weaving" (that is, movement of one side independently of the other); the bracing should be designed so that the bending will be synchronous; 4.—The clip pedestal binder is preferable to thimble and bolt; 5.—Cylinders should be drained properly.

LOCOMOTIVE PERFORMANCE.

Few reliable tests of modern locomotives have been made, and it is difficult to get accurate data as to their performance. The tests which are now being conducted by the Pennsylvania Railroad Company, in their plant in the Transportation Building, St. Louis, are the most comprehensive ever attempted, and they promise to show the most valuable results ever obtained by such methods. They are the only laboratory tests which have been made with the large locomotives representing present practice, and, as the reports are not now available, they are here recommended for future reference to those interested in the most refined measurements of locomotive performance.

An indication of the capacity of large passenger locomotives may be had from the performance of those handling the Alton trains between Chicago and St. Louis, where the engines of the Atlantic type haul nine cars, weighing 500 tons, at an average speed of 46 miles per hour. These engines weigh 183,800 lbs., and the weight on the four drivers is 103,700 lbs. The engines of the Pacific type, on the same road, haul 12 cars, weighing, with passengers and baggage, 675 tons, on the same schedule of 46 miles per hour. These engines have a total weight of 219,000 lbs., with 141,700 lbs. on six drivers.

## Comparative Cost of Wood and Steel Frame Factory Buildings.

BY H. G. TYRRELL.*

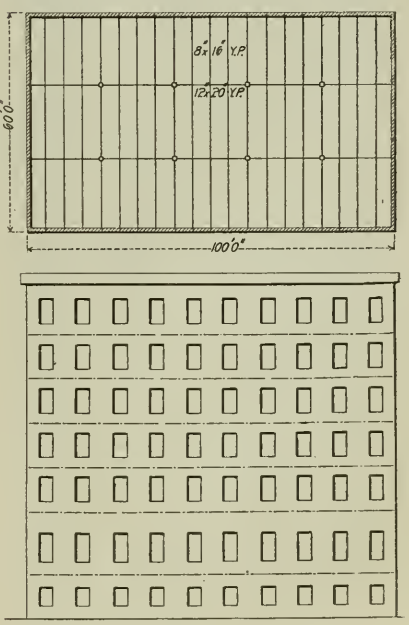
The following estimates give the comparative costs of a factory building, framed in slow burning wood construction, and steel fireproof construction. The building is 60 ft. x 100 ft., and six stories high, containing six floors and roof. The floors are designed to carry an imposed load of 100 lbs. per sq. ft. The building has windows in all four sides and the walls in both cases carry the ends of the floor-beams. The thickness of walls in the basement is 24 in., while in the first four stories it is 17 in. In the remaining two stories the wall is 13 in. thick. The estimates are for the structural part of the building only, including walls, columns, floors, roof, excavation, doors and windows, foundations, but do not include any partitions, stairs, elevator, plumbing, heating, lighting or wiring.

The framing for the slow burning design is as follows. Eight tiers of columns, spaced 20 ft. apart in both directions which carry the floors and roof. From the roof down through four stories, the columns are yellow pine. In the lowest of these stories the size of column used is 14 in. x 14 in. Below this where a greater size would be required than can be secured economically, round cast-iron columns have been used, 11 in. x 1¼ in. in the first story, and 12 in. x 1½ in. in the basement. All the columns have cast-iron bases, 3 ft. square and 16 in. high. Lengthwise through the building in the floors, run two lines of 12 in. x 20 in. yellow pine, which rest on the brackets of cast-iron column caps. The cross floor-beams are 8 in. x 16 in. yellow pine spaced 5 ft. apart. At the columns they rest on column caps, and at intermediate points they hang from the 12 in. x 20 in. header beams by means of wrought iron stirrups. In the walls the cross floor-beams rest on cast-iron wall plates, 9 in. x 20 in. x ¾ in. The floor is made of ⅞-in. matched maple, laid on 1¾ in. yellow pine. The roof is similar in construction and has a tar and gravel covering.

The quantities of material in the building as outlined above are as follows:

| | |
|---|---|
| Excavation | 1,800 cu. yds. |
| Cellar cement floor | 6,000 sq. ft. |
| Foundation concrete | 150 cu. yds. |
| Brick | 39,000 cu. ft. |
| 238 windows | 4 x 7 ft. |
| Roofing | 6,000 sq. ft. |
| Yellow pine timber | 116,000 ft. B.M. |
| Yellow pine flooring | 73,000 ft. B.M. |
| ⅞-in. matched flooring | 46,000 ft. B.M. |
| Iron work | 46 tons. |

The estimated cost of this design is $35,000, which is equivalent to 6.1 cents per cubic foot of the building, or 83 cents per square foot of the entire area of all the floors. The interior framing of floors and columns, including wall plates, columns, caps and bases and stirrup irons, is 27 cents per square foot of floor area.




Slow-Burning Factory Building.

In the fireproof design the arrangement of beams and columns is similar to that for the slow burning design. Riveted steel columns are used from cellar to roof, and the floors are framed with steel beams. The flooring between the beams is reinforced concrete. In this case the quantities are as follows:

| | |
|---|---|
| Excavation | 1,800 cu. yds. |
| Cellar floor | 6,000 sq. ft. |
| Foundation concrete | 150 cu. yds. |
| Brick | 39,000 cu. ft. |
| 238 windows | 4 x 7 ft. |
| Roofing | 6,000 sq. ft. |
| Steel columns | 105 tons. |
| Steel beams and wall plates | 252 tons. |
| Concrete floor and roof | 42,000 sq. ft. |

The cost of the building in this case is

*Chief Engineer, The Brackett Bridge Co., Cincinnati, Ohio.

$57,000, which corresponds to 10.2 cents per cubic foot of building, or $1.36 per sq. ft. of the total floor area. Floors and columns cost 75 cents per sq. ft. of floor area.

Hence the comparative estimates are as follows:

| | —Construction.— Slow-burning. | Fireproof steel. |
|---|---|---|
| Cost per cu. ft. of building.... | 6.2 cts. | 10.2 cts. |
| Cost per sq. ft. floor area.... | 83 cts. | 136 cts. |
| Cost of floors and cols., sq. ft.. | 27 cts. | 75 cts. |
| Total cost ..... | $35,000 | $57,000 |

## Growth of the Missouri Pacific.

### IV.

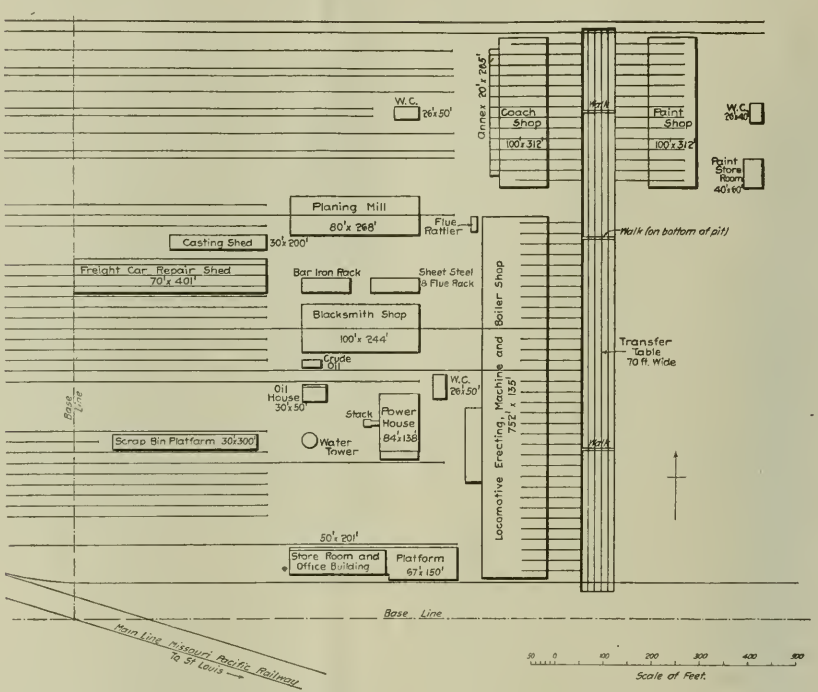
(*Continued from p. 327.*)

Ground was broken on May 10th of the present year for grading the site of the new general locomotive and car repair shops of the Missouri Pacific at East Sedalia, Mo. All of the preliminary work has been completed and work on the buildings is now in progress. The foundations are nearly completed, and the brick, steel and carpenter work has been contracted for. The grading contract was awarded to Henry Daumhoff, Little Rock, Ark.; the concrete contract to Edward Crebo, Kansas City, Mo.; the steel work to the American Bridge Company; and the carpenter work to Wyatt & Donovan, St. Louis. These contracts, with one exception, are for labor only, the railroad company furnishing all material on cars at the site. This departure from the usual method of doing such work is expected to result in a considerable saving to the railroad company. The exception noted is for the steel work, which will be furnished and erected by the American Bridge Company.

It will be seen from the general plan that the principal departments are ranged along one transfer table pit, the machine, erecting and boiler shops being combined in one building. The power station is to the rear of, and close to, the latter, as is also the blacksmith shop. The planing mill is about midway between the coach shop and the freight car repair shed. The storehouse has been located to procure the best track facilities and has a track on each side. The space opposite the locomotive shop is reserved for future extensions. The dimensions of the principal buildings are as follows: Erecting, machine and boiler shop, 752 ft. x 135 ft.; smith shop, 244 ft. x 100 ft.; coach shop, 312 ft. x 120 ft.; paint shop, 312 ft. x 100 ft.; planing mill, 268 ft. x 80 ft.; power house, 134 ft. x 84 ft.; freight car repair shed, 401 ft. x 70 ft.; office and storehouse, 201 ft. x 50 ft.

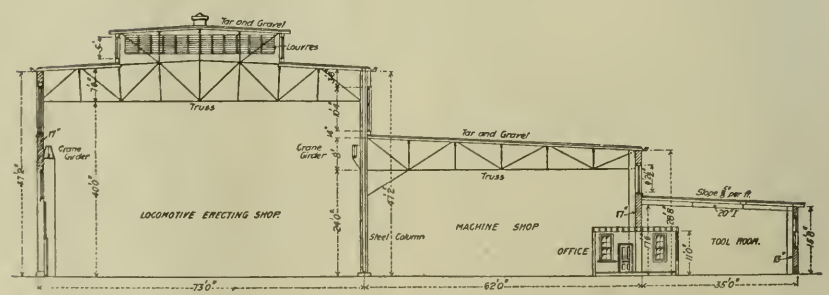
In designing the buildings, particular attention was given to uniformity of details, especially in the matter of doors and windows. The locomotive door used is the same for all the buildings, and is a special design made by Mr. Schaub. The size of the glass in all windows is the same for all shops—16 in. x 18 in. The walls of all buildings are brick, on concrete foundations, and all roofs have steel trusses with steel purlins. The jack rafters are 4-in. x 6-in. southern pine, and on them is laid 2-in. planking. Above this is a layer of asbestos roofing paper, then a layer of 1-in. tongued and grooved plank, and finally a five-ply, felt and gravel roof. All down-spouts are made of 4¾-in. well casing, and all flashing, ventilators, etc., are to be of zinc instead of the usual galvanized iron. The gutters on all buildings are a part of the roof proper. They are made of wood and covered with felt and gravel, the same as the roof. The freight car repair shed is open at the sides and ends and the roof is supported by 8-in. x 10-in. posts resting on concrete piers.

*Locomotive Shop.*—The erecting, machine and boiler shops are combined in one building. It is a transverse shop with 34 doors opening to the transfer table. Ten pits are intended for the boiler shop and 24 for the erecting shop. These pits are to be served with one 70-ton electric traveling crane, which is equipped with power for hoisting only; and by one 15-ton electric traveling crane for general service which will also be used for moving the 70-ton crane. The main erecting shop has a 70-ft. span and a height of 40 ft. from the floor to the bottom chord of the roof trusses. There is a large lantern in the roof with glass in the sides and louvre ventilators in the ends. There are no skylights in any of the buildings, so that all light must come from the sides. On one side the run-way girders for the traveling cranes are supported on pilasters on the building wall, and on the other side they rest on steel brackets secured to the main columns. The machine shop bay of the building is 62 ft. wide and 24 ft. high to the roof trusses. There will be no traveling crane in this shop, but heavy tools will be served by jib cranes. The tool room, air-brake room and tin shop will occupy a lean-




General Plan of New Shops at Sedalia, Missouri Pacific.

Part Side Elevation of Erecting and Machine Shop.

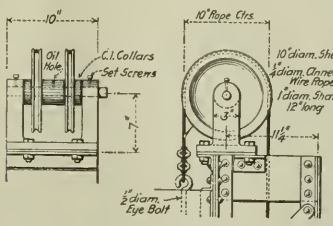



Cross-Section through Erecting and Machine Shop and Tool Room.

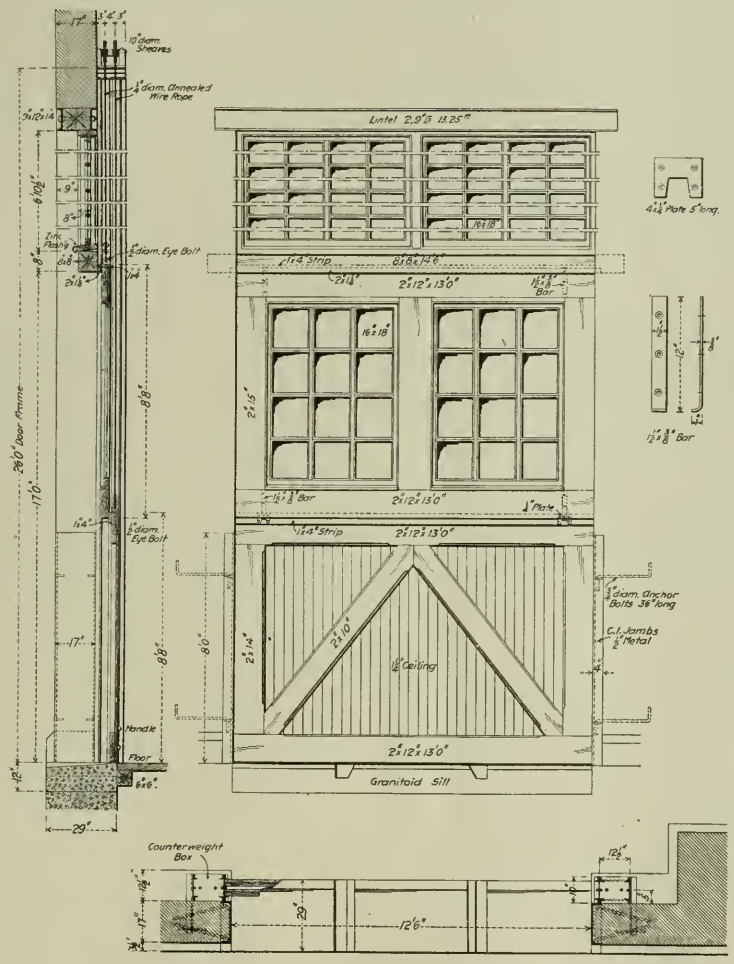
to, 160 ft. long and 35 ft. wide, alongside of the machine shop. The boiler shop riveting tower will be covered with cement plaster both inside and outside. All lantern walls in all the buildings are also to be covered with cement plaster.

*Power House.*—The power house is separated transversely into a boiler room and an engine room, each 49 ft. 5 in. wide, with a pump room 20 ft. wide between. Brick partition walls 13 in. thick separate the pump from the other rooms, and support the inner ends of the roof trusses spanning the boiler and engine rooms. The floor of the building is 5 ft. above grade, and a basement having 7 ft. headroom is below. The floor of the basement consists of 7 in. of granitoid laid over 8 in. of sand filling, while that of the building is concrete laid on I-beam supports. The entrance stairs of the building are concrete. The engine room will be served by a 15-ton hand-power traveling crane. The boiler room has a lean-to, which will furnish approximately 1,000 h.p.

*Other Buildings.*—The blacksmith shop is 244 ft. long and 100 ft. wide. The clear height to the roof trusses is 22 ft. There are no columns in the building, the trusses making a clear span from wall to wall. A large lantern with louvre ventilators extends nearly the full length of the building. The louvres are arranged so that they can




Detail of Counterweight Sheaves.




Locomotive Door for All Buildings.

16 ft. wide, for coal storage, coal being delivered from a trestle by gravity through the door openings. The chimney will be 175 ft. high and 7 ft. inside diameter, and will be built by the Alphons Custodis Chimney Construction Company. The contract for the power house equipment has not yet been let. There will be, however, five 260-h.p. water-tube boilers, furnishing steam at 150 lbs. to three Corliss compound non-condensing engines, and one high-pressure engine. The generators will deliver direct current at 245 volts to the switchboard. There will be three 200-k.w. units and one 75-k.w. unit, be closed in case of severe weather. This building will have a cinder floor.

The planing mill, which is 268 ft. x 80 ft., has a clear height to the roof trusses of 21 ft. There is no lantern and the only openings in the roof are for the 24-in. ventilators. There is a standard-gage track through the center of the building.

The coach and paint shops, on opposite sides of the transfer table, are both 312 ft. long, the former being 120 ft. wide and the latter 100 ft. They are three-bay buildings with steel, roof-supporting columns. The coach shop is two stories, the second floor being intended for upholstery and general repair work for coaches. There is a lean-to 22 ft. x 265 ft. on the west side, for a truck repair room, an 80 ft. car not allowing sufficient room in the main building for this work. There are stalls for 14 cars. The paint shop is of equal capacity, and has a concrete floor.

The freight car repair shed, already briefly described, is built of wood, and is open all around to a height of 8 ft. There are three longitudinal tracks, giving about 1,200 ft. of track space.

The storehouse and office building has three floors and a basement. The top story is quite low and is intended principally as an air space to improve the comfort of the offices on the second floor. The upper floors and the roof are supported by steel columns, there being a double row running longitudinally through the building. The first floor is carried on 20-in. 65-lb. transverse, and 15-in. 42-lb. longitudinal I-beams, the second floor on 10-in. 25-lb. I-beams, and the third floor on 9-in., 21-lb., I-beams. The floors are all dressed and matched plank, 2¾-in., 2½-in. and 2-in. respectively for the three floors of the building, secured to 3-in. x 8-in. nailing strips. A part of the building will be fitted up for offices for the mechanical department. The floors of all buildings not otherwise specified are 3-in. plank laid on 6-in. x 6-in. sleepers bedded in sand on cinders.

A detail of the locomotive door which will be used on all the buildings is shown in one of the accompanying drawings. It is made in two parts which are hung with separate counterweights and are raised vertically like window sash. The top sash has two window lights each made up of 12 panes of glass, 16 in. x 18 in., and the bottom sash is made with a single panel of matched cypress. Where these doors occur in long buildings, they are provided with a narrow wicket so that the building can be entered without raising the large doors. The two top and bottom sash are arranged with stop lugs so that the bottom sash engages the top sash when the former is raised half the height of the door, and both parts are then raised together to the full door opening. In closing the door the bottom sash is lowered first and when it has been pulled down half-way it engages with the top sash and both halves are lowered the rest of the way together.

Mr. E. Fisher, Engineer of Bridges and Buildings of the Missouri Pacific, has the supervision of the entire work, and all plans, etc., are submitted to him for approval. Mr. J. W. Schaub, Consulting Engineer, Chicago, has prepared all plans, specifications and bills of material for the buildings and power plant, and has charge of the entire work as consulting engineer for the railroad company. We are indebted to him for the accompanying drawings of the buildings and these notes concerning them.

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The Ganz and Finzi systems of alternating current traction will shortly be given competitive trials on the Valtellina branch of the Adriatic Railroad. One of the electric storage battery motor-cars of the Bologne-Modena branch of the railroad will be rebuilt and the experimental storage battery equipment will be replaced by a Finzi single-phase alternating current equipment. Four single-phase geared motors of 100 h.p. each will form the equipment. Step-down transformers will reduce the line voltage to 3,000. The maximum speed expected is 72 kilometers an hour and trains of 100 tons will be hauled. The storage battery cars of the Milan-Monza line have been withdrawn from service, after trials extending over four years.

## Traffic on Improved Waterways and Railroads in the United States.*

BY EDWARD P. NORTH, M. AM. SOC. C. E.

In one great source of national wealth, cost of transportation, which is not a natural product, the United States has an undisputed advantage over all other countries. Shortly before his death, Mulhall said that the average rate received by railroads of different countries for transporting a ton of freight one mile was, reduced to cents: United Kingdom, 2.80; Italy, 2.50; Russia, 2.40; France, 2.20; Germany, 1.64; Belgium, 1.60; Holland, 1.56; United States, 0.8. These figures show that our low cost of internal transportation has been the principal cause of our augmented wealth; an augmentation that was greater in the decade ending with 1900 than during the 80 years preceding 1870. For not only does a low freight rate allow more to be divided between producer and consumer, but it has a more potent effect in inviting the production of commodities which with higher freight charges could not reach consumers; thus adding greatly to the employment offered to labor and capital.

Any estimate of the beneficent effect of low freight rates on production is as liable to be governed by enthusiasm as by knowledge. Table 1, compiled from "Poor's Manual," the United States Census returns, and those of the Bureau of Statistics, shows the direct contributions made by our railroads to the wealth of the nation. The highest freight rate during this period was, in 1885, 1.057 cents, and the lowest, 1899, 0.726; since which time the rate has increased by about 5 per cent. to 0.764. If our rates had remained as in 1885 we would have paid $3,500,000,000 more for transporting our freight than we did, and if our freight rates had been equal to those of England, as stated by Mulhall, and with as large a volume of business possible at such rates, the cost would have been nearly $33,000,000,000 greater, or more than our increase in wealth during the last decade. Our railroad freight rates are the lowest in the world, and this is probably true also of our coastwise freight rates. The low cost of assembling and distributing our commodities has also had an important influence on their production and consumption.

TABLE I.—RAILROADS OF THE UNITED STATES.

| Years. | Average Per annum: Tons of freight shipped. | Ton-miles. | Freight earnings. | Haul, miles. | Per ton-mile: Freight earnings, in cts. | Per capita. | Au'l paym't for freight, per capita. |
|---|---|---|---|---|---|---|---|
| 1885-89 | 536.0 | 60,523.0 | 602.4 | 113 | 0.995 | 1.031 | $10.26 |
| 1890-94 | 717.4 | 83,524.6 | 764.0 | 116 | 0.915 | 1.283 | 11.73 |
| 1895-99 | 841.6 | 104,371.0 | 817.2 | 124 | 0.783 | 1.457 | 11.41 |
| 1900-02 | 1,116.0 | 148,915.0 | 1,125.0 | 133 | 0.755 | 1.918 | 14.49 |

NOTE.—Figures in 2d, 3d, and 4th columns should be multiplied by 1,000,000.

It is noticeable that we have reached this distinctive position as transporters with the highest wages paid for labor known, and until lately with a higher cost for materials than our neighbors and competitors. But both the high wages and high prices have, by stimulating production and consumption, added to the volume of freight moved and reduced its cost.

We have had, until lately, freedom from those laws based on the theory of vested interests which are used both to prevent improvements and solidify monopolies, while our development has been aided by subsidies of various kinds from both State Governments and the General Government, to which local aid has often been added. Since our organization as a nation we have been pre-eminent for the energy and persistence with which we have developed and improved such aid to our wealth as is offered by water transportation. Improvement of the Mohawk west of Schenectady, the precursor of the Erie canal, commenced with the adoption of our constitution, and concurrently the navigation of many streams falling into the Atlantic was improved and extended. Our canal-building era was virtually inaugurated by the building of the Erie canal connecting the navigable waters of the Hudson river with all of our Great Lakes under legislation by the State of New York in 1816. The great influence on land values of this canal after its completion in 1825, and its success as a channel for transportation, led not only to more or less successful efforts to connect the James, the Potomac, the Delaware and the lakes above Niagara with the affluents of the Mississippi, and to many less important projects, but also to such an enlargement of the Erie canal, authorized in 1835, so that the burden of boats could be increased from 40 to 240 tons.

The net area of lands granted by Congress to States, Territories and Corporations has been: In aid of railroads, 162,000,000 acres; in aid of canals, 4,433,000 acres; in aid of wagon roads, 2,554,700 acres; 168,987,700 acres in all.

On the 6th of April, 1802, the United States entered on its policy of River and Harbor Improvements with an appropriation of $30,000 for the improvement of the Delaware river. Up to March 3, 1903, the sums appropriated on this account have reached the aggregate of $451,344,907.20. During the 58 years ending with 1860 but a little more than $16,500,000, or less than 4 per cent. of this sum, had been appropriated. Taking the appropriations for these improvements by decades we have:

| | |
|---|---|
| 1861-71 | $17,290,445.80 |
| 1871-80 | 60,440,417.96 |
| 1881-90 | 111,687,724.36 |
| 1891-1900 | 175,372,564.22 |
| 1901-March 3d, 1903 | 70,067,231.24 |

Approximately 55 per cent. of this sum has been expended on the improvement of rivers, 35 per cent. on harbors and 10 per cent. on canals. The total expenditure by the Government for all harbors and waterways on the lakes above Niagara has been $68,000,000. Of this sum probably about $40,000,000 has gone to lake harbors.

Excepting a few instances, and then but for a short time, the rivers, harbors and canals improved and built by our Government have been absolutely free from charges for their use. While a large proportion of the money expended for improvements has gone to important centers, and the main lines of distribution minor streams and small harbors have not been neglected.

Trunk line railroad building in the United States was inaugurated at "a meeting of a number of citizens to take into consideration the best means of restoring to the City of Baltimore, that portion of the western trade, which has lately been diverted from it by the introduction of steam navigation, and by other causes," held in the City of Baltimore, Feb. 12, 1827. This meeting resulted in a charter for building a railroad from Baltimore to the Ohio river. At substantially the same time, May, 1828, Congress appropriated $1,000,000 in aid of the Chesapeake and Ohio canal, which was also to connect the waters of Chesapeake Bay with the Ohio. The Hudson & Mohawk Railroad, which has developed into the New York Central & Hudson River Railroad, was built to abridge the delay to canal traffic caused by the 22 locks between the Hudson river and the Schenectady level of the Erie canal. The Boston & Albany was built to divert trade at the eastern terminus of the Erie canal from New York to Boston. The South Carolina road was projected to connect the harbor of Charleston with the Ohio at Cincinnati.

The first roads were built under special charters, which were generally obtained without difficulty, except in such cases as the Pennsylvania's objection to the Baltimore & Ohio reaching Pittsburg, on the honest plea that there could not be traffic enough for two roads. The menace to invested capital, now so strenuously insisted on, is a doctrine hardly 25 years old with us. Afterwards the more enlightened States passed general railroad laws, under which any persons filing the requisite papers became a body corporate, and could make the necessary surveys, and build as much road as they could finance. Only one State, New York, ever penalized a railroad. The Utica & Schenectady, now a part of the New York Central & Hudson River Railroad, was for a time prohibited from carrying freight, whether the canal was closed by ice or not, and the railroads which formed that system paid canal tolls to the State on all freight carried until 1851.

The Government of the United States gave a great impetus to railroad building by its legislation of Sept. 20, 1850, giving to a trunk line railroad between Lake Michigan and the Gulf of Mexico, substantially, six square miles of land for each linear mile built. This aid was so continued that every State and Territory west of the Mississippi and five States east of it, viz.: Alabama, Illinois, Mississippi, Michigan and Wisconsin, are indebted to land grants, in a greater or less degree, for their transportation facilities. In aid of the Texas Pacific the land grant was 40 square miles, through the territories, per mile of road. The Union and Central Pacific Railroads, with some of their branches, in addition to a land grant of 20 square miles per mile of road, amounting to nearly 32,000,000 acres, secured a loan of Government 6 per cent. 30-year bonds, varying with the difficulty of construction from $16,000 and $32,000 to $48,000 per mile. This loan was in the aggregate $62,652,952, of which the Union Pacific received $27,236,172 and the Central Pacific received $25,885,120. These loans were repaid with outstanding interest about 1898, excepting a small default on the part of one of the branch roads. This combined aid was sufficient to induce the Union Pacific to build 535 miles in one year and 20 days.

The British Government in 1853 subsidized its main lines of steamers "to afford a rapid, frequent and punctual communication with those distant ports which feed the main arteries of British commerce, etc."; refusing aid to, if not oppressing, internal communication. On the other hand, the Government of the United States, and also individual States, counties and localities, subsidized the turnpikes, watercourses and railroads almost entirely, for the improvement of internal communications, and neglected or oppressed our efforts to reach distant ports. England is pre-eminent as a shipbuilding and ship-sailing country, but its people pay the highest internal freight rates known. America now has a contemptible merchant marine, but its internal freight is handled at a rate unapproached in other countries. If, as has been lately urged, our Government was unable to develop at one time both foreign and internal communica-

*Extracts from a paper read before the International Engineering Congress, at St. Louis, Oct. 5, 1904.

tions, it has apparently adopted the most profitable alternative, although our annual payments to foreigners for over-sea freights are said to exceed the receipts from either custom dues or the internal revenue tax.

While the land subsidies granted by the Government in aid of turnpikes, canals, colleges, etc., have not generally hurried the lands granted into cultivation, it is noticeable that in the case of land granted to railroads the recipients have had a financial interest, strong enough to be a governing interest, in its quick distribution in small holdings, as the possible ultimate value of the land is secondary to the development of traffic on the road. The Immigration Bureau is greatly aided in its efforts by low freight rates. As the cost of transportation is vital in the eyes of the prospective buyer, its cost has been kept down on non-competitive branches. The beneficent results following the practices of the land-grant aided railroads have not, however, prevented the "friends of the plain people" exhibiting fierce opposition to the development of our unsettled areas through the aid of land grants or other forms of subsidies.

The free development of railroad building and the fall in freight rates have been impeded to some extent by the action of State Railroad Commissions. The first of these, for the State of Maine, was appointed in 1853. There are now 34 of these commissions. At first their action was doubtless beneficent, but in some States the appointment of commissioners seems a perquisite of the railroads, and, as notably in the State of New York, it seems virtually impossible for an oppressed community to secure better accommodations or lower rates by investing their own money in a railroad which may reduce the profits of an existing line, all such efforts being apparently held by the commissioners, as well as the stockholders of existing lines, to be a piratical venture and a speculative strike of more or less colossal magnitude. The railroads of New England, dominated by the most respectable and highly appreciated Commissions, exact the most onerous charges on traffic known in this country, and have driven nearly all heavy manufacturing out of their territory.

A considerable amount of the 451 million dollars appropriated by the Government for the improvement of rivers and harbors, has been expended on isolated or semi-isolated projects, where the statistics covering the consequent development of traffic are not available without great research. In other cases like the 18,500,000 net tons of freight traffic found 12 years ago on the Hudson river, or the 11,610,000 tons of freight carried on 11 improved tributaries of the Ohio in 1902, as reported by the Department of Commerce and Labor, no idea of the cost of freightage is given. Nor are the rates charged on the total traffic of the Great Lakes given in the report of the same department, which gives the average arrivals and departures in domestic trade for the two years 1902-03 for which statistics have been gathered as 74,390,000 and 74,340,000 net tons of freight. During the same two years the average imports of foreign merchandise at these lake ports have been valued at $61,187,000 and the exports at $88,076,000.

As the natural depth at most harbors on the Great Lakes was originally about 6 ft., and not more than 8 ft. could be carried over the St. Clair Flats, above Detroit, this large traffic would be impossible without the increased depths made by the expenditures authorized by the various river and harbor bills. The first appropriation, 1823, was for the harbor of Erie. Ohio followed in 1825 with appropriations for Cleveland and Fairport. Buffalo did not get an appropriation from the Government until 1826, Chicago in 1833, and the St. Clair Flats received its first appropriation, $20,000, in 1852.

In 1852, Congress gave the State of Michigan 750,000 acres of public land in aid of a canal connecting Lake Superior with Michigan, Huron and Erie. This canal, built for the State by an incorporated company to which the land was transferred, was opened June 18, 1855, with two locks of 9 ft. lift, each 350 by 70 by 11½ to 12 ft., to overcome the 18 ft. difference of level at the Falls of St. Mary, or, as it is generally known, the "Soo." The Government took over this canal from the State of Michigan, June 9, 1881, and completed the "Weitzel" lock, 515 by 80 by 17 ft., Sept. 1, 1881, and the "Poe" lock, 800 by 100 by 22 ft., August 3, 1896. The Canadian Government had in the meantime built a lock 900 by 60 by 22 ft., opened Sept. 9, 1895. The depths of lake channels, in general, have been less than the depths on the lock sills. Tolls amounting to $778,128.41 were collected on the 19,414,242 net registered tons of shipping passing through the canal in the 26 years, including 1880, that the canal remained State property. They were 6 cents per net registered ton until 1871, 4½ cents until 1879, and after that 3 cents. Since 1880 the traffic through both the American and Canadian locks has been free.

Since 1887 the U. S. Engineers in charge of the canal, with the co-operation of those in charge of the Canadian Canal, have kept and published statistics which are among the most valuable in the history of transportation. From these data Table II has been compiled.

*TABLE II.—Freight Tons Passing the Soo.*

| Year. | Tons. | Total value. | Value per ton. |
|---|---|---|---|
| 1851..... | 12,600 | $1,675,000 | $133.00 |
| 1861..... | 88,000 | 6,000,000 | 68.00 |
| 1871..... | 585,000 | 13,000,000 | 22.00 |
| 1881..... | 1,568,000 | 30,000,000 | 19.00 |
| 1891..... | 8,889,000 | 128,000,000 | 14.50 |
| 1901..... | 28,403,065 | 289,916,865 | 10.20 |
| 1903..... | 34,674,437 | 349,405,014 | 10.08 |

The Engineer Officers' statistics of the traffic through the "Soo" show that the difference on an equal classification between the actual and railroad charges is nearly four times the total expenditures for river and harbor improvements by the Government.

As only 41½ of the 958¼ miles between Duluth and Buffalo have required improvement to accommodate vessels of 20-ft. draft, and the same improvement has sufficed for the 885 miles between Chicago and Buffalo, the combined traffic on these routes being without an equal in any other channel, no other improvement undertaken by our Government has had so beneficent an effect on our national wealth, nor has returned so large a dividend on the money expended.

It is not proposed to refer to the economies, many of them calling for large expenditures, by means of which our railroads have become the chief of the labor saving appliances, not only of this country but of the world. But aside from the influence of our, one time, free railroad building, these economies have in almost all instances been forced on our railroad managers by the competition of improved waterways; which, while their traffic fed, and was fed by, the railroads, cut rates to an extent that called out extreme effort in the attempt to compete on a paying basis. This competition has resulted in our being able to produce and ship a third more freight per capita, despite our longer haul, than any other people, and has filled our country with consumers, who, as James Bryce says in his "American Commonwealth," "allow themselves luxuries such as the masses enjoy in no other country." And the traffic in luxuries as well as in passengers is generally transported by rail.

There has been one noticeable instance in which the railroads led in improvements to waterways, forcing the deepening of the lake channels. This was a consequence of the rate wars of the seventies, which covered much of the United States, but were most intense between the roads connecting Chicago with New York. Under this rivalry the lake commerce seemed to be dying. The situation at that time is tersely and ably described in the "Report of the Committee on Canals of New York State, 1899," made to Governor Roosevelt. It says:

"In 1875 the total tonnage on the lakes was nearly 600,000 tons. . . . The traffic, as estimated by entrances and clearances at American ports, was for that year about 15,000,000 tons.

"This development had, however, been secured without any material increase in the size of the vessels in use—a limit being placed on size by the depth of water in the harbors and in the channels connecting Lake Erie and Lake Superior with Lake Huron and Lake Michigan. By 1875 the advance in railroad construction and management had reached a point which enabled the railroads to compete with the lake vessels; and when to this was added the railroad rate wars of the next few years there was not only a cessation of increase in lake commerce, but a positive decline both in equipment and traffic. New construction of vessels, which had reached as high as 73,000 tons in 1874, was only 7,000 tons in 1877, and averaged only 13,000 tons a year for the five years ending in 1880. In the latter year all the vessels on the lakes aggregated only 560,000 tons, 30,000 less than five years before.

"The beginning of the new decade marked a significant revival in lake commerce, which cannot be disconnected from the improvements in lake harbors and channels undertaken by the national government. The most important work brought to completion at this time was the openinng of the ship canal with an 18-ft. draft, which took the place of the 12-ft. canal and locks maintained by the State of Michigan at Sault Ste. Marie, but other works were well under way, which have had for their ultimate aim the securing of 20 ft. of water in all the main channels and important harbors on the lakes."

If the existence of the lake business as well as the lake marine, had not been threatened by the development of improved methods of conducting railroad traffic, it may be doubted if Government would have received sufficient support to justify it in entering on the heavy expenditures necessary for navigable channels 18 and eventually 20 ft. in depth. There is always available such testimony as was given in 1870, by one prominent in lake commerce:

"It had been clearly established that vessels of over 700 or 800 tons were not so profitable on the lakes as vessels of a smaller size. Nature has placed barriers in front of most of our harbors, also wide flats across some of our greatest thoroughfares, that will, in spite of art, for ages to come, make it necessary to build lighter-draft vessels. Sail vessels of over 800 tons could not safely navigate the lakes even if harbors were deep enough."

Such testimony, by an authority, is always available and influential in procuring delay and insufficient improvements unless there is a strong interest capable of organization to confute it. And as the nearly accomplished improvement has resulted in 19 vessels, carrying over 8,000 net tons each,

passing the Soo last year, the testimony seems confuted.

The United States possesses no noticeable superiority in natural resources, and is handicapped by the necessity of finding money to do in a part of a century that for which other countries have taken nearly a thousand years. It has in the aggregate exhibited a superiority in general honesty of purpose and in the broad-mindedness of its legislators, both national and local. It is largely through legislation, notably and peculiarly in its help to all schemes for increasing wealth by diminishing the cost of interchange between producers and consumers, that this country has attained its superiority. From the fairly equal distribution of subsidies and direct payments between waterways and railroads, there has issued a system of mutually beneficent rivalry, in that the railroads often own boat lines and the boat lines have owned railroads, which has given a higher remuneration to the producer, and a lower cost to the consumer, than would have been possible under any other system.

As a result our internal commerce for 1902 is estimated at $20,000,000,000. This estimate is based on one transaction in each of the leading classes of commodities produced in the several different divisions of national industry. Our foreign commerce amounts to nearly 12 per cent. of this sum, and 6.8 per cent. of it suffices to settle our foreign balances, and pay for our foreign transportation with such luxuries and raw materials as we require from other countries.

Exclusive of the benefits derived from land grants, there seems to be no reason why any other country should not develop its transportation systems in a manner analagous to that pursued by the United States and reap as substantial a reward.

## The Stansstad-Engelberg Electric Railway.

BY EMILE GUARINI.

The narrow-gage electric railway between Stansstad and Engelberg is another of those electric-mountain roads of which Switzerland furnishes so many interesting examples.

Motor Car—Stansstad-Engelberg Railway.

The road was built by Brown and Boveri, and has a length of 22½ kilometers. The current is transmitted in the form of a three-phase current of 750 volts, one of the phases being connected to the rails which are laid one meter apart. A distinguishing feature of this mountain line is that, although the grades vary from level to 5.8 per cent., the car is at times propelled by its own motor, at other times it trails motorless cars behind it, and again the train is drawn by locomotives at the points where the grade is the heaviest.

Over a distance of 21 kilometers the ordinary adhesion of the car to the rail furnishes sufficient traction; for 1½ kilometers, however, a rack and an extra engine is used. The rack section is close to the central power station, and since it requires the greatest expenditure of energy, it receives the triphase current at 750 volts direct from the alternators. For the rest of the line the current from the alternators at 750 volts is transformed into a current of 5,300 volts, whence it is sent out on the high tension line to be stepped down again by two transforming stations to 750 volts, the working tension. The central or generating station is at Obermatt, near the terminal point at the Engelberg end.

The power is obtained from several springs which feed a covered reservoir of about 100 cu. meters capacity. A conduit 1,634 meters long leads from this reservoir to the turbine house. For about 230 meters, cast-iron pipes, 300 millimeters in diameter, having a thickness of from 7½ to 8½ millimeters, are used. The effective fall is 390 meters. The power-house, to which is annexed a harn for the locomotives and a repair shop, contains three generators and two exciters. Each of these machines is coupled direct to a horizontal axle water turbine. The three groups of electric generators are 180 h.p. each and run at 650 revolutions, while the exciters are 12 h.p. each. The large turbines are regulated by hydraulic governors. The exciter turbines, on the contrary, have no governors, for the load of the exciters is kept constant by a compensating resistance in the field circuit of the generators. The exciters and generators are coupled in parallel. A special apparatus is provided, which, in case a high tension wire should break, cuts out automatically the exciters from the dynamos.

A Transformer Sub-Station.

A sub-station is at Dallenwyl and at Stans. The line starts from the steamboat landing at Stansstad and runs on a level as far as Stans. After leaving Stans the line turns toward Oberdorf, whence it follows the left bank of the Aa, which it crosses beyond the station of Dallenwyl by means of a bridge 35 meters long; from here it runs to Grafenort by way of Wolfenschissen. At this

Three-Phase Electric Locomotive.

A Steep Grade on the Stansstad-Engelberg Railway.

point the road ascends a grade of 5 per cent. Upon a viaduct the line now crosses the Kaltebach and comes into Obermatt, where the cog-wheel section begins and runs along for 1½ kilometers over a 5 per cent. grade. In the middle of this rack ascent is the station of Grünenwald; immediately after leaving this station the line cuts the cantonal highway which crosses it about one meter above the rails. Since both the roads have curves at their point of crossing, it did not seem feasible to have a grade crossing, especially since there is extensive teaming on this cantonal highway and there was fear that the proper maintenance of the rack would be made difficult. On the other hand natural characteristics did not permit the cheap building of a tunnel or cut. Under these conditions the only feasible plan was to build a lift bridge, which was finally done. The construction of the lift bridge was difficult because the contact wire must be elevated to a great height above the highway and also above the level of the rails which are below the road. It became necessary to use a system that would permit the elevation of the contact wire sufficiently to allow the passage of vehicles of all sizes as well as to arrange the parts so that the opening of the bridge should automatically lower the contact wire into a position that would permit the passing of the train. The bridge is worked entirely by hand, the opening of the bridge and the lowering of the contact wire requiring no more than a minute.

From Gherst, at the terminus of the cog road, the track runs over an easy grade to Engelberg. Much blasting was needed for the completion of this section of the road on account of the rocky nature of the ground, and not infrequently sustaining walls, several hundred meters long, had to be built.

The rails are the Vignolle type, 10½ meters long, and weighing 20 kilogrammes per meter. They rest upon iron ties that weigh 30 kilogrammes each; eleven of these ties per rail are laid except on the rack section, where 12 to a rail was found preferable. The rack is of trapezoidal form and is made of two parallel plates between which are riveted the cast steel teeth. It weighs 52 kilogrammes per meter and is laid in segments, each 3½ meters long. In order to insure the meshing of the cog-wheels at the entrance of the rack, this latter is terminated by a segment resting upon springs and joined to the line in such a manner that it may be lightly depressed in a vertical plane.

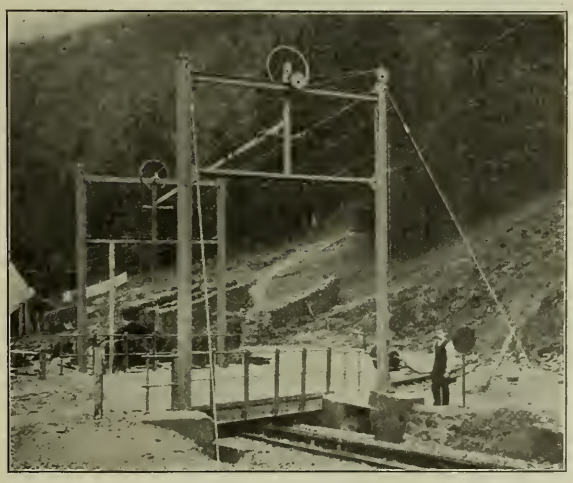
The buildings of the several stations are wood and brick. The stations are lighted electrically by means of small transformers fed from the trolley wires, and which reduce the tension to 110 volts. At Stansstad there is a barn for five motor cars, also a repair shop and a depot for materials and tools.

The entire line is divided by section insulators into five divisions which are independent of each other, being fed separately. Between the feeders and the trolley wires are fuse blocks which act as interruptors. These fusible cut-outs are placed in metallic boxes on poles. The feeders, which are formed of two copper wires 7½ millimeters in diameter, have a total length of 4,200 meters, and are carried on porcelain insulators attached to the trolley poles. The high tension line consists likewise of two wires, but they are only 3½ millimeters in diameter and extend over 11 kilometers. They are supported upon another line of poles. These poles are eight meters high and are, for the most part, placed close to the track, at a distance of 80 centimeters from the trolley poles, being braced by struts outside of the track. Wherever the high tension line crosses highways or above lines of telegraph, telephone or trolley wires, they are surrounded with net work in order to avoid any accident that might arise from the breaking of one of them. Upon the caps that cover the trolley-wire poles is carried the telephone line, which is composed of two silicious bronze wires 2 millimeters thick, having cross connections at about every 100 meters. The high tension line is protected from lightning by horn lightning-arresters, while for the trolley wire the Westinghouse lightning arresters have been adopted. In the neighborhood of Stans the three-phase current line crosses the Stansstad-Stans tramway, which is operated by direct current, so that a special arrangement for the crossing as well as for the ends of the trolley or contact poles was necessary.

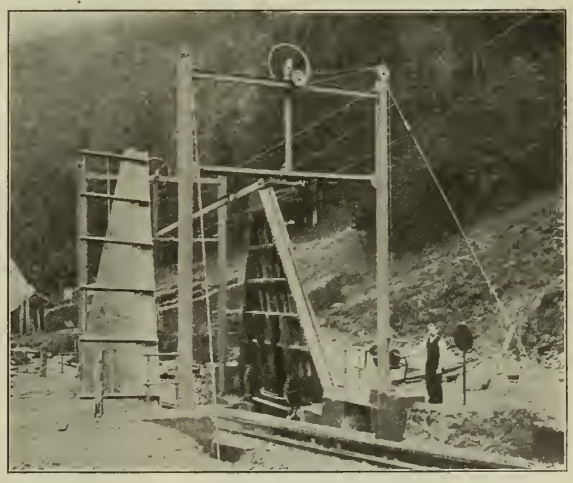
The locomotives weigh about 12 tons. They have two three-phase motors of 75 h.p. each, wound for 750 volts and making 650 r.p.m. These motors weigh two tons each. Both motors work in common upon a single toothed wheel keyed upon an intermediate

A Level Portion of the Stansstad-Engelberg Railway.

Beginning of Rack Road at Overmatt Station.



Lift Bridge (Closed)—Stansstad-Engelberg Railway.



Lift Bridge (Open)—Stansstad-Engelberg Railway.

shaft, which communicates its power by a simple train of gears to the axle carrying the cog which engages the rack. Upon the stretches where simple adhesion to the track is sufficient, a friction clutch allows the motors to work direct upon the axles. The speed of the locomotives is five kilometers per hour on the cog-wheel section and twice that upon the other sections. Three entirely independent systems of brakes are available for stopping the locomotives. They are: (1) A hand brake bearing directly upon the supporting wheels. (2) A hand brake acting upon the cog-wheels. (3) An automatic speed limiting brake. This brake may be controlled by the hand of the motorman on the locomotive, or by any of the motormen on the train. This brake is constructed in such a manner that when a certain determined speed limit is exceeded the flow of the current is automatically interrupted and at the same time the brake bearing upon the cog-wheels is brought into action. Moreover, the motors act as automatic brakes, whenever the down grades are such that the speed of the motors exceeds more than about 4 per cent. of the normal speed during the ascent. The contact device consists of two double bows which are fixed upon the roof of the locomotive by means of two frames furnished with spring tighteners. The lighting current is obtained from small transformers.

The motor cars are mounted upon two four-wheel trucks. Their length is 14 meters and they weigh 14 tons. They are divided into second and third class compartments, affording seats for 46 persons; and also have a small compartment for baggage. On the axles of the forward truck two three-phase motors of 35 h.p. each are mounted. They are wound for a tension of 750 volts and make 480 r.p.m. Each motor weighs 950 kilogrammes. A train of gears transmits the power to the driving wheels. The cog-wheels are cast steel and their lower peripheries run in an oil well. The rear truck is furnished with a brake that acts upon the cog-wheel. This has been installed as an auxiliary to the powerful hand brake. The current is taken from the contact wires in a manner similar to that described for the locomotives. The maximum speed is fixed at 20 kilometers an hour. Starting is made in a gentle, hardly perceptible manner. For lighting the car, a small transformer is in one corner of the baggage compartment, whereby the current taken from the line is reduced to 100 volts. The cars are heated by means of 14 heaters grouped in sevens and connected in series cut in between one of the contact wires and the rails. A motor car is capable of drawing a second car weighing 10 tons at the rate of 20 kilometers an hour, upon a grade of about 2.3 per cent. Upon those stretches where the gradients vary between 1.5 and 3.0 per cent. the cars run alone at about 20 kilometers per hour. When mounting the steep grades of 5.8 per cent. they require from 80 to 90 h.p. for a load of 16 tons. After leaving Obermatt the cars are pushed by one of the locomotives to the top of the rack road. On this run the car is not coupled to the locomotive, so that in case of accident either unit can act independently.

From Gherst, which is at the summit of the rack road, to the terminal station at Engelberg, the cars continue the journey unassisted. When the cars descend the steep grades the motors act as generators. The energy thus restored, and the load removed from, the generators at the central station would cause the turbines together with their dynamos to race, but to avoid this the dynamos may be loaded with liquid resistance, and for this purpose the spillway canal has been used. Trials have been made which show that, when a train of 28 tons descends the rack road, the energy restored to the central station equals 75 h.p. This energy, except where it is consumed in carrying a like train up the incline, must be absorbed by the liquid resistances and a little more if the generators are not to be permitted to run altogether light. Since the company controls a water power more than sufficient for its needs no provision has been made to automatically cut out this resistance when not required, consequently it is for the greater part of the time included in the circuit. This is an installation which does honor to Brown and Boveri, of Baden. The traffic from the Lake of the Four Cantons towards Engelberg is heavy, particularly in the summer season.

## Railroad Shop Tools.

(*Continued.*)

RADIAL DRILLS.

The accompanying illustration, Fig. 1, shows a semi-radial drill made by the Bickford Drill & Tool Co., Cincinnati, Ohio. The head is a single casting and is adjustable on the arm by a spiral gear. The spindle is made of hammered steel; it is provided with both hand and power feed and with quick advance and return movements. The machine has three rates of feed ranging from .008 to .016 in. per revolution of the spindle. The driving mechanism contains seven gears by which five changes of speed can be obtained ranging from 50 to 170 r.p.m. The frame of the machine consists of five parts, the base, the column, the cap, the arm and the arm shaft. The construction of the bearing for the upper cone pulley is shown in the line drawing, Fig. 2. The general dimensions of the machine are:

| | |
|---|---|
| Traverse of spindle | 18 ins. |
| Horizontal range of head | 3 ft. 6¾ ins. |
| Receives under spindle over table | 24 ins. |
| Receives under spindle over base | 4 ft. |
| Receives under spindle over floor | 4 ft. 7 ins. |
| Drills work in plane of base of center of | 8 ft. |
| Size of table, working surface | 20 x 20 ins. |
| Size of base, working surface | 3 ft. x 4 ft. 1 in. |
| Distance from floor to extreme height of spindle | 9 ft. 4¼ ins. |
| Floor space required | 9 ft. 3 ins. x 11 ft. 9 in. |
| Weight, net | 6,500 lb |

The 72-in. radial drilling machine, Fig. 3, is made by William Sellers & Company, Philadelphia, Pa. The spindle of this machine is 2½ in. in diameter and it has an adjustment of 17¼ in. The maximum distance from the center of the spindle to the center of rotation of the arm is 59 in. The greatest distance from the floor to the nose of the spindle is 67 in. The drilling-head arm has a power-vertical adjustment. The spindle is counterbalanced and is fitted with friction feed. The slotted work table is 24 in. square by 30 in. high. The countershaft pulleys are 10 in. in diameter by 4 in. face and should run at 110 r.p.m.

The machine shown in Fig. 4 is a 6-ft. arm, plain radial drill made by the Fosdick Machine Tool Company, Cincinnati, Ohio. The column of this machine is of box section cast in one piece, and it is bolted to the base. The saddle which carries the radial arm is gibbed to the column, and is raised and lowered by power. The arm is of box sec-

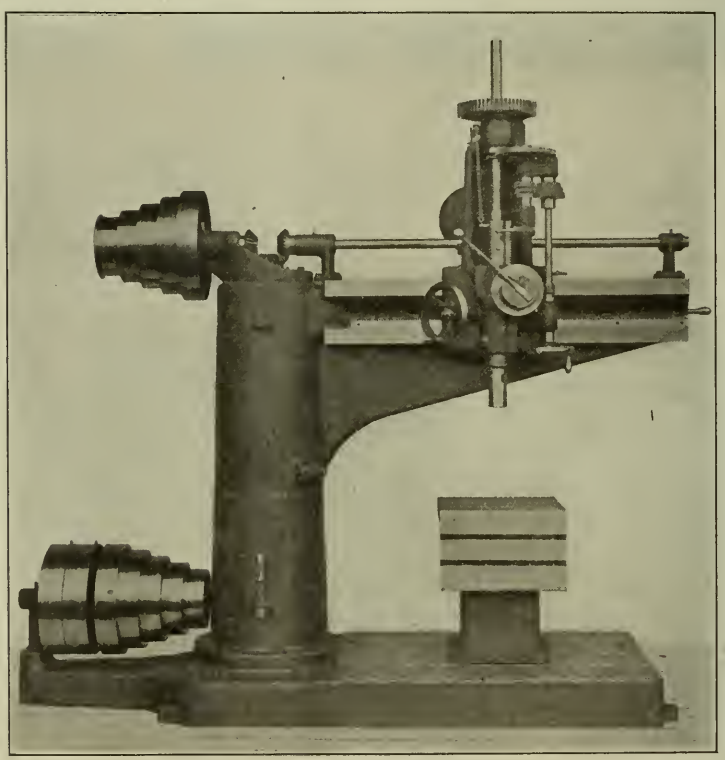


Fig. 1—The Bickford Radial Drill.

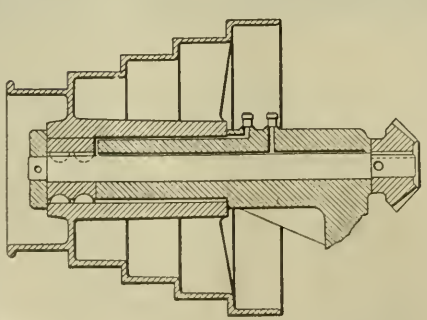


Fig. 2—Detail of Upper Cone Bearing.

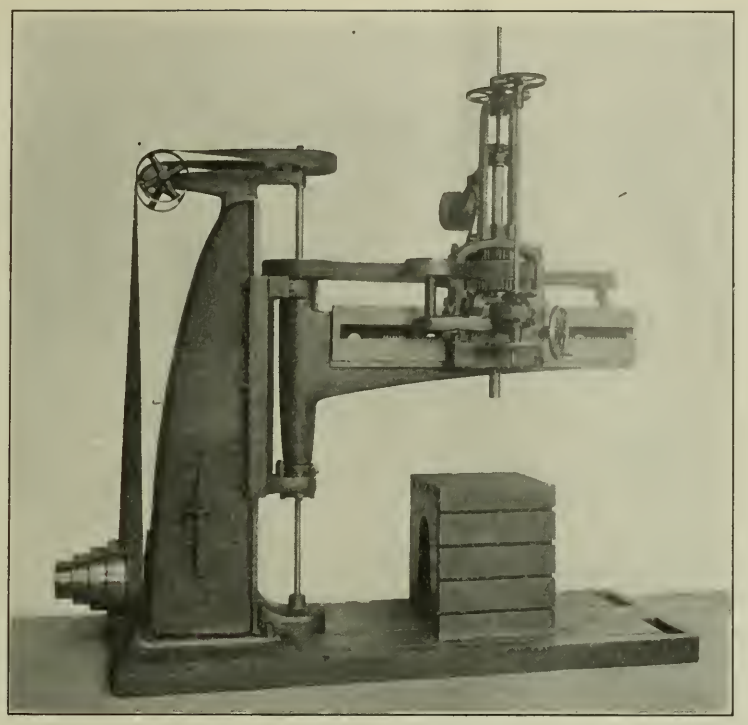


Fig. 3—The Sellers Radial Drill.

tion and well ribbed. Its weight is carried on ball thrust bearings which permits of its swinging freely when unclamped. The back gears and tapping device are located on the spindle head, and are arranged so that they can be engaged or disengaged without shock while the machine is running.

The positive geared feeds are eight in number and can be operated by hand or power. They are arranged in geometrical progression from .007 to .064 in. per revolution of the spindle. The spindle is counterbalanced and has 18 changes of speed ranging from 113 to 300 r.p.m. It is provided with automatic stop and quick advance and return. All operating levers are located on, and travel with the head, and are always directly in front of, and convenient to the operator. The lever for the tapping device starts, stops and reverses the spindle and when used in connection with the back gear lever, taps can be backed out at three times the tapping speed.

The speed box gives any one of six speeds, obtained by shifting the speed changing lever to positions as indicated on an engraved speed plate attached to the box. The drive is positive and is arranged so that the driving gearing is always started at a slow speed. The initial speed device overcomes the inertia of the gears and shaft and prevents any strain that might be caused by throwing in the regular shifting gears.

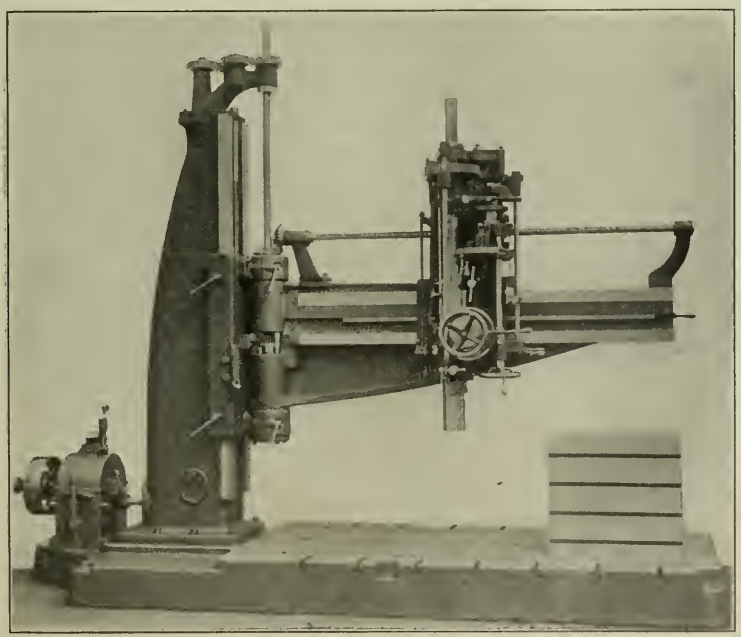


Fig. 4—The Fosdick Radial Drill.

The machine will drill to the center of 144 in. The traverse of the spindle is 20 in.; the minimum distance from the column to the spindle is 22 in.; the traverse of the saddle on the column is 50 in., and the traverse of the head on the arm is 54 in. The maximum and minimum distance of the spindle to the base plate is 72 in. and 22 in. respectively. The table is 24 in. x 27 in. and is 24 in. high. The total height of the machine is 11 ft. 1 in., and the highest position of the spindle is 11 ft. 11 in. The floor space required for the machine is 12 ft. 6 in. x 14 ft. 2 in., and the net weight is 14,115 lbs.

*(To be continued.)*

## The Substitution of Electricity for Steam as a Motive Power.*

Ever since the first electric tram line was built in the Industrial Exhibition at Berlin in 1879, the possibility of using electricity as motive power on railroads has been discussed, and it may be claimed that for suburban traffic the superiority of electric motors over steam locomotives has been firmly established.

Such lines have been successfully in operation for some years near Milan and in other parts of Northern Italy, where the water-power of the Alps could be utilized, others have been started in Switzerland, Germany and France, while in the United Kingdom, the North Eastern Railway Company works its suburban lines near Newcastle by electricity, and the Lancashire & Yorkshire runs electric trains between Liverpool and Southport, and in London the conversion of the Metropolitan and Metropolitan District Railways is in active progress.

Naturally, the introduction of electric motors for working long-distance traffic has received considerable attention, and almost from the first the idea of accelerating the service was connected with that suggestion. A first attempt to solve the problem was made by M. Heilmann, who did not exactly substitute electricity for steam as a motive power, but placed a steam-driven generating plant on his locomotive to supply current to the electric motors which propelled the vehicle. Such locomotives were used for some time to work long-distance traffic; their use, however, has not been extended, although their introduction would not require any capital expenditure for altering the permanent way, or for the erection of central stations for generating electricity.

When secondary batteries were first introduced to public notice the promoters suggested constructing an electric locomotive which should carry its supply of electric energy in secondary batteries, but this idea was never carried out, as the weight of the cells required for a long journey is far too great, at least as long as the present form of accumulators has to be used. For the same reason it would be economically impossible to replace the propelling machinery of steamships by electric motors supplied with current from secondary batteries, in all cases where the batteries cannot be frequently recharged.

Judging by these failures, the way to introduce electric motors on main lines appears to be indicated by the success of tram lines and suburban railroads. In this direction experiments were carried out by Siemens & Halske, first at their own works and later on an experimental line near Gross Lichterfelde, but the shortness of the line

*Abstract of a paper by Alexander Siemens, M. Inst. C. E., presented before the International Engineering Congress, St. Louis, October, 1904.

prevented their making much progress, and they applied to the German Government for permission to equip a suitable length of the Government railroads.

During the negotiations with the Government a powerful syndicate was formed for carrying out the experiments on a suitable scale, and the results obtained on the experimental line between Marienfelde and Zossen have been officially stated by the syndicate in three yearly reports. The line is the property of the War Office, and was built for slow goods traffic. It is about 30 km. long, almost level and has no curves with a radius less than 2.000 m.

In 1901 the first set of experiments were carried out, which proved that the existing permanent way was unsuitable for any speeds exceeding 120 km. (75 miles) per hr. The next year was occupied by further preliminary investigations, and it was only in 1903, after the permanent way had been relaid in a manner equal to the construction adopted on the first class main lines of the German Government, that the real high-speed runs could be attempted.

For the purpose of these experiments two cars were built by v. d. Zuypen and Charlier, of Cologne, and their electrical equipment was supplied by the Allgemeine Elektricitäts-Gesellschaft and by Siemens & Halske, respectively, while the necessary current was supplied by the Berliner Elektricitäts Werke, at varying voltages, up to 14,000 volts. Each car carried transformers to reduce this voltage to the working pressure of its motors, and it was equipped with all the necessary apparatus for measuring and regulating all the various forces coming into play during the running.

In addition, Siemens & Halske supplied the electrical equipment of a locomotive, also built by v. d. Zuypen and Charlier, in which the high-tension current was supplied direct to the motors without the intervention of transformers.

The two cars, as well as the locomotive, were successfully tried at various speeds, either running alone or drawing a train, and a very complete series of observations were taken during each run, which were set out in detail in the official reports.

Owing to various circumstances the experiments will probably not be resumed this year, although the syndicate intend to resume them in the near future, but the conclusions arrived at up to the present may be summarized as follows:

1.—Permanent way, constructed in accordance with the standard specification for first class main lines of the German Government Railways, is sufficient for a line on which electric trains run at a speed of 200 km. (125 miles) per hr., but the radius of any curve should not be less than 2,000 m. (100 chains).

2.—The collector, devised by Siemens & Halske during their preliminary experiments, and modified according to the experience gained at Zossen, is well adapted for conveying the necessary electrical energy at high tension and at the highest speeds from the fixed conductors to the cars.

3.—The construction of the fixed conductor along the line as devised for Gross Lichterfelde, has proved its efficiency at Zossen.

4.—The successful running of the locomotive has demonstrated that high-tension currents can be used direct, without the intervention of transformers.

These results prove that technically it is possible to work trains by electricity on main lines, even at speeds greatly exceeding those of the present express trains. In their last report the syndicate publish two projects for such a line between Berlin and Hamburg, according to which such a railroad should also prove a success commercially. As already stated further trials are contemplated to determine the most suitable equipment for the cars and to experiment with modifications of the general arrangements.

While the problem has not yet been completely worked out, electric motors are accepted without question in the mining industry as decidedly superior to steam engines for underground work, and they will replace them also for working the main winding-drums, as soon as the qualities of electric motors are better appreciated.

Comparing generally the working of steam engines with electric motors connected to a permanent source of supply, the features in favor of the latter may be summarized as follows:

1.—The most suitable size of conductors to convey the current to an electric motor can be accurately determined beforehand, with the certainty that the loss of energy calculated upon will not be exceeded.

Such conductors are generally in the form of flexible leads, which are easily handled and readily adapted to their surroundings which they will not affect when properly selected and fitted, nor do they give rise to waste products that have to be separately disposed of.

2.—Owing to the simplicity of their construction and the absence of reciprocating parts, much less supervision is required for electric motors than for steam engines.

3.—For the same reasons the vibration caused by the working of electric motors is reduced to a minimum, and in consequence, heavy foundations can be dispensed with.

4.—This again makes it possible to shift motors readily from one position to another especially as the conductors in the shape of "wandering leads" are specially adapted for such purposes.

5.—Lastly, an electric motor connected to a permanent source of supply, is always ready to commence working, while a steam engine requires warming up, and very often, if the engine has a separate boiler, steam has to be raised specially, causing great delay in starting.

Against these advantages due account has to be taken: 1.—Of the losses, caused by the double transformation of energy; and 2.—Of the interest on the additional capital expenditure.

When the current is obtained from a public supply both these items are partly represented by its price.

It will be noticed that by utilizing electric motors it is possible greatly to diminish current expenses, while the interest on capital outlay is increased and with it the charges for depreciation, so that the most economical result may be expected when the electric motors can be kept working for long hours. In other words a high load factor is as advantageous with motors as with generators to obtain a satisfactory return for the change from steam power to electric motors. This makes it possible in many cases to decide without difficulty whether it is advisable to substitute electric motors for steam engines, but there are also instances where electric motors are cheaper although the load factor is low, and this has to be determined by carefully considering in each case all the possibilities for providing power.

Generally speaking, the experience gained hitherto makes it clear that in certain cases, notably for the propelling of ships, it is not likely that electric motors will ever replace steam engines, on the other hand it appears certain that the days of small, scattered, steam engines are over, whether they have separate boilers, or are fed by long steam pipes from a nest of boilers.

Electric motors have not only replaced steam engines, but they have been adopted for a great many purposes where steam engines have either never been used or have proved to be unsuitable; these cases are not, however, germane to the subject set for this paper, nor would it be appropriate on this occasion to discuss the relative merits of alternating and continuous-current motors beyond referring to the generally accepted opinion, that continuous-current motors are most suitable in cases where the speed of running has to be varied often and to a great extent, while alternating-current motors are most efficient in cases where long runs at constant speed are required.

The conclusion to be drawn from the consideration of the relative position which steam engines and electric motors occupy at present, appears to be that it is more correct to regard the one as the supplement of the other rather than to expect a complete substitution of electricity for steam as a motive power.

## The St. Louis, Memphis & Southeastern Railroad.

On June 1st last, the completion of a line from Southeastern Junction, near St. Louis, to Cape Girardeau, Mo., 124 miles, opened to through traffic a new single track road of favorable grades between St. Louis and Memphis. The line thus opened forms a part of the St. Louis, Memphis & Southeastern Railroad, which operates 458 miles of main track, running for the most part adjacent to the Mississippi River and which is a part of the Frisco system.

The heavy full lines on the map indicate properties of the St. Louis, Memphis & Southeastern and the heavy broken lines indicate the lines of the St. Louis & Gulf, the entire network now being known as the Third District of the St. Louis & San Francisco. A few miles south of Cape Girardeau, Mo., the line divides into two main branches; one, the Memphis division, continuing due south to a connection with the St. Louis & San Francisco at Big Creek, Ark., and the other, the Hoxie division, running southwesterly, connecting with the "Frisco" at Hoxie, Ark.

In building the Memphis division, the St. Louis, Memphis & Southeastern acquired for $648,000 on March 1, 1902, the St. Louis & Memphis, extending from Lilbourn, Mo., to Luxora, Ark., 72 miles. During the summer and fall of 1902, 47 miles were built north from Lilbourn to a connection with the Hoxie division at Shepley, Mo. On June 1, 1904, 34 miles extending from Luxora to Big Creek, Ark., were assigned to this division for operating purposes, thus constituting 153 miles of continuous single track road operated as the Memphis division.

In completing the Hoxie division the following lines were acquired: First, Cape Girardeau & State Line, 46.7 miles long, extending from Cape Girardeau to Mingo; second, the Southern Missouri & Arkansas, 35.4 miles long, from Mingo south to the Arkansas State line; third, the Hoxie, Pocahontas & Northern, 45.8 miles long, from the southern terminus of the Southern Missouri & Arkansas south to a connection with the St. Louis & San Francisco at Hoxie, Ark. These roads, with the Hunter branch, 46 miles long, comprise the Hoxie division.

To utilize these lines as through connections and to compete with river traffic between St. Louis and Memphis it was necessary to build a road with favorable grades from St. Louis to Cape Girardeau. Early in 1903, the St. Louis, Iron Mountain & Southern opened for traffic the St. Louis Valley, a competing line, along the east bank of the Mississippi River from East St. Louis to Thebes, Ill. This made the situation more

urgent and hastened the completion of the St. Louis line.

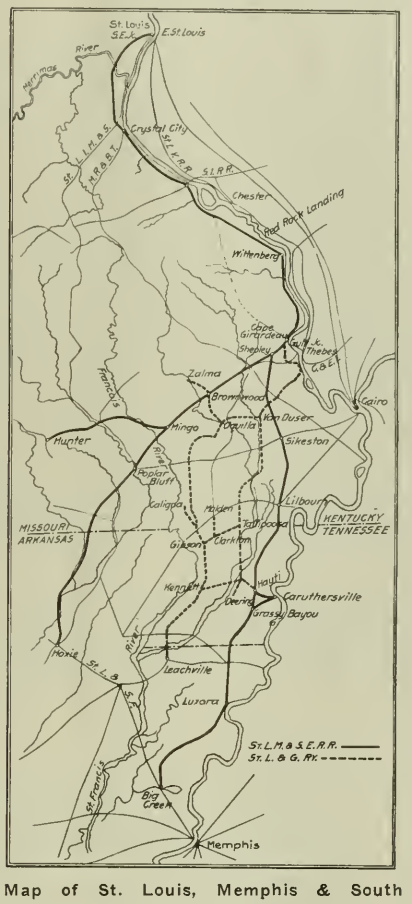
From Southeastern Junction to Cape Girardeau is 124.1 miles, and for this entire distance the new line follows the river closely. The alinement is therefore quite irregular, there being 317 curves, with an aggregate length of curved line of 35.2 miles. There are 58 ascending grades, the sum of the ascents being 7,089 ft. and the aggregate length of ascending grades 36.3 miles; 65 descending grades, with a sum of descents of 8,223 ft. and an aggregate length of descending grades of 58.5 miles. The length of level line is 29.3 miles. The section built in 1902 from Shepley to Lilbourn, 47.2 miles, has 24 ascending and 37 descending grades, but these are much lighter than on the river divisions, the sum of the ascents being 813 ft. and of the descents 1,300 ft. There are only 11 curves. Expressed in percentages, 78 per cent. of the total length of 171 miles is tangent and 22 per cent. is curved. The length of the longest tangent is 6.9 miles. the longest curve 0.6 mile and the sharpest curve is 5 deg. The ruling gradient between Southeastern Junction and Crystal City, a distance of 33 miles, is 52 ft. per mile, compensated. From Crystal City south to Big Creek, Ark., 242 miles, there are no grades in either direction heavier than 15 ft. to the mile.

The width of roadbed in excavation was generally 24 ft. with 1 to 1 slopes in earth. On embankments the width was generally 18 ft. with side slopes 1½ to 1. For the first 28 miles north of Cape Girardeau, the earthwork quantities averaged about 17,000 cu. yds. per mile. Where the line followed close to the river, considerable rock was blasted from side hill cuts and was used as riprap. From Wittenburg to Red Rock Landing, 14 miles, the earthwork was light and was borrowed principally from the sides. From Red Rock Landing to Crystal City, 50 miles, the construction involved no especially heavy work or unusual features.

From Crystal City north to the Merrimac river, 22.5 miles, the earthwork quantities averaged 37,000 cu. yds. excavation and 46,000 cu. yds. embankment per mile. The profile shown is from this section of the line. One cutting, 4½ miles south of the Merrimac river, was one-half mile long, 60 ft. high and contained 116,000 cu. yds. of material, of which 70 per cent. was solid rock, 15 per cent. loose rock and 15 per cent. earth. This cut was opened in April, 1903, and completed in April, 1904. From the Merrimac river north to Southeastern Junction the quantities averaged 36,000 cu. yds. excavation and 39,000 cu. yds. embankment per mile.

The grading contract from Southeastern Junction to Crystal City, 33 miles, was let to McArthur Brothers Company, Chicago, and from Crystal City to Lilbourn, 91.5 miles, to Johnston Brothers, St. Elmo, Ill. The movement of material under these contracts began in January, 1903, and the grading was practically completed in April, 1904. During the latter part of April of the present year considerable work was damaged by high water from the Mississippi River and tributary streams.

The smaller waterways were provided with stone box culverts or iron pipe varying from 12 in. to 30 in. in diameter. Between Southeastern Junction and Cape Girardeau there are 164 timber bridges aggregating 20,200 ft. in length, also a number of permanent structures as follows: Fourteen plate-girder spans aggregating 870 ft. in length and 11 through pin-connected spans of a total length of 1,350 ft. The most important bridge, that across the Merrimac river, consists of three pin-connected through spans, each 150 ft. long. These spans are supported by four piers containing some 3,300 cu. yds. of concrete. All bridges were designed for Cooper's E-40 loading. Difficulty was encountered in the erection of this and other structures by reason of spring freshets carrying away the falsework.

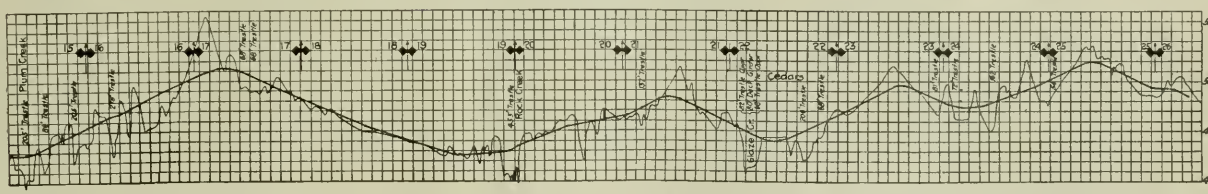



Map of St. Louis, Memphis & South Eastern.

From Southeastern Junction to Big Creek, Ark., 275.8 miles, the line is laid with 75-lb. rails on white oak ties averaging 3,100 per mile. Eighty-three miles are ballasted with crushed limestone, 51 miles with chats and the remainder principally with sand. Tracklaying was started at Cape Girardeau on January 16, 1903, and proceeded northward at the rate of about 1,800 ft. a day. The track reached Red Rock Landing, 41 miles north, on August 16, 1903. Crystal City, 91 miles north, was reached about Feb. 8, 1904.

Early in 1903, a Holman track-laying machine and the force to man it were shipped across the river and began laying track south from Southeastern Junction. On Feb. 11, 1904, the track reached the rock cut, 16 miles south, where work was stopped. The force then resumed laying north from Crystal City about the middle of February, 1904, and a connection was made with track from the north on March 17. The rate of progress on this section was about 3,800 ft. a day.

We are indebted to W. S. Dawley, Engineer Maintenance of Way, and to R. Y. Maxon, Assistant Engineer, for the foregoing information.




Profile of New Line of St. Louis, Memphis & South Eastern from Crystal City North to St. Louis.

## Small Curtis Turbines.*

The problems of design which have to be solved in the small steam turbine units are of a somewhat different character from those involved in the larger sizes. In order to keep the dimensions and cost of apparatus at a proportionate figure, the diameter of bucket wheels must be kept small, and this necessitates a comparatively high speed. These speeds must be chosen with reference to the possibilities of generator design in order that the units may be direct-connected. Therefore a proper balance must be struck between the requirements of the turbine and those of the generator. The speed necessary in the small units (from 1,800 to 5,000 r.p.m.) gives rise to a set of conditions not met with in large units and certain differences in design have arisen from this fact.

Some of the special problems which require solution on these small sizes are balance, construction and lubrication of bearings, flexible couplings between turbine and generator for sizes of 75 k.w. and above, and the commutator construction on direct-current apparatus. It is possible to balance the turbine parts statically with success, to operate at the speeds given, since the wheels may be balanced individually and collectively and the metal of each wheel is disposed in the form of a flat plate. With the generator, however, this condition is not present, and furthermore we have the liability of the generator or winding undergoing some change after being put into service, due to heating and other causes. For this reason it is necessary to balance the generator parts by rotating them in a vertical position and suspended by a flexible shaft. The rotating parts in this system of balancing take up rotation about the center of gyration of the system and by the addition of balancing weights at various points this center is made coincident with the center of rotation of the shaft. Due to the symmetrical shape of the Curtis buckets a very small amount of end thrust has to be taken care of; whatever thrust exists being due to accidental variations in bucket or nozzle shapes and this is easily taken up by hardened steel thrust washers placed on each end of one of the bearings. No balancing pistons are necessary.

The question of bearings is of course a

*Extracts from a paper presented to the St. Louis Convention of the American Street Railway Association by Richard H. Rice.

very important one and has been made the subject of a great deal of investigation. The bearings now in use are supported on spheres, so that they are self-alining. The linings are made in two parts and lubrication is effected by forced feed from a pump which is geared to the main shaft of the turbine and supplies oil at a pressure of from 3 to 6 lbs. per sq. in. The circulation of the oil is constant, passing from the pump to the bearing, thence to a reservoir in the pump chamber, from which it again goes to the pump. It has not been found necessary to provide any cooling arrangement for the oil and a very small amount of make-up oil is necessary.

A number of small sets are being used for train lighting service. Some are placed on the buffer beam, or just in front of the steam-dome of the locomotive, and others in the baggage car. The conditions of service are widely different on the locomotive and in the baggage car. In the former case the turbine is supplied with steam at 175 to 200 lbs. pressure and exposed to great variations of temperature. Some trouble was experienced last winter with the sets mounted on the buffer beams, due to congealing of the oil circulation, but this was overcome by the use of a special oil. It is not expected that this trouble will be met with in the sets which are mounted on top of the boiler. Dust and cinders are very troublesome on the locomotive and the machine is enclosed as much as possible, to prevent their access to the vital parts. It is, however, necessary to take in a large quantity of air for the purpose of cooling the generator and this air necessarily carries with it a certain proportion of fine dust, which, however, does not prevent satisfactory operation. In the baggage car the turbine is normally supplied with steam at 80 lbs. pressure, but for various reasons the pressure actually realized varies from this figure down to 40 lbs.

The 1½, 15 and 25-k.w. turbines are governed by throttle valves, these being of the piston type, moved directly by a very sensitive and powerful centrifugal governor with spring. The nozzles are therefore supplied with steam at pressures varying with the load. The governor joints are supplied with knife edges and do not require lubrication. All of these machines are of the single-stage type, having a single group of nozzles with single sets of buckets, consisting of three rows of moving buckets with corresponding rows of stationary buckets. The larger sizes are multi-stage and have only two rows of moving buckets per stage. The method of governor control on these larger sizes is somewhat different from that just described. One or more nozzle groups are supplied with steam from a single poppet valve and a sufficient number of poppet valves is supplied to furnish the total number of nozzles necessary for developing the capacity of the turbine. Each poppet valve is therefore the means of controlling the admission of steam to one or more nozzles and the governor, by means of an intermediate mechanism, opens or closes a succession of poppet valves as the demands of the load require.

Two types of intermediate mechanism for operating these poppet valves have been developed and constructed. The 75-k.w. turbine is supplied with one of these types, consisting of a hydraulic cylinder the controlling valve of which is directly actuated by the governor. A movement of the controlling valve, caused by a change in the speed, admits oil to one side or the other of the piston of this cylinder and a movement of the cylinder results, through the intermediate mechanism, in the opening or closing of corresponding poppet valves. The 150-k.w. turbine is supplied with a mechanical valve gear, the valves being actuated by gearing which derives its motion from the main shaft. The governor control operates a mechanical device which produces the same effect on the poppet valves as that above described.

The operation of direct-current commutators at the speeds in question has necessitated the development of various special features in the commutator. Carbon brushes are used throughout, the best form of brush being one which has been treated with a lubricant, and with this form of brush, commutation is very satisfactory. On account of the high speed and great length of the commutator bars they are provided with nickel-steel shrink rings at the ends and middle of their lengths to prevent deflection. These rings are shrunk on over insulation and provide a very effective means of supporting the commutator bars and also have the advantage of giving a greater wearing depth of copper than the usual construction. The steam consumption curves of these small turbines differ somewhat in characteristics from those of large turbines of the same type, in having a comparatively high steam consumption at light loads. This is because the fixed losses, such as bearing friction and windage of the wheels are a greater proportion of the total output.

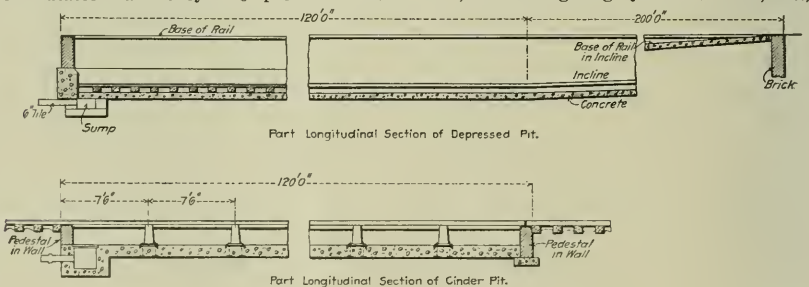
All of these turbines are of the horizontal type, the vertical type commencing with the 500-k.w. and proceeding upward. The three smaller sizes have two bearings. The turbine wheels are overhung on the end of the shaft and the shaft is in one piece, with the turbine and armature both mounted on it. Beginning with the 75-k.w. size and upward the shafts are in two pieces and the sets have four bearings.

In the four-bearing sets the generator and turbine shafts are united by a flexible coupling which permits some little inaccuracy in the alinement of the two shafts without affecting the operation of the set. After extended experience with various forms of these couplings a construction involving the use of metal parts only has been found to be the most satisfactory. This coupling is a modification of the Oldham coupling, the necessary flexibility being secured by the use of links turning on pins.

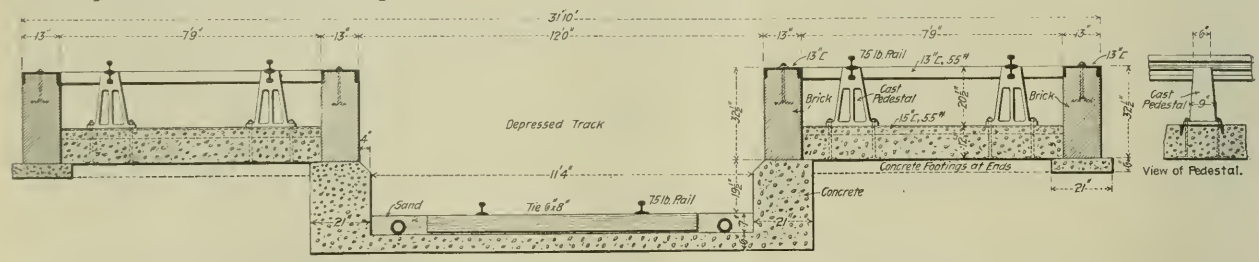
Some progress has been made in the application of turbines to driving other forms of apparatus than electric generators. Some small turbines are in operation with a belt drive with a fair amount of satisfaction. Other forms of gearing are under construction and experiment, and it is safe to predict that it will soon be possible to couple the smaller sizes, at least, of these turbines to slow-moving apparatus with satisfaction.

## The Illmo Yards of the St. Louis Southwestern.

The St. Louis Southwestern, which is one of the roads interested in the Southern Illinois & Missouri Bridge Company, owner of the Thebes bridge across the Mississippi River, is building large yards at Illmo, Mo., for use in connection with the bridge. The yards are located about two miles west of the Missouri end of the bridge and are entirely new. They lie on level ground, at the foot of a range of low hills running east and west. Protection against the drainage from these hills is provided by a large intercepting ditch along the north side of the yards, which discharges through a covered culvert under the tracks at the west end of the yard. There will be 31 yard tracks with yard room for about 2,000 cars. The facilities will include a brick roundhouse on concrete foundations, with a stall depth of 80 ft., and served by a 70-ft. turntable. It is planned for a full circle, but only 19 stalls will be built at present. Two stalls of the house will be partitioned off and equipped as a machine shop. Provision will also be made for car repairing on stub tracks west of the roundhouse. Small store and oil houses will be built, and a steel stand-pipe 20 ft. in diameter and 100 ft. high. There will be a 24-pocket coal chute, and between the latter and the roundhouse a double cinder pit which is a special design will be built. The accompanying drawings show the details of this pit.




Longitudinal Sections of Double Cinder Pit.




Cross-Section of Double Cinder Pit, Illmo Yard, St. Louis Southwestern.

There are two pits 120 ft. long, on opposite sides of a depressed track. The pit for the latter has a bottom lining of concrete 6 in. deep, above which is a filling of sand in which the ties are bedded. The walls of this pit are concrete 21 in. thick for a height of 32½ in., which is the level of the tops of the concrete footings for the brick side walls of the cinder pits. These latter are 32½ in. high and are protected on top by 13-in. 55-lb. channels held in place by 14-in. anchor bolts bedded in the brick work. The cinder pit tracks are carried on cast-iron pedestals 7 ft. 6 in. on centers. The pedestals rest on 15-in. 55-lb. channels laid transversely and bedded in concrete, a 12-in. layer of which lines the pit bottom. The pedestal anchor-bolts extend through this concrete. The track rails, which weigh 75 lbs. to the yard, are laid on inverted rails of the same weight which fit into recesses in the pedestal tops conforming to their outline. The flanges of the upper and lower rails are riveted together.

The Southern Illinois & Missouri Bridge Company is building a similar yard parallel to and immediately south of the St. Louis Southwestern's yard. The drawing of the cinder pit was sent us by Mr. M. L. Lynch, Chief Engineer of the St. Louis Southwestern.

## Sleeping Cars for the Western Australian Government Railroads.

The Western Australian Government Railroads have recently placed extensive orders for locomotives and rolling stock in the United States and in England. The American Car & Foundry Company furnished 50 steel hopper coal cars and a large number of 16-ton gondolas, and the Gloucester Railway Carriage & Wagon Company, of Gloucester, England, obtained a large order for new passenger equipment, including a number of

First Class Sleeping Car, Western Australian Government Railways.

first class sleeping cars and second class corridor cars. The accompanying illustration shows one of the first class sleeping cars made by this company. It is 58 ft. long over the end platforms, 8 ft. 9¾ in. wide at eaves. and weighs 32 tons. The standard gage in Australia is 3 ft. 6 in., and the six-wheeled trucks on which these cars are mounted are built for that gage. The sleeping cars are divided into six compartments, four of which can be made up into four berths and the other two, which are in the center of the car, can be made up with a single upper and lower berth. For day travel the four-berth compartments will seat six passengers each, and the two-berth compartments will seat three passengers each. A narrow corridor runs along one side of the car and the compartments are entered through doors leading off from this corridor. The two single compartments in the middle of the car are connected by a door through the partition, so that they may be used in common if desired. The seats are transverse, as in Pullman sleeping cars, but each seat is long enough and wide enough so that transverse berths can be formed by lifting the seat backs and slinging them from the roof. There are lavatories at each end of the car having a water supply from tanks built in the roof, with a reserve supply carried in two tanks hung underneath the floor. The cars have open end platforms, as will be seen from the illustration, and are fitted with automatic vacuum brakes applied to four of the six wheels on each truck. The body framing of the car is teak wood and the underframe is made up of steel channel sills and pressed steel cross members.

The interior decoration of the car is very ornate. All the panels and mouldings are of polished teak, decorated with hand carved work, and the seats are upholstered with dark maroon-colored leather. An interesting feature of these cars is the very complete system of ventilation which has been designed. The roofs are double, with air intake and exhaust ducts running in between the layers. These ducts are connected with intake and exhaust ventilator hoods extending up through the roof, and they are also carried down inside the car frame and open into each compartment. By this means each compartment is constantly supplied with a current of fresh air, which is kept in constant circulation. The cars are lighted throughout with electricity.

## The International Engineering Congress.

The International Engineering Congress held under the auspices of the American Society of Civil Engineers at the World's Fair, St. Louis, met for the first time on the morning of October 3 in Congress Hall in the Administration Building. Col. Henry S. Haines, chairman of the committee in charge, presided at the general meeting, and in addressing the Congress reviewed briefly the history of its inception and organization. The managers of the Louisiana Purchase Exposition requested the American Society of Civil Engineers to undertake the arrangements for the meetings and the invitation was accepted. The other three national engineering societies declined the invitation extended to them by the committee appointed by the Civil Engineers to participate as organizations in the work of the Congress and so the Civil Engineers undertook the work alone. The committee in charge determined to confine the discussions at the meetings to a few live topics rather than to attempt to cover the whole field of engineering and having selected these subjects, invited papers on them from leading engineers from all over the world. North and South America, Europe, Africa and Asia all responded so that the Congress was indeed an international one.

Mr. Charles Hermany, President of the American Society of Civil Engineers, and President of the Congress, was then introduced and delivered an address of welcome. He expressed the hope that the work of the Congress would result in great benefit to those in attendance and that the papers and discussions would stand as a review of the engineering accomplishments of the last ten years. Enthusiasm and extraordinary effort, he said, overcame the apparently insurmountable obstacles where earnestness of purpose and industry failed before, and more than any other body of men, engineers must have these qualifications to be really great.

After the address of welcome had been responded to by Mr. F. B. V. Skiff, Director of Exhibits at the Exposition in the absence of President Francis, Mr. Hermany introduced Sir William White, K.C.B., F.R.S., President of the Institution of Civil Engineers of Great Britain, who headed a delegation of that body at the Congress. He spoke at some length in a charming and appreciative manner. For the first time in the 86 years of its existence, the Institution was holding a meeting outside of England as a part of this Congress. On behalf of the Institution and all the visiting delegations of engineers he thanked the American Society for its reception in this country and for the work which it had done in organizing and carrying out the work of the Congress. He referred to the work of the Institution of Civil Engineers in the matter of standardization in engineering work, and called attention to the value of concerted action in that direction not only to engineers but to manufacturers as well. The Institution has also taken up another broad phase of its work, engineering education, and a committee is already formulating recommendations which will tend to raise the profession of engineering to the high plane which is properly its own. St. Louis had a monument to one of the greatest of their profession in the Eads bridge across the Mississippi river. Capt. Eads' name was cherished in England as well as in America as a man knew not what it was to fail in carrying out the stupendous works with which he was identified.

Speaking of the work of the Congress, he mentioned the educational effect of holding it at such a place as this Exposition when the members were surrounded by examples of the skill and scientific achievement of their fellow-workers. Science and engineering went hand in hand and the engineer must be a man of science to deal with the great problems confronting him. But while the trend of engineering was specialization, the branches of that profession must ever overlap and be dependent on one another. Thus while this Congress was considering many subjects apparently widely separated, yet each was related to the other, and all of those who participated in the discussions would be bound by the common tie of engineering. As an example of this he spoke of the modern ship in the construction of which all of the branches of engineering take an essential part and yet the naval architect takes the immediate responsibility and only avails himself of the skill of his associates.

As director of naval construction Sir William White had directed the expenditure of more than 500 million dollars on ships and armament, and yet he held that this had made for peace rather than for war. The engineer had made possible the modern war-ship and hence he was responsible in a way for the world's peace. The execution of a war demanded the highest skill of the engineer in many if not all of the branches of the service. His text, if it might be so-called, was that engineers the world over were an army fighting the adverse forces of nature for the benefit of mankind.

Representatives from France, Germany, Argentine Republic, Russia and Austria then spoke briefly, and some further routine business was disposed of before the meeting adjourned.

At a session held Monday afternoon, the American Society of Civil Engineers held its

annual meeting. President Hermany read his annual address and routine business was disposed of. The selection of a place of meeting was referred to a special committee, although Secretary Hunt said the result of a recent letter ballot showed a strong preference among the members for holding the next meeting at Cleveland, Ohio.

On Tuesday morning each section held an independent meeting for the discussion of the subjects assigned. Only abstracts of the discussions of a few of the sections can be reprinted here.

SECTION F—ELECTRICAL.

*The Substitution of Electricity for Steam as a Motive Power.*

This section was presided over by Mr. George H. Pegram in the absence of Mr. Frank J. Sprague. The paper by Mr. J. G. White, M. Am. Soc. C. E., was read and the discussion was opened by Mr. L. B. Stillwell, of New York. He thought that the application of electricity should not even be considered for steam roads on which the present traffic is not more than 10,000 ton-miles per mile of double track. The saving in cost of transportation by electricity over steam with a traffic density as low as this is more than offset by the charges on increased capitalization. One great advantage of electric traction about which little has been said is the fact that with motors properly distributed through the train, grades of 6 per cent. and even as high as 10 per cent. are not prohibitive, the objection to such grades being the difficulty of holding trains when descending them. With electric traction it is possible to utilize the magnetic track shoe brake as well as shoes on the wheels so that this objection might well be overcome. The ruling grade on any line should of course take into consideration power requirements as offset by first cost of line construction. The Wilkesbarre & Hazelton uses a 3 per cent. grade and competes with the steam roads which it parallels, in places on which the grades are less than 2 per cent. The electric road has a route only 30 miles long compared with 50 miles for the steam roads, chiefly because the heavier grade could be used: and a speed of 30 miles an hour is maintained going up this grade with a trailer car attached.

Referring to the third rail and its protection from sleet and snow as well as from accidental contact with employees or trespassers Mr. Stillwell suggested the use of a plank covering above the rail supported from brackets attached to the rail itself. This has been successfully tried in severe storms and while not altogether satisfactory is still much better than an unprotected rail. It requires a special form of collector shoe pivoted to the truck.

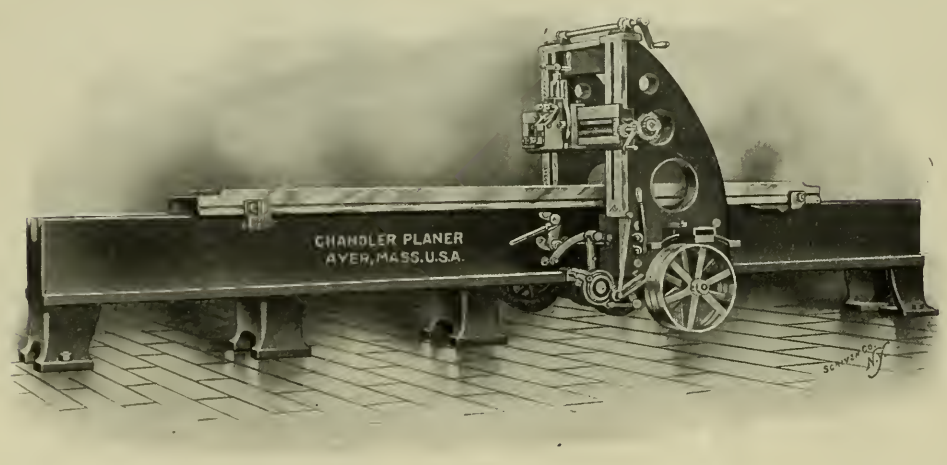
Roads operated by electricity have lighter charges for maintenance-of-way because of the better distribution of weight under motor cars and the entire absence of the effects of unbalanced reciprocating parts. Track construction for electric roads cannot be made too substantial even though the expense of its maintenance is much less than for similar construction on steam roads.

The saving in coal with a central station electric power plant over steam locomotives is greater than is often assumed. The plant of the Manhattan Elevated delivers power to the switchboard at the rate of 2.6 lbs. of coal per kilowatt hour under conditions of full load, and the power is delivered to the motors through the third rail with about 60 per cent. efficiency, giving a consumption of 4.3 lbs. per kilowatt or 3 lbs. per horse-power at the drawbar. A road with heavy traffic and a large and efficient central power station should use only about half as much coal as when using steam locomotives, and this may even be reduced under favorable conditions to one-third.

The repairs to electric machinery ought not to exceed 2½ per cent. per annum on the first cost, and if in addition a sinking fund of 5 per cent. is provided for, the total charge for maintenance and renewals is only 7½ per cent. as against about 20 per cent. for repairs alone in the case of steam locomotives.

In discussing the paper presented by Mr. Alexander Siemens, Mr. Stillwell pointed out that the single-phase alternating current motor requires more weight on the drivers for a given drawbar pull than the three-phase motor, since the torque of the former varies with the alternations, and theoretically the average torque is one-half the maximum. Investigations made at Buda Pesth showed the ratio of adhesive weights required for single-phase and three-phase motors was actually about 3 to 1 instead of 2 to 1, since the three-phase motor has a nearly constant torque and the single-phase motor exerts only a small effective drawbar pull in proportion to the weight on drivers. The electric motor has an advantage of 15 to 20 per cent. in this respect over a steam locomotive because of the unequal rotative effort on the two cranks. The mechanical efficiency of the average steam locomotive derived from the power developed in the cylinders and the power delivered at the drawbar has been found by road tests to be less than 50 per cent., but with electric motors no such loss as this occurs.

The discussions of papers of other sections will be printed in abstract in a subsequent issue.




The Chandler Planer.

## The Chandler Quick Return Planer.

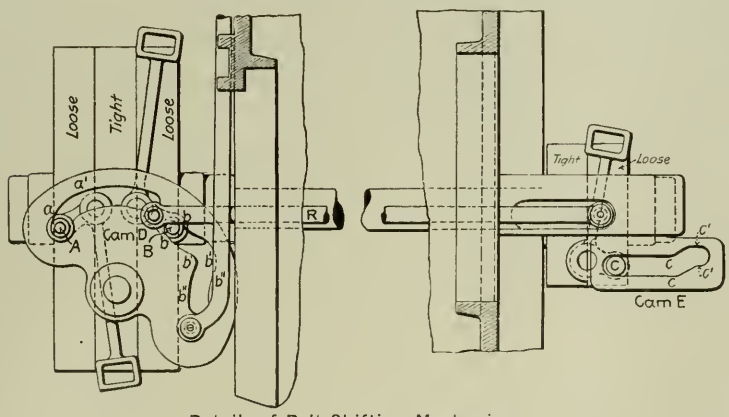
The accompanying illustration shows a planer made by Chandler Company, Ayer, Mass., and designed for the use of high-speed tool steel. The main feature of this machine is the high cutting and quick return speeds which can be obtained. Any cutting speed up to 100 ft. per min. is guaranteed. If the cutting speed does not exceed 75 ft. per min., the platen is returned at a speed of 200 ft. per min., and if the cutting speed exceeds 75 ft. per min. the platen is returned at 150 ft. per min. It is claimed that at these high speeds the platen reverses smoothly and without shock or jar. A novel method of changing the speed of the platen without changing the speed of the driving belts is used. This variable speed mechanism is in the train of gears, between the pulley shaft and the bull gear. It is operated by a lever and serves the same purpose as back gears of a lathe; that is, the pressure at the tool point is inversely proportional to the platen speed. Three belts are used on the planer, one for driving when cutting, one for reversing, and one for running the platen back at high speed. As the platen approaches the end of the cutting stroke, the tappet encounters an incline on the dog and is lifted to a position which throws off the cutting belt and throws on the reversing belt, running at a speed that will most effectively reverse the cutting movement of the platen. The two belts are shifted practically as they are in planers of other makes.

As soon as the platen starts back on its return stroke, however, the tappet encounters a second incline on the dog and is further elevated, throwing off the reversing belt and throwing on the high-speed return belt, which remains in action until near the end of the return stroke, when the tappet encounters a two-step dog, which, on the first step, throws off the high-speed return belt and throws on the slow return or reversing belt. The second step of the dog then throws off the reversing belt and throws on the cutting-speed belt.

The cutting-speed and reverse belts are on the front side of the planer, as in the ordinary type, and the high-speed return belt is on the opposite or rear side of the machine. The arrangement of the belts, pulleys and cams is shown in the accompanying illustration. At the left are two loose pulleys and one tight pulley and on the same shaft at the right are the tight and loose pulleys for the high-speed belt. The two belt shifters at the left are controlled by an oscillating

cam having two slots for the rolls, *A*, *B*, attached to the short arms of the shifters. This cam is connected with the sliding cam at the right by the rod *R* so that the two move in unison.

Starting with cam *D*, and with the cutting-speed belt on the tight pulley, as shown, a movement of the cam to the left causes roll *A* to ride up on surface *a*, *a'*, shifting belt to loose pulley, where it remains until the cam again returns to this point. In the meantime roll *B* travels on surface, *b*, *b'*, causing the reversing belt to shift to the tight pulley, where it remains momentarily, and then shifts back to the loose pulley again as the roll passes over the cam surface from *b'* to *b''*. While this belt is being shifted back to the loose pulley, the curved part of cam *E* comes into action and shifts the high-speed belt onto its tight pulley, the roll *C* being in contact with cam surface *c*, *c'* during this motion. When the platen finally reaches the other end of its stroke these successive motions occur in the reverse order and the platen is finally carried back to its original position by the slower cutting-speed belt. When the quick return speed is not desired, such as when doing short stroke work, etc., the high speed belt can be thrown out of operation by lifting a latch on the return dog, and the platen is returned on the intermediate speed or reversing belt. The feed regulating mechanism is operated by a lever moving on a marked dial and is always under the immediate control of the operator. The shafts and bearings in this planer are of liberal proportions and are case hardened and ground.




Details of Belt Shifting Mechanism.

It is claimed that with a cutting speed of 50 ft. per minute, this planer removed from machinery steel, with a 2 in. belt transmitting 6½ h.p., a chip ¼ in. deep x ⅛ in. feed. Allowing that 6 h.p. out of the total of 6½ h.p. are required in the act of cutting, and conceding but one-half horse-power is required for operating the planer, these figures would indicate the removal of 54 lbs. of steel per horse-power per hour. From cast-iron, at a cutting speed of 50 ft. the Chandler planer removed a chip ⅝ in. deep by $^1/_{16}$ in. feed. The belt in this case was transmitting 6½ h.p., which on the above basis is equivalent to removing 68 lbs. per h.p. per hour. At a cutting speed of 50 ft. per minute and a return speed of 200 ft. per minute, the Chandler planer on a 13-ft. stroke, makes a round trip in 20 seconds. At the request of a large ship-building company who desire to use a high-speed planer on brass work, a Chandler planer is being run at a cutting-speed of 92 ft. and a return speed of 150 ft., on a stroke of 6 ft., making the round trip in 7½ seconds.

The production of anthracite coal of the first nine months of this year decreased 4,922,525 tons over last year.

## Twenty-Seven Passengers Killed at Warrensburg, Mo.

On the morning of October 10, before daylight, a butting collision between an eastbound passenger train and a westbound freight on the Missouri Pacific, about two miles east of Warrensburg, Mo., resulted in the wrecking of both engines and many cars and the complete destruction of the leading coach of the passenger train. Twenty-seven passengers and one brakeman were killed and about 30 passengers and five trainmen were injured, some of them fatally. Both trains were running at high speed, the point of collision being near a hollow between two summits. It is said that the engineman of the freight forgot a meeting order.

## Six Men Suffocated in St. Clair Tunnel.

On the morning of October 9, five trainmen of the Grand Trunk Railway and the company's Superintendent of Terminals at Port Huron were killed in the tunnel under St. Clair river between Port Huron, Mich., and Sarnia, Ont., a freight train having broken in two, causing a long delay in the tunnel. The train, which entered from the American end of the tuunel and was made up of 17 cars of coal, broke in two. Engineer Coleman, with the three cars that were still attached to the engine, ran to Sarnia, detached his engine and went back for the stalled cars. He attempted to push them back through the tunnel and out of the American portal, but could not get up the grade, and the engine and cars rolled back into the gas-laden tunnel. Coleman was suffocated at his post in the cab. His fireman, Fred Forester, with great presence of mind, jumped into the partly filled tank of the engine, where there was enough air to preserve his life, although he was taken out in a serious condition.

When news of the broken train reached the American side of the tunnel, Mr. Begg, Superintendent of Terminals, accompanied by two other employees, started in on foot, but they had gone but a short distance when the coal gas became stifling, and Begg succumbed. The other two rescuers succeeded in crawling to the portal.

Meanwhile preparations were being made at the Sarnia end of the tunnel to rescue the imprisoned crew. An engine with a party of rescuers entered the tube and had proceeded but a short distance when they found John Haley, a track walker, lying unconscious on the track. He was taken out and again the engine plunged into the tunnel. The rescuers were overcome, however by the gas before the train was reached, and Brakeman McGrath died. Switchman Blake, who was a member of the party, after a time made another attempt, and succeeding in reaching the stalled engine, coupled it to the cars and ran the train out into the daylight. Conductors Simpson and Tinsley, and Brakeman Gillis were found dead in the caboose. Fireman Forester was in the tank of the engine nearly two hours before he was rescued.

## Structural Steel Fractures Under Alternating Stresses.

At the meeting of the British Association for the Advancement of Science, Professor Arnold, of Sheffield University, read a paper on August 23 in which he said that, to pass from generalities, through the kindness of his friend, Mr. J. T. Milton, Chief Engineer of Lloyd's, he was enabled to publish, with a certain degree of reserve, important facts ascertained during a two years' research carried out with the assistance of his friend and colleague, Mr. Andrew McWilliam, A. R. S. M., at the University College of Sheffield, under instruction from Lloyd's Committee.

To select one instance. The shell plates of the boiler of a colonial cruiser, split longitudinally from end to end, under the hydraulic test. The fractured plates were about 1 in. thick, and each weighed nearly three tons. The average analysis of the plates was about as follows: Carbon, 0.20; silicon, 0.02; manganese, 0.50; phosphorus, 0.04; sulphur, 0.04; copper and arsenic, very low. This analysis is beyond reproach. Pieces from the fractured plate, bent double and closed right up under violent hammering, without any sign of flaws. The average tensile tests registered about elastic limit, 15 tons per square inch; maximum stress, 29 tons per sq. in.; elongation, 29 per cent. on 2 in.; reduction of area, 50 per cent.

The above mechanical tests leave little to be desired. The microscopical structure showed a distinct and unusually sharp segregation of the pearlite and ferrite, the latter being angular and intensely crystallized. It was also large in pattern and frequently occurred in those long white lines, rich in sulphur and phosphorus which are technically known as "ghosts."

In the early stages of the research, it was thought that the sharp crystallization might be regarded as an effect due to that cause which produced also the effect of brittleness. As will be seen, presently, this theory was decisively negatived by subsequent experiments. In order to measure the mechanical brittleness incapable of being detected by ordinary static or bending tests, the author caused to be devised a machine by means of which the test piece is placed under severe rapidly alternating stresses, slightly beyond its elastic limit. The number of alternations are registered by a counter, adjusted to zero for each test. The rate of alternation can be varied at will and in the near future these data will be supplemented by a record of the energy expended per test piece, ascertained by means of a delicate, integrating watt meter.

This method of testing (which practically carries out the almost impracticable Wohler test in one or two minutes) has already thrown important light on the obscure phenomena under investigation and has also exhibited remarkable delicacy. These facts are proved by the data now submitted to the section by the author.

In preliminary tests on standard English acid open hearth boiler plate steel the remarkable fact was noted that in all probability the resistance of structural steel to rupture under rapidly alternating stresses is inversely proportional to the rate of alternation. This law, if fully established by the exhaustive experiments now being carried out at the Sheffield College, demands care-

ful attention from every engine designer. The following figures indicate concretely the data upon which the author provisionally enunciates the law. The subjoined table has reference to alternating shock bending tests carried out on a good boiler plate steel, the test bars being ⅜ in. square and the bending force being applied 4 in. from the line of maximum stress, with a range $^{9}/_{16}$ in. each side.

| Mark. | Rate of alternation. | No. of alternations necessary to complete fracture. | Mean. |
|---|---|---|---|
| S 1 | 158 per min... | 1,330 | 1,375 |
| S 2 | | 1,456 | |
| S 3 | | 1,352 | |
| S 4 | | 1,361 | |
| S 5 | 266 per min... | 860 | 378 |
| S 6 | | 870 | |
| S 7 | | 916 | |
| S 8 | | 868 | |

Whilst the above results exhibit considerable concordance, those obtained from the fractured boiler plate were so erratic that for a time the author was almost in despair, when the curious clue to the situation presented itself, that one side of the plate was brittle and the other tough under alternating stresses. This theory is about to be put to a more careful experimental test, but in the meantime the following data are, in all probability, substantially accurate:

| Mark. | Alternations: Rate. per min. | Alternations: No. endured. | Heat treatment. | Probable position of test-piece. |
|---|---|---|---|---|
| L 3 | 168 | 420 | Heated to 950°C. and cooled in air | Inside |
| L 4 | 168 | 1,232 | | Outside |
| L 7 | 168 | 1,378 | Oil quenched from 950° C. | Outside |
| L 8 | 168 | 694 | | Inside |
| L 11 | 266 | 435 | as received. | Inside |
| L 12 | 266 | 854 | | Outside |
| L 18 | 266 | 260 | Heated to 950°C. and cooled in air | Inside |
| L 19 | 266 | 500 | | Outside |
| L 20 | 266 | 388 | Annealed, heated to 950° C., slowly cooled. | Inside |
| L 21 | 266 | 781 | | Outside |
| L 22 | 266 | 630 | Oil quenched from 950° C. | Outside |
| L 23 | 266 | 240 | | Inside |
| L 26 | 266 | 400 | Water quenched from 900°: heated to 600°. | Doubtful. |
| L 27 | 266 | 336 | | |

The somewhat disconcerting lessons to be drawn from the above table are: (1) That once a steel has assumed decisive brittleness in alternation, it cannot be restored by heat treatment of any kind short of re-melting; (2) That the injury to this steel was on one side of the plate, and hence due to unskilful reheating of the ingot, and not to an improper casting temperature, since the latter must necessarily have affected every portion of the plate. A third and still more regrettable confession has also to be made, namely, that the microstructures of the pairs, including both brittle and tough steel were in all respects identical, though of course that of each pair varied with the heat treatment to which they had been subjected.

## Reminiscences of Early Railroading.

BY C. H. CARUTHERS.

During the latter part of the sixties, the writer attended school in the city of Pittsburg, for ten months of each year, and traveled each school day on the trains of the Pennsylvania Railroad between the city and his home—about 22 miles out. Deeply interested in railroad matters from early childhood, the impressions of those days of long ago are still vivid and afford many points of interesting comparison with twentieth century practice.

Until 1863, but few of the passenger engines burned coal, and instead the tenders were heaped high with cord-wood which was replenished as the supply diminished, from "woodsheds" at convenient intervals. One of these sheds was located at my home station and the conductors and brakemen always assisted the sawyer and fireman in loading this fuel on the tender, while the engineman (we called him "engineer," then) oiled and inspected his engine. These engines, as will be remembered by many, were painted in gaudy colors, and the tenders especially were profusely decorated with striping and arabesques in which gold-leaf and all the hues of the rainbow combined to evidence the painters' skill. Much polished brass also added to the brilliancy of the engines, and in some instances the domes, sandboxes, cylinders and steam chests were entirely encased with this metal.

The passenger coaches, on the contrary, were rather plain and the clear-story did not come into extensive use until about the latter part of 1863. Rosewood, mahogany, black walnut and bird's-eye maple composed the interior woods, but the windows were very small, and the headlining was a sort of oilcloth stamped with an exceedingly plain design. Except for a brief period, extending from 1862 to 1864, when compressed gas supplied light to three burners in each coach, but was quickly abandoned after an accident in the year last named, when the destruction by fire of the wrecked train, with the loss of many lives, was attributed to the gas, *two* sperm candles supplied the "illumination" for each coach! It can readily be seen that a night ride of any length was a rather dreary affair.

The crews wore no uniforms; only a badge indicating their ranks, and it was no unusual sight in warm weather to see a conductor resplendent in a suit of white, and wearing a broad-rimmed hat. Railroading was at that time still a comparatively new industry. In still earlier days men had naturally drifted from the stage coaches and the canal boats into the newer method of transportation, and had unfortunately brought with them many of the baleful habits such as drinking, profanity, gambling, and other vices, which characterized the lives of men in those earlier callings. Although the worst of such men were gradually dropped from the service, their influence had to an extent produced fruit in some of the younger men.

Length of service appeared to be the chief qualification in selection of men for handling special trains, thus when in 1860, the Prince of Wales, now King Edward VII., was to pass from Pittsburg to Philadelphia, an engineman was brought with his own engine, No. 166, from the Philadelphia Division, to haul the special over the road. It will be remembered that previous to 1857, the Allegheny Portage R. R., and the Columbia & Philadelphia had been the property of the State of Pennsylvania, and the employees had been given positions, and were retained in them, more on account of their efficiency in working for the dominant political party than for any especial ability in handling trains. This fact naturally tended to produce a class of employees somewhat similar to that evolved from the stage and the canal boat. Labor organizations as now known, did not exist among these men, but there was a sort of unwritten "comraderie" which found many ways of rendering burdensome the lives of the few who were trying to follow a higher plane of conduct. Neatness in personal appearance was ridiculed by these older men, and the engineman of to-day who skillfully and modestly handles his magnificent engine as he sits with cleanly-shaven face, white collar, neat tie, and gloved hands, would at that time have been a veritable Pariah among railroad employees.

There were days when the passenger equipment proved insufficient to meet an unexpected number of passengers, and at such times the conductor usually stopped at the first siding containing empty gondolas (this name was not then in use, such cars were known variously as flats or trucks) and attaching a sufficient number, seats having been hastily improvised of boards taken from the nearest pile kept to use at the doors in loading box cars with coal, the train went on and the occupants of these open cars enjoyed their ride, and incidentally the plentiful supply of sparks and cinders which rained upon them. Several times during the later years of the Civil War, all the coaches but one (retained for the use of women and children) of the accommodation on which my schoolmates and I made our daily trips, were taken to carry soldiers to the front, and after their return we soon had evidence, to the consternation of our mothers, that everything pertaining to army life had not been removed from these cars when the soldiers left them! Microbes, fumigation, germs, etc., were not then so much spoken of as at the present time.

The air-brake, as is known, did not come into use on regular trains until late in 1869, but from about 1862 we had the Loughridge continuous brake. This consisted of a transverse shaft behind the rear driver, having a chain attached to its center, and this chain was connected to the brakes of each coach, and was operated by a friction wheel on one end of the shaft, which at that end was carried in a sliding box, and this box was attached to a lever extending into the cab by means of which the friction wheel could be brought into contact with the flange of the driver and thus apply the brakes. This brake, owing to difficulty of taking up the slack chain, was of very little use on more than four cars from the engine. The chain often gave way when most needed, and then ensued a wild rush for the hand-brakes, on the part of the crew. Another type of power brake, known, I think, as the Cramer, and used for a number of years on the New York Central & Hudson River, was tried on a Pennsylvania coach, but did not impress the Altoona officials, nor anybody else, with its superiority to the Loughridge. Its principle was a powerful spring coiled in a drum about 18 in. in diameter by 6 in. deep. Each passenger car was provided with a spring so coiled, the whole using the vertical brake-shaft at one end as an axis to which it was connected in such a way as to permit its being wound up by turning the shaft the opposite direction to that used in braking by hand. A trigger and ratchet were placed on the top of the drum and from these a cord passed upward and was connected to the continuous signal rope of those days. In cases of emergency, the fireman was expected to pull the rope toward the engine, and this released the triggers and set the vertical shaft and its surmounting wheel to revolving furiously and thus set the brakes. A notice was placed on each car cautioning passengers to keep their hands off of the brake-wheels on account of possible injury from a sudden release of the spring. These drums were despised by the trainmen, as they were but a few inches above the ordinary ratchet, and when brakes were set by hand, the employee so using them often "barked his shins" as he moved his foot toward the pawl.

The average railroad passenger employee of to-day has but little idea of the real difficulties with which his predecessors of those days had to contend; and they did it, too, with but little, if any, complaint. With all their faults, they were generally a contented, happy-go-lucky set of men, kind under a rough exterior, and in the matters of correct living referred to, rather the subjects of environment than of premeditation. When that environment gradually changed for the better, a large number of these very men changed with it, and thereafter gave their hearty support to the efforts to maintain correct living among their fellows; so that the churches and the Young Men's Christian Association have found a large number of these older railroad employees among their most valued supporters.

## CONCRETE FOR RAILROAD WORK.

American Portland cement has been marketed as a commercial product only about 15 years, yet in that time the production has increased from 355,000 barrels in 1890 to more than 17 million barrels in 1902. The production of natural cement in 1902 was eight million barrels, and a trifle less than two million barrels of Portland cement were imported from Europe, so that the total consumption for that year was 27 million barrels. Most of this was used for concrete masonry, although prior to 1895 the use of concrete for exposed structures other than hydraulic work was almost unknown. Exhaustive tests have demonstrated that the American product is equal in every respect to the imported Portland cements which have been in use long enough to prove their durability; and with the increased production, the cost has been reduced to a point where concrete can be put in place under almost any conditions at a less cost than an equal quality of stone or brick masonry.

For railroad structures concrete has many advantages over brick or stone besides cost; and it is coming into very general use for such structures. Elsewhere in this issue are descriptions of two important and interesting applications of concrete masonry to structures under railroad track, one showing plans for a number of standard arch-culverts, abutments, cattle-passes and solid bridge floors for a new road, and the other giving detail costs of work in which concrete was used to replace timber trestles or brick and stone walls. On the St. Louis, Kansas City & Colorado, about 500 culverts and all the necessary bridge piers, abutments and road crossing arches were made of concrete; and in all 75,000 cubic yards were used in the construction of 300 miles of new road. No brick or stone arches or walls were put in. The Nashville, Chattanooga & St. Louis is now using concrete, laid with the company's own force of unskilled laborers, for all of its masonry work, including foundations, retaining walls and culverts, replacing wooden trestles. These are but two of many examples of the extensive and varied applications of this comparatively new material.

Some roads, notably the Pennsylvania and the New Haven, still hold to standard third-class broken range stone masonry for arched bridges and piers, heavy retaining walls and similar work, because they believe that better structures can be built in that way at little greater cost than for concrete. This is doubtless true if a good quality of stone is available at some point on the company's lines not far from the site of the work, and if the magnitude of the work is such that a force of masons and stone cutters of sufficient size to be handled to advantage can be used. In Newark, N. J., the Lackawanna has recently completed its track elevation and depression, covering a distance of 3½ miles, at a cost of $3,000,000, and concrete has been used exclusively for all retaining walls and bridge abutments. This work was begun simultaneously with the Pennsylvania's track elevation in the same city, on which rock-range masonry was used throughout. No comparison can be made between the time of completion of the Lackawanna's work and the Pennsylvania's work, because of the different conditions encountered in the nature and amount of the excavation and filling work which was done. The Lackawanna change of grade was made under conditions which were probably more difficult than those encountered by the Pennsylvania. But the two undertakings were finished at about the same time, and the concrete work probably cost much less than stone masonry would have cost under the same conditions. One piece of work is apparently as substantial and durable as the other, and the question of using stone or concrete for similar work in other places can be decided entirely upon the estimates of relative costs.

The detailed statement of cost for concrete culverts and other small structures, as given by Mr. H. M. Jones, shows that in some cases unskilled negro labor at 90 cents a day was employed under the direction of a competent foreman, and these men, after some little experience, were able to do the work quite as well as higher priced men could do it. The only high-priced men employed were the carpenters who built the forms. When not engaged on that work they were used in the mixing and placing gangs. To build stone culverts of similar size would require practically the same amount of timbering for the arched centers, the installation of a derrick and hoisting engine, and the employment of masons and other high-priced labor for doing nearly all of the work. There would be besides this the possible delay to trains on a busy road by holding the work train at the site to unload material. In case it was necessary to build a storage spur for holding cars loaded with material, the cost of such a spur would have to be charged against the work. In many places, as for example, under an existing wooden trestle, it would be extremely difficult to place the stones in the arched ring, because of the interference of the bents and bracing with the free movement of the derrick. Where concrete is used the material can be dumped from wheelbarrows or shoveled into the forms directly from the mixing boards in very close quarters, and without difficulty.

Suitable building stone is not always at hand, but almost any kind of hard, homogeneous stone or clean gravel can be used as a body for concrete. Very often, also, stone taken from a newly opened quarry which appears to be sound and durable will disintegrate after some years' exposure, and fall to pieces little by little. Concrete made from a reliable brand of cement is of known quality and can be depended upon. Tests have shown that its strength increases with age, and in at least one case of a burned factory building with concrete walls and floors it was found that the strength of the concrete had materially increased after being exposed to heat that would have cracked and chipped stone or brick. Perhaps the greatest advantage of concrete is its adaptability for any complicated or unusual form. In every stone arch each ring-stone must be carefully laid out and cut to accurate dimensions in order that the stresses may be transmitted uniformly through the arch, and it is seldom that the plans for one stone structure can be used for another without changes. Concrete can be moulded into any shape, and, if properly placed and well spaded next to the forms, a smooth, clean surface can be obtained.

One point which does not yet seem to be satisfactorily established is the effect of freezing concrete before the final set has taken place. Some specifications require that no concrete shall be placed during freezing weather, and, on the other hand, some of the most extensive pieces of concrete work in this country have been carried out and completed during severe winter weather. Neat cement will take an initial set after about half an hour, but the final set does not take place until after from thirty to sixty days' exposure. The water which is added in the mixing brings about the first chemical combination of the particles which gives the cement its initial set. If this action is arrested by freezing, the mixture remains inert until thawed out, when the chemical action again begins. Numerous tests have been made to determine the effect of freezing and thawing, but unfortunately there is still a wide divergence of opinion. Mr. Campbell states that tests made during the progress of the work on the St. Louis, Kansas City & Colorado showed that freezing resulted in a loss of strength and that salt was worse than useless as an ingredient of the mixture to prevent it, since it takes place only at temperatures below which a salt solution will freeze. The only satisfactory method of placing concrete in winter weather, which appears to have been tried to any extent, is heating the ingredients, before mixing, in stoves and placing the concrete while still hot. If the mass is large enough and is covered by straw or some other frost-proof covering, enough heat is retained to prevent freezing until after the water in the mixture has combined with the cement as water of combination. After this there is little damage to the concrete by exposure to freezing temperatures, and work carried out in this manner during the coldest weather has not yet developed any serious defects. There is need of a reliable series of tests and experiments made under actual service conditions and in the laboratory, to determine the effect of freezing temperatures on large and small bodies of concrete.

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The report that the American Railway Association will next week enthusiastically adopt a rule requiring all applicants for employment in the train and station service, or for promotion therein, to undergo and pass a thorough physical examination, ought to be (and we suppose is) true. There is no question of the desirability and importance of such examinations, and if any railroads are waiting for the Association to declare itself before they establish examinations, their excuse ought to be demolished without delay. The Chicago & North Western and other enterprising companies have examined applicants for nine years or more. That examinations should deal with all vital parts and important functions is indicated by the results of the North Western's examinations, which were published by Mr. R. C. Richards, general claim agent of the company. Out of

443 men rejected, 102 rejections were for "hernia, heart and lung troubles, loss of fingers, etc." A defective heart sometimes causes a train accident. Of 8,397 men examined, including some who were already in the service as firemen and brakemen and who desired promotion, 1,061 or 12.6 per cent. were rejected; and Mr. Richards believes that the knowledge that examinations would be required led as many more defectives to refrain from applying. They could go to roads not so strict. Railroad surgeons sometimes appear to be over-nice in their standards, as, for example, when they talk in conventions about sleeping-car sanitation; but in this matter of excluding defective men from the service there is no danger of setting the mark too high, and the surgeons' influence ought to be extended. An examination for color-blindness alone is a poor apology for a complete physical examination. There would be no harm in going even beyond the surgeons' requirements, and letting Dr. Scripture, or some other psychological expert, measure the men's quickness and accuracy of perception and the clearness and precision of their mental processes. Such an innovation would call forth a vigorous remonstrance no doubt—as did color-blind examinations a few years ago (and in some places even now)—and we are not advising any superintendent to pick a quarrel with a brotherhood; nevertheless the diplomatic superintendent who will put in practice some of the good advice that Dr. Scripture has given, will do the world a service.

Probably the liveliest discussion in the meeting will be that on per diem, a subject on which many members will have very definite views, and ready tongues to express them. As intimated in the foregoing paragraph, physical examinations ought to have no discussion at all, everybody ought to vote aye at once. But on the subject of per diem one feature alone, the amount of the price per day, could be discussed for a week. The notes on the subject by Mr. Hale, published in this paper last week and this, would seem to indicate that he does not think the rate ought to be changed at present; and as his committee report recommends nothing but changes in details it is fair to conclude that the majority of his fellow members agree with him. But the advocates of an increase of the rate from 20 cents a day to 30 cents or more have much logic and reason in their arguments, as well as a mass of facts with which to drive them home, and they can hardly be expected to keep still. It is right for the committee to be conservative at this stage—though it was so bold at the outset—but cars are constantly increasing in average value and capacity and an increase in the exchange rate is bound to come. It is not believable that it can be as long coming as was the change from mileage to per diem, and members who have facts which will support the propaganda have a duty to lay them before the Association; for many minds will have to be informed thoroughly on the subject before satisfactory progress can be made. The spread of knowledge as to the need of more equitable rates—different rates for different classes of cars, perhaps—will be a great aid in securing the adoption of per diem rates for private cars, which every enlightened operating officer desires to see accomplished; for if the rates offered on refrigerators, for example, were to be 50 cents a day some of the car owners might yield.

The discussion on refrigerator-car rates which took place at Chicago last week, and which was reported widely in the newspapers, while telling nothing new to operating officers may be useful in arousing some of these officers' superiors to the inequitable arrangements that are in effect. The remedy for the evil, however, is not easily found. The payment by railroads of exorbitant rates for the use of shippers' cars—or cars which are used as a means of giving shippers a benefit—is essentially a cutting of transportation rates, and is usually as vicious and as hard to detect and prevent as other kinds of rate cutting. While some car-owners make 50 per cent. annually on their capital others do not make nearly so much. The evidence that the cars of the Union Tank Line earn only 5 or 6 per cent. on their cost was one of the most significant incidents of the Chicago hearing. If the rates were to be reduced and the car line driven out of business, and the railroads were obliged to furnish tank cars themselves, apparently the only change effected would be that losses, when borne by the railroads, could be concealed. It is not likely that they could be abolished (unless railroads could get capital at a lower rate than the car company), for the Tank Line probably builds, maintains and distributes its cars with reasonable economy; and losses would simply fall on some other department of the railroad service.

The tank line incident sharply illustrates the point made by Mr. Hale, in his paper, that a single uniform rate cannot be made to fit different kinds of cars used in many different kinds of traffic. Mr. Midgley has done a useful service in making public some crying abuses; but to find and apply a remedy it will be necessary to go far. Commissioner Prouty seems to think that Congress is the place to go; but a journey to that fountain head of justice will be a long one in time if not in space, for the members of the Congressional Committee would probably ask for time to accomplish something on their present anti-trust puzzles, before being required to take up a new one. A Federal law requiring the railroads to themselves provide all kinds of cars would be so inequitable in many of its applications that it would be likely to prove unworkable. To draft a statute which would fairly regulate the use of cars not owned by the railroads would, very likely, prove impossible. The only alternative to Mr. Prouty's suggestion is to appeal to individual railroad managers to clean out their own Augean stables, each for himself. Any hope of a general success by working in this direction must depend on finding a large number of rather unusual men; men who manage their railroads with full regard for the interests of their stockholders and the rights of shippers but with careful disregard of big shippers' unreasonable or illegal demands; with intelligent knowledge of the workings of their freight-car department and of the logical superiority of the per diem principle over the mileage principle; and possessing the courage and persistency necessary to induce other and weak-kneed railroad officers to join in the battle for decent and rational business methods. Such a railroad officer must, of course, be actuated by a high public spirit and never think of his own pocket.

## Erie.

The net income of the Erie Railroad for the year to June 30 was $4,552,053. This amounted to 9.5 per cent. on the first preferred stock, or to 7.1 per cent. on the first and second preferred together. If 4 per cent. had been paid on both preferred stocks there still would have remained nearly 2 per cent. for the common.

The year was a peculiarly severe one. The company suffered from disastrous floods in the early part of the year, and this was succeeded by a very rough winter. The upward movement of wages and prices continued and culminated during the year, while the freight traffic declined. The only favoring factors were the increase in the coal tonnage and in the average receipts per ton-mile on merchandise freight. Erie's mileage for many years has been practically unchanged, but there has been a steady increase of second track. This year 35 miles of such track were added. This mileage was pretty well distributed over the road to provide passing tracks where most needed. Ten iron bridges were replaced by heavier steel bridges. In general the bridges and roadbed have been kept in very fair condition. The bridges of the main line are now up to requirements of the heavy engines.

Some $44,000 was spent in grade reductions and relocations. Extensive improvement work by the roadway department has, apparently, been deferred again this year, and is waiting upon the final formulation of an adequate improvement policy that shall attack comprehensively the problems of grade, terminals and road facilities. The rail of the main line is now up to 90-lb. standard, and the renewals for the year have been fair.

Erie's equipment has for years been conspicuously inadequate. The past year is specially marked by the heavy additions of new power, with 2,200 freight cars and 62 passenger train cars. One hundred and fifty new locomotives have been added. This reduces the average age of locomotives 11 months, bringing it down to a little under 13 years. The new freight cars are very few compared with the real need. Since the close of the fiscal year the company has bought 3,500 more. These displace 5,261 of an average age of 23 years. With these changes, Erie now has about 51,000 freight cars of all kinds, of which about 40 per cent. are nine years old or less.

The financing of the year was principally concerned with the purchase of this new equipment. The entire expenditure upon the property was $9,028,602. Of this amount about $6,000,000 went for equipment charged to capital account; and $800,000 was spent for land, yard improvements, coal storage plants, signals and interlocking, elimination of grade crossings, and additional tracks and sidings; this also was capitalized. The remainder, or $2,250,000, was spent for additional tracks and sidings, yards, stations and buildings, docks and piers, bridges and culverts, and various other roadway improvements, and was paid for out of earnings. The financing is told by the table below:

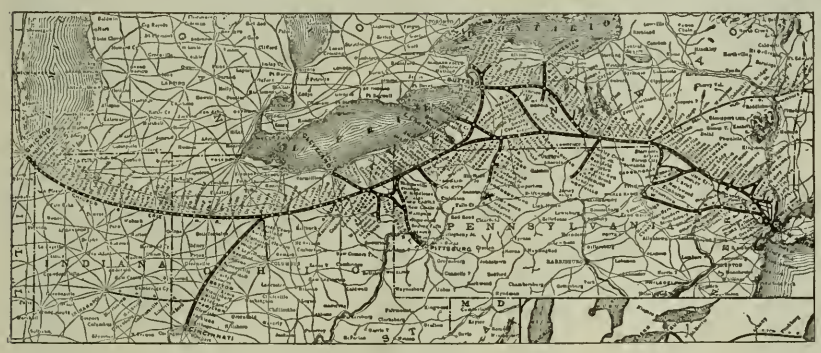
| *Debit.* | |
|---|---|
| Liabilities increased— | |
| Funded debt | $3,860,000 |
| Interest and rents accrued | 15,037 |
| Pa. Coal Co., sinking fund | 313,606 |
| Current liabilities: Profit and loss | 1,398,209 |
| Assets decreased— | |
| Miscellaneous securities | 270,221 |
| Current assets (net) | 4,940,825 |
| | $10,797,898 |

| *Credit.* | |
|---|---|
| Assets increased— | |
| Road and equipment | $7,263,521 |
| Materials and supplies | 1,186,165 |
| Trust and sinking fund | 301,232 |
| Due from subsidiary companies | 517,896 |
| Advance payments | 35,646 |
| Liabilities decreased— | |
| Construction obligations | 25,916 |
| Mortgages | 4,000 |
| Equipment trusts | 522,915 |
| Reserve funds | 940,607 |
| | $10,797,898 |

The earnings were as follows:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Earnings | $45,201,163 | $45,830,413 | $629,250 D. |
| Expenses | 32,581,838 | 29,925,758 | 2,656,079 I. |
| Net | $12,619,325 | $15,904,654 | $3,285,329 D. |
| Other income. | 789,312 | 1,430,230 | 640,918 D. |
| All income | $13,408,637 | $17,334,885 | $3,926,248 D. |
| Charges | 8,856,584 | 8,901,618 | 45,034 D. |
| Net inc.. | $4,552,053 | $8,433,267 | $3,881,214 D. |

The striking thing in the income account is the heavy increase in expense with the decrease in earnings. This disparity is yet greater when we examine expenses in greater detail. Of the entire increase in expenses, $2,656,079, maintenance was accountable for but a little over $1,100,000, while transportation and general expense is chargeable with the remainder, or about 60 per cent. of the whole. The ton-mileage of



Erie.

all freight fell off 4 per cent., while the expense of handling it increased 9.2 per cent. This puts Erie this year into the class of roads which have not been able to hold their transportation expenses in hand. A large and unstated part of this was due to floods and the severe winter, but the detail of expenses would indicate that higher wages and higher prices for materials played a large part. One item stands out most conspicuously, namely, the increase in the coal bill. This amounts to $610,000, or nearly 20 per cent. The expense of fuel per locomotive mile as a result has this year reached 11.75 cents. The entire expense per locomotive mile is 32.55 cents, which must be regarded as excessive.

The operating averages were:

| | 1904. | 1903. | Change. |
|---|---|---|---|
| Tons of freight* | 29,835 | 31,645 | 1,810 D. |
| Ton-miles.* | 5,189,158 | 5,407,350 | 218,192 D. |
| Average haul | 173.93 | 170.87 | 3.06 I. |
| Receipts, ton-mile, cts | .627 | .612 | .015 I. |
| Frt. earn'gs per mile | $15,125 | $15,362 | $237.0 D. |
| Frt. train mile earngs | $2.51 | $2.48 | $0.03 I. |
| Pr. ct. loaded car-miles | 68.7 | 68.3 | .4 I. |
| Tons per train | 400.12 | 406.20 | 6.08 D. |
| Tons, per loaded car. | 17.44 | 17.88 | .44 D. |
| Passengers carried* | 20,395 | 19,976 | 419.0 I. |
| Passenger miles* | 549,757 | 528,997 | 20,760 I. |
| Pass. train mile rev. | $1.108 | $1.110 | .... |

*(Thousands.)

The increase in ton-mile revenue amounts to 2½ per cent., and materially assisted in holding down the net decline in gross earnings. The balance of traffic was fair and changed little from the previous year. The tons per train fell and the tons per loaded car, but the better revenue more than offset these declines and produced a freight train mile revenue three cents greater than last year. Altogether this year will be conspicuous for the heavy expenses, the halting tendency of business, the purchase of new power, and the dissolution of the voting trust which has had the financial management of the property since its receivership.

## Canadian Pacific.

In connection with the report of this company for the fiscal year, an announcement has recently been made that the stockholders have authorized an issue of $25,500,000 capital stock, to be used from time to time for improvement purposes. This raises the total capital stock from $84,500,000 to $110,000,000. In 1902, there was an increase of $19,500,000, making a total increase in two years of $45,000,000. But these figures, vast as they are, simply measure the tremendous growth of the system. During the last few years, the mileage has steadily increased, and large amounts have had to be spent on equipment and roadbed in order to meet the growing requirements of traffic. How fast this traffic has developed is shown by the large increases in gross receipts during the past eight years. For the present fiscal year, gross receipts were $46,469,132, an increase of $2,511,759 over 1903, while only as far back as 1896, the total gross earnings amounted to but $20,681,597—an increase of 130 per cent. in eight years. Freight receipts this year were $29,235,821, as against $28,502,082 in 1903 and $13,187,560 in 1896. Passenger receipts this year increased $1,416,445 over last, and $7,598,276 over 1896. The company has also added largely to its ocean, lake and river steamship service, and part of the $15,516,745 4-per cent. consolidated denbenture stock issued during the year was used for the purchase of 15 new Atlantic steamships. The continued expansion of revenues in the last few years is particularly satisfactory from the fact that it does not come from grain traffic alone, as in former years. The company has built up a varied traffic in lumber and in manufacturing, mining and farming articles. Notwithstanding a loss in the amount of grain hauled during the past year, the gains in other kinds of freight have enabled the company to show a fair increase in freight earnings.

The expansion of traffic having been large the expenses have necessarily been heavy, and the severity of last winter, almost unprecedented, caused an extra drain. For the year, operating expenses were $32,256,027, an increase over 1903 of $4,135,500. This left a decrease in net earnings of $1,623,741; and with a dividend on the common stock of 6 per cent. (instead of 5 per cent. as formerly) the surplus for the year comes down to $1,666,204.

The report contains an interesting table showing that total expenditures for improvements and additions to rolling stock and equipment since 1901 have amounted to $31,017,355. Of this sum, $19,500,000 was supplied by the stock increase made in 1902, $979,373 was obtained from the proceeds of the sale of preferred stock, $3,000,000 was especially set aside for that purpose from surplus earnings and $7,537,962 was temporarily advanced from earnings.

The average mileage worked during the year was 8,332, an increase of 594 miles. This includes those parts of the Pheasant Hills and Souris branches, which, although practically completed in 1903, were not included in the traffic returns of last year. The report states that 338 miles are now under construction, including an extension from Esterhazy in a northwesterly direction and the Arcola-Regina line. The more important statistics of operation follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 8,332 | 7,748 |
| Gross earnings | $46,469,132 | $43,957,373 |
| Passenger earnings | 12,418,419 | 11,001,974 |
| Freight earnings | 29,235,821 | 28,502,082 |
| Mail and express | 1,743,604 | 1,567,003 |
| Steamships and misc. | 2,350,282 | 2,248,672 |
| Parlor and sleeping cars | 721,006 | 637,642 |
| Operating expenses | 32,256,027 | 28,120,527 |
| Maintenance of way | 7,372,408 | 6,642,165 |
| Maintenance of equip. | 5,873,163 | 4,864,551 |
| Conducting transportat n | 16,149,578 | 14,045,460 |
| Other expenses | 2,860,878 | 2,568,348 |
| Net earnings | 14,213,105 | 15,836,846 |
| Net income | 8,318,277 | 10,071,461 |
| Surplus | 1,666,204 | 3,983,960 |

## St. Louis Southwestern.

One of the interesting features of this company's report is the steady increase in the average train load which it has now shown for several years. Although the train load this year is not so very much larger than it was in 1903, it still shows a fair percentage of increase. The following table gives the average train loads of the St. Louis Southwestern proper, the St. Louis Southwestern of Texas and the entire system for the past five years.

| | St. L. S-W. Ry. | St. L. S-W. Ry. of Texas. | Entire system. |
|---|---|---|---|
| 1900 | 292 | 149 | 231 |
| 1901 | 318 | 151 | 236 |
| 1902 | 344 | 160 | 256 |
| 1903 | 384 | 167 | 282 |
| 1904 | 388 | 172 | 285 |

Gross receipts for the year were $7,649,485, an increase of $370,910 ($191,606 in freight, $137,753 in passenger). The ton mileage for the year was 508,377,628 tons, an increase of 6,158,163 tons. The average class of freight carried was of a higher quality, consisting of lumber, agricultural products and general merchandise, which increased the average ton-mile revenue from .110 cents to .113 cents. There was a gain of 10 per cent. in passenger receipts.

Although maintenance of way charges decreased slightly, increases in the maintenance of equipment and conducting transportation accounts resulted in an increase in the total operating expenses of $165,434. Expenditures for betterments and additions to existing lines were $718,157. This amount, together with a portion of the expenditures made during the preceding year for the same purpose amounting to $375,984, were originally charged to a temporary current account; but the company has issued first consolidated mortgage bonds and the total amount of these expenditures, aggregating $1,094,141, has now been entered under cost of road.

Net earnings were $2,227,888, an increase of $205,499. After subtracting all fixed charges for the year, there was a decrease in surplus of $26,007 over 1903. This was due to an increase in interest charges resulting from the issuing of $120,000 of first consolidated mortgage bonds, and to the sum of $25,000 charged to income account for equipment payments. The chief statistics of operation follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 1,303 | 1,291 |
| Gross earnings | $7,649,485 | $7,278,575 |
| Operating expenses | 5,421,597 | 5,256,164 |
| Net earnings | 2,227,888 | 2,022,411 |
| Surplus | 668,828 | 694,835 |

### Northern Pacific.

The Northern Pacific earned, net, in the fiscal year closing June 30, 1904, $15,229,310, or 9.82 per cent. on the $155,000,000 of stock. Last year it earned $14,745,889, or 9.51 per cent. The policy of building small feeders still continues, and in the past year 202 miles were added to the operated mileage of the road. Fifty-seven miles of this consisted of two extensions, one of 45 miles in North Dakota, and one of 12 in Washington. The lines bought were the Monte Cristo Railway, 42 miles; Washington Railway and Navigation lines, 56 miles; Bellingham Bay & Eastern, 23 miles; Seattle & San Francisco, 3 miles. In addition to these 106 miles, composed of 6 small extensions, are in process of construction, but not finished.

Grade revisions of the year to be completed this fall reduce the maximum grade on the Idaho division to .4 per cent. westbound and .5 per cent. eastbound. During the year 285 bridges were replaced and one eliminated, the whole length thereby changed amounting to 5.3 miles. There was little change in the equipment. The 16 added locomotives came with the purchase of the branch lines. Only about 200 freight cars were added, and there was practically no change in passenger train equipment.

About $4,630,000 was spent upon the property and its equipment and charged to capital account. About $1,000,000 of this was raised by increasing the funded debt. Other changes in the balance sheet were not of significance. They resulted in an accumulation of about $7,000,000 more of cash, which was drawn from various funds and by deferring certain payments. The reserve funds, however, have increased over $1,000,000.

The income account for the year was:

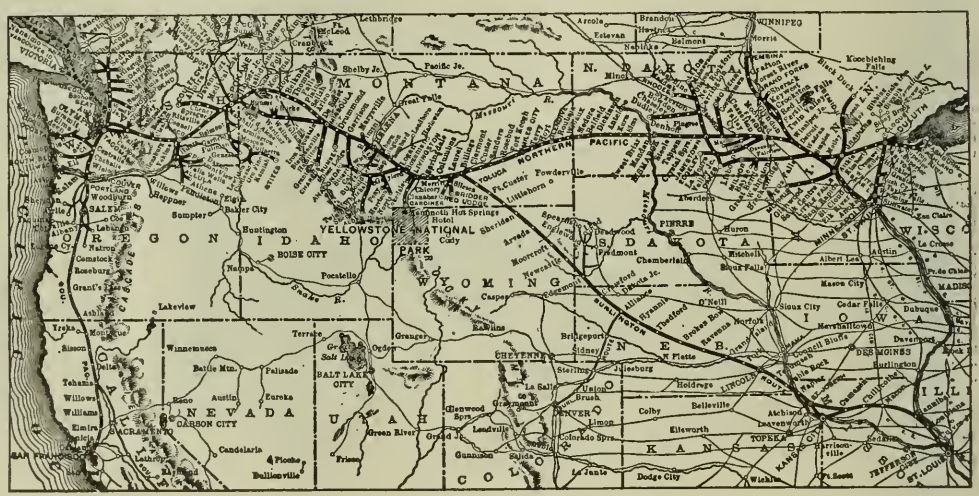
| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Earnings | $46,524,574 | $46,142,104 | $382,470 |
| Expenses | 24,234,542 | 24,032,092 | 202,450 |
| Net | $22,290,031 | $22,110,011 | $180,020 |
| Less taxes | 1,421,433 | 1,421,433 | 41,341 |
| Balance | $20,827,256 | $20,688,578 | $138,677 |
| Other income | 1,483,354 | 1,112,550 | 370,803 |
| All income | $22,310,610 | $21,801,129 | $509,481 |
| Charges | 7,081,299 | 7,055,239 | 26,060 |
| Surplus | $15,229,311 | $14,745,890 | $483,421 |

The income account, for the first time in seven years, is practically stationary, showing an increase of only about 1 per cent. in gross earnings. Northern Pacific has had a tremendous expansion of gross earning power, due to the development of the territory which it serves; and the income figures of the year show certain of the tendencies which we should expect to find in time. The ton mile revenue has declined nearly 3 per cent., and the ton miles hauled have increased nearly 2 per cent. The actual freight earnings show a decrease of a little less than 1 per cent.

Another tendency which we should expect to find is the development of passenger business. This year passenger earnings increased $484,000, which more than made good the loss on freight earnings, so that out of both passenger and freight the road was able to produce a net gain of $382,000. The tonnage moving was fairly well balanced by direction. It is an interesting fact that the balance, such as it was, shifted so that the preponderance of movement was westbound instead of eastbound. The principal factor in this change was the decline in wheat, flour, other mill products and forest products eastbound, and the increased shipment of forest products westbound.

The expenses were about $202,000 greater than last year, and the increase in the two items of maintenance of equipment and conducting transportation (about $561,000) was much greater than the net increase of all the items (including general expenses) for there was a decrease in maintenance of about $471,000. The increase in transportation expense is not unreasonable, in view of the fact that there has been an increase in ton mileage of 2 per cent. and a very considerable increase in passenger earnings, while this has been a year of advances in wages. In transportation expenses the fuel bill, as is the case on most roads, is the principal item of increase. And this difference seems to be very largely a difference of price and not of quantity consumed.

There does not appear to be in the report of the year past anything of especial moment except the fact which stands out above all others that the traffic has not increased with its former rate of expansion. Two per cent. increase in freight ton mileage is less than we should expect to find in a fairly normal year on Northern Pacific. In the previous year the increase was nearly 16 per cent.




Northern Pacific.

## NEW PUBLICATIONS.

*American Railway Shop Systems.* By Walter G. Berg, Chief Engineer, Lehigh Valley Railroad. New York: Published by the *Railroad Gazette.* 6 in. x 9 in. Cloth, 198 pages. Price $2.

The subject of this work is one with which Mr. Berg is peculiarly well adapted to deal. It necessitates the gathering of a great mass of drawings, photographs and descriptive matter, and it has to be arranged philosophically, because the reader usually finds it necessary, or at any rate desirable, to examine the data on which are based the author's conclusions. No summarizing in words takes the place of drawings. Mr. Berg has collated with his usual care and industry and has made simple and rational classifications. He has brought together ground plans of over 40 prominent railroad shops for repairing locomotives, or cars, or both; and including some large shops of establishments not owned by railroad companies; and he has grouped his material for easy comparison, study and reference. He has recent examples in abundance, but has neglected no meritorious plan because it was not new. Besides the line drawings there are numerous full-page half-tone photographic engravings. There is a bibliography filling seven pages and containing references to apparently all of the good articles on this subject which have appeared in the railroad journals within the past dozen years.

*Reinforced Concrete.* By A. W. Buel and C. S. Hill. New York: Engineering News Publishing Company. 1904. Cloth, 434 pages.

Reinforced or armored concrete is of such recent origin and development that as yet the theory of its design is unsettled and lacking in agreement between the results of the investigations by the many engineers who have attempted to work out a rational theory which conforms to the results in practice. A great mass of literature has been written on the subject, much of which is contradictory and misleading, but notwithstanding, reinforced concrete has made rapid strides in advance and is being used more and more every day. For some purposes it is the ideal material, and many engineers would be glad to have, in some concise form, practical working formulas for the design of reinforced concrete structures. The authors of this book have endeavored to supply this want. As far as possible theoretical discussions have been omitted and practical working formulas, with records of actual practice in the selection of materials and of methods of workmanship and construction, have been supplied instead. For convenience the book has been divided into three parts. Part 1, which has been written by A. W. Buel, considers the formulas necessary for the calculation of stresses and the design of all classes of reinforced concrete structures, together with many facts about the properties of concrete and steel which are necessary in developing economical engineering designs. Part 2 is devoted to descriptions of a number of representative structures of reinforced concrete. Part 3 takes up materials, workmanship and methods of construction, and is illustrated by examples from actual practice. Much space is devoted to the construction of centers and forms for concrete work and to methods of facing and finishing exposed surfaces. The illustrations in the book are uniformly good and supplement the very complete descriptions.

*New York Air-Brake Catechism.* By Robert H. Blackall. New York: Norman W. Henley Publishing Company. 1904. Cloth, 250 pages. Price $1.25.

Blackall's Catechism of the Air-Brake is a standard book among railroad men and the information which it contains about the Westinghouse air-brake apparatus has been practically duplicated in this latest book, which describes the apparatus of the New York Air-Brake Company in the form of a catechism. Nearly a thousand examination questions on the New York air-brake apparatus, together with complete answers, are given, and many illustrations of the apparatus are shown to make clear the text.

*Centrifugal Pumps.* By Charles H. Innes. M. A. Manchester: The Technical Publishing Company, Ltd. D. Van Nostrand Company, New York. 1904. Cloth, 340 pages. Price 4s. 6d.

The theory of turbines, centrifugal pumps and fans has been completely covered in this book, which is a fourth and enlarged edition. All of the necessary data and formulæ for designing water and steam turbines and centrifugal pumps has been worked out in great detail. The book is illustrated with numerous diagrams and illustrations of machines built for commercial purposes.

## TRADE CATALOGUES.

*The Ingersoll-Sergeant Drill Co.*, New York, sends a copy of a pamphlet bearing the title "The Storage Air-Brake System at the St. Louis Transit Company." This pamphlet contains a short sketch of the storage air-brake system adopted by the St. Louis Transit Company. Reference is made to the tests of the system recently made by the Railway Test Commission at the Louisiana Purchase Exposition. Illustrations help to explain its operation. The pamphlet is issued jointly by the Ingersoll-Sergeant Drill Company and the Westinghouse Traction Brake Company, and is of special interest to street railway men.

*The Buda Foundry & Manufacturing Co.*, Harvey, Ill., devotes its September Bulletin to switch stands. It is a complete catalogue of these devices and contains 31 pages. Seven general classes of stands are shown, including Ramapo automatic safety stands, semaphore stands, open-base stands, column stands, stands with tripod, yard-throw stands and ground-throw stands; also different kinds of connecting rods. The illustrations are all half-tone work from wash drawings and are clear and well executed. This bulletin is the seventh of these interesting publications.

*The Yellow Strand* is a publication of the Broderick & Bascom Rope Company, St. Louis, the October number being the first. On the first page is "Ropeology," a series of short, bright paragraphs about "Yellow Strand" and other things. On the inside are brief articles on "Rope Drive vs. Motor Drive," "Conscience in Rope Making," and a description of the B. & B. exhibit at the World's Fair. There are also a number of anecdotes in which the point always appears to be nicely applicable to "Yellow Strand," the company's trade-mark for its wire rope.

*Arthur Koppel*, New York, maker of industrial and standard gage railroad materials, is distributing a booklet bearing the title "On the Track." It opens with a reprint of an article from *Cassier's Magazine*, written by Ernst Wierner, manager of Arthur Koppel. The object of this article is to put parties who are looking for an economical method of handling materials "on the right track." Illustrations of equipment for industrial railways, such as steel rails, light turntables, wheels and axles, special cars, etc., are also given.

*The Crane Company*, Chicago, is distributing its special catalogue No. 100. It is 7 in. x 10½ in. and contains about 100 pages. Illustrations, descriptions and sizes of the different styles of valves made by this company are given as well as a number of illustrations of boiler fittings such as gages, chimes, steam-whistles, safety-valves, wrought iron and steel pipe bends, flanges, etc.

*The Holland Company*, Chicago, sends a circular about the Racine rail anchor, a device to prevent creeping of rails. It consists of two malleable-iron jaws which engage the rail flange on each side and are drawn together with a bolt. They bear against the tie, and if desired, anchors on opposite rails can be joined by one long bolt through the two to prevent spreading of the rails.

*The Spaulding Print Paper Company, Inc.*, Boston, Mass., sends a pamphlet descriptive of its Federal blue-printing machine. This is a continuous printing apparatus for making blue prints by electric light. A detailed description as well as illustrations showing the general construction and method of using the machine are given.

*The Northern Electrical Manufacturing Company*, Madison, Wis., is distributing its bulletin No. 37. It is descriptive of the northern variable speed motor. A number of illustrations are given which show the application of this motor to the different types of machine tools.

*The Stanley Electric Manufacturing Company*, Pittsfield, Mass., sends its bulletin No. 140. It contains a detailed description and illustrations of the form M oil switch. The switch is made in the two, three and four-pole style for both 2,500 and 6,600 volts.

*The Becker-Brainard Milling Machine Company*, Hyde Park, Mass., issues an illustrated pamphlet descriptive of its exhibit at the Louisiana Purchase Exposition.

*Joseph Dixon Crucible Company*, Jersey City, sends a pamphlet bearing the title, "The Lubrication of Axles." It describes "Dixon's everlasting axle grease," and also contains a number of testimonial letters from persons who have used it.

# CONTRIBUTIONS

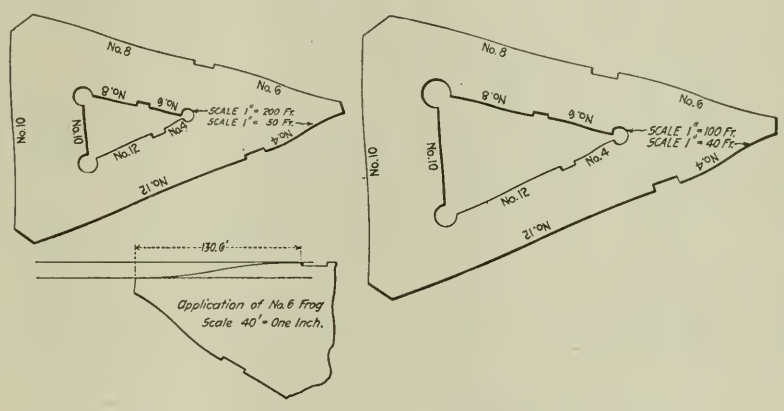
### Curves for Cross-Overs.

Williamsport, Pa.

To the Editor of the Railroad Gazette:

The accompanying illustration shows a handy tool, a pair of which should hang in a convenient place in every drawing room where track work is done. The average civil engineer and maintenance of way draftsman can see at a glance the advantage to be gained by the use of such a tool, as the neat drawing of cross-overs is one of the most tedious tasks with which the draftsman has to contend.

The curves can also be used to determine almost instantly whether it is possible to get a cross-over in certain places as the length of the cross-over is given from one notch to the other.




Templets for Laying Out Curves for Cross-overs and Switches.

These templates can be made of pear wood, brass, rubber or xylonite (celluloid), the latter being the best, although the pair I have are brass and can be made to suit any scale. Mine are worked out on a basis of 12 ft. 2 in. track centers and to the scales of 40, 50, 100 and 200 ft. to the inch, which serves most purposes. The curves are also used for laying out shop yards.

A. P. SHARP.

### Cost of Concrete Structures.*

BY H. M. JONES.

In attempting to get accurate costs of concrete work done by a railroad company's own forces, one is met at the outset with many difficulties.

1. Ignorance on the part of the foreman in charge of what is wanted as to cost records and his lack of experience as an accountant if he knows what is wanted. The separation of different classes of work where the same men are often called upon to execute both is a matter of judgment and is subject to wide variation.

2. Not many small jobs justify the time necessary to keep a record of cost of the various details of the work. Only foremen who have proved themselves efficient for the work are put in charge of gangs; and it is expected that they will prosecute all work under their supervision as rapidly and as

*Extracts from a paper presented to the Nashville Section of the Engineering Association of the South at the October meeting.

well as possible. To burden such men with the work of keeping the detail costs of the work would worry them to the extent of causing a neglect on their part of the work itself. Of course where work is of sufficient magnitude to employ a special timekeeper a cost record can be kept with accuracy.

3. The cost of unloading material is a very variable one, depending on the amount of traffic passing over the line on which work is being done, on the proximity to stations, on the character of cars material is sent in, etc. The cost of moving a gang to a piece of work also cuts quite a figure when the job to be done is small, as the price per yard is then unreasonably high as compared with a large job.

4. Sand is usually shipped from a sand pit which is owned by the railroad, and the only cost is that of loading and a proportion of the original purchase price of land and cost of stripping. For purposes of comparison it has been placed at 40 cents per yard in the tables given herewith, as this probably represents the cost to the company. In a few instances on the Atlanta Division of the Nashville, Chattanooga & St. Louis, sand has been purchased on the line for a number of jobs at 60 cents per yard, as the company's sand pit is too far from that division to justify shipping it.

5. Lumber is variable on account of the fact that rarely if ever is the entire amount at any one place bought new. Some jobs, however, get a much larger proportion of new timber than others, thus accounting for the wide differences noted in table No. 1.

6. All material is carried company service.

The above conditions, however, prevail to a more or less degree on all railroads, and what is of most concern is: What does it cost to do concrete work under these conditions? The costs herein given are compiled from the work reports of foremen in charge, from the records of material purchased, etc., in the Chief Engineer's office; and while no claim is made that they are absolutely accurate, yet it is believed that they represent the fair average costs of work done under the conditions to be described.

The first exposed structure built of concrete by the Nashville, Chattanooga & St. Louis was an 18-ft. full-centered arch culvert near Paris, Tenn., on the Paducah & Memphis Division. At this point there was a frame trestle 65 ft. high and 1,333 ft. long, which had so deteriorated as to require renewal. The drainage area was estimated to be 3,600 acres; and the bottom was a long, flat one, very sandy—being, in fact, filled with sand from the adjoining hills. The 18-ft. culvert gave a water way of 289 sq. ft., minimum fall, and 162 sq. ft. up to the spring line. The railroad company was not at that time equipped to do concrete work, but had built with its own forces many brick culverts; and it appeared most economical at first to build the structure of brick. However, bids were solicited from outside contractors for a structure of concrete, and that of the Nashville Roofing & Paving Company was accepted. Not being able to get a foundation at a reasonable depth, it was decided to drive piles to assist in supporting the structure and its load. These piles were spaced about 2 ft. 9 in., center to center, under the side walls of the culvert, and were driven with a specially rigged land driver. Ties 8 in. x 16 in., spaced about 9 ft. apart, were bolted to the foundation piles to prevent any possibility of the spreading of the foundation. Louisville cement concrete about 2 ft. deep surrounded the piles at the tops, about 6 in. of the heads of the piles being left exposed to give bond with the side-wall concrete. Paving 20 in. thick was put in, the lower 12 in. being of Louisville cement concrete and the upper 8 in. being of Alsen Portland. The piles and foundation concrete was put in by the railroad company's force. The middle third of the culvert was made heavier than the ends on account of the great weight on the center and the necessity of securing broader footings. Alsen Portland was specified for the main portion of the arch, because full confidence in the American product had not yet been firmly established. No expansion joints were provided in the structure; but vertical cracks have developed since about 50 ft. apart, showing that it would have been well to have made such a provision. The stone was shipped in drop-bottom cars; the sand, in ordinary coal cars; and both were dumped or shoveled from the cars into bins under the trestle. A cement house was constructed at surface elevation, and cement was sent down a chute to it. The mixing boards were also on the surface, and runways were built up as the work progressed. The stone used here was hand crushed in part. The contractors had given to them a large quantity of spalls from a quarry nearby, much of which was too large for the concrete, and this was broken by hand. An itemized statement of the cost is as follows:

| | | Av'ge, per cu. yd. |
|---|---|---|
| Superintendent's salary and expenses, 100 days | $550.00 | $0.29 |
| Foreman, 100 days at $2.50 pr day | 250.00 | .13 |
| Carpenter work | 354.65 | .19 |
| Mixing and placing concrete | 2,209.35 | 1.17 |
| Hauling material | 84.75 | .04 |
| Lumber centers, cement house, and hardware | 1,215.80 | .64 |
| Loading and breaking broken stone | 471.00 | .25 |
| Sand, 977 yd. at 60 cts. per yd. | 586.20 | .32 |
| 1,360 bbls. Old Dominion cement | 2,720.00 | 2.26 |
| 550 bbls. of Alsen cement | 1,567.50 | ... |
| Total | $10,009.25 | $5.29 |

The volume of concrete in the culvert is 1,894 yds.

Table No. 1 gives a detailed statement of the cost of the more important concrete structures put in recently by the forces of the Nashville, Chattanooga & St. Louis. In order that it may be clear just what conditions prevailed at each place a short description will be given:

Five-foot concrete culvert, Northwestern Division.—This is a full-centered arch culvert built under an open trestle 33 ft. high. The cost of excavation was excessive on account of blasting out much rock in order to secure a straight water way in a crooked ravine. The stone was dumped and the sand was shoveled into bins built on the ground between the trestle bents. The stone and the sand were near the site of the culvert. Cement was brought in wheelbarrows from the cement house constructed for another culvert job 1,000 ft. away. There is a large traffic on this division, and unloading had to be done as soon as the train arrived at the site, regardless of what work was going on. The material was handled to the mixing boards and from the mixing boards to forms in the usual manner by wheelbarrows. The cost of forms per cubic yard is usually considered as varying inversely with the size of structures of similar kinds. By reference to the table it will be seen that the cost here was considerably in excess of the average. Carpenters were held here to work on the other culvert 1,000 ft. away; but as this work could not be begun promptly, they were put to work mixing concrete. This accounts for the high average price for labor per day. The proportions used in mixing were 1 of cement to 5.5 of stone. This is somewhat richer than usual. The items not classified were such as hauling drinking water, cutting a ditch to turn the water, taking out bents of the old trestle and constructing false work to carry the track, and sidetracking cars.

Sixteen-foot concrete culvert, Northwestern Division.—This is a full-centered arch culvert of 16-ft. span built under an open trestle 47 ft. high. The foundation is rock. The cost of excavation was very heavy, because flinty rock had to be blasted to secure the foundation, divert the roadway through the arch, and change the creek channel. The culvert is on an angle of 70 deg. to the track. The middle third of the culvert had the arch ring thickened 6 in. The sand and stone were unloaded into bins constructed between the trestle bents and the cement was unloaded by hand into a cement house constructed at track elevation, being sent from there down chutes to the mixing boards. The rock and sand were handled to and from mixing boards, as usual, by wheelbarrows. The organization of the gang who did the work consisted of a foreman at $3.20 per day, a subforeman at $2 per day, and negro laborers at 90 cents per day, the railroad company paying the board of all, which averaged nearly 20 cents per day. This gang had had considerable experience in concrete work before beginning the job. The proportions, as reported, were 1 of cement to 6.5 of stone. The large volume in the job and the experience of the gang, of course, had a good deal to do with the low cost per yard at which the work was done. The entire cost of the work was only $6.27 per yard, while the cost of the concrete work proper was only $4.96.

Seven-foot-eight-inch concrete culvert, Chattanooga Division.—This is a full-centered arch culvert under a 16-ft. fill. It replaced an old stone box, which was too small. Piles were driven just wide enough to permit of the construction of the culvert, the bank was dug out, and lagging was put in. Part of the stone from the walls of the old culvert was used to build aprons; part of it was hand broken and used in the paving concrete. At the lower end of the old culvert a large hole had been washed out. This was filled up with stone from the old culvert, and paving was put in over it. The handling of material here was quite difficult, as the room for it was contracted. A water box was built lengthwise along the center of the paving to take care of possible rains, and the crushed stone was dropped through on top of the paving and box from drop-bottom cars and then wheeled out so as to give room enough to put up the forms for one side wall and then the other. When the side walls had been brought up to the spring line, the balance of the crushed stone needed to finish the job was dropped on top of the walls and paving and wheeled out. The centers were then put up, and the arch was finished. The breaking of the stone from the old culvert by hand cost 80 cents per yard, and the double handling of much of the material also added to the cost. The total cost of the work was $7.13 cents per yard; the cost of concrete proper was $5.31 per yard. While the average cost per day of labor here was low, the cost of mixing and placing was high. This was largely due to the conditions above explained, but was partly due to the inexperience of the negro laborers employed. The proportions used were 1 of cement to 6.5 of stone.

Twelve-foot concrete culvert, Chattanooga Division.—This is a full-centered arch culvert under an open trestle about 25 ft. high. The foundation was good gravel. One bent of trestlework was taken out, and a long temporary span was put in over the trestle. Bins were built under the trestle for the stone, which was dumped into them from drop-bottom cars. A chute on the side of the fill carried the sand almost to the mixing boards. A battery of water barrels was filled with water from the engine and carried with a sprinkling hose to the mixing boards. Owing to the small height of

the side walls they were carried down straight. The finish of the wings was also somewhat different from the general type of culverts. The mixture here averaged 1 of cement to 5.8 of broken stone—somewhat richer than usual. The organization of the gang was a foreman at $3.20 per day and laborers at 90 cents per day, the railroad company paying the board of all, which amounted to about 18 cents per day. The record made on this culvert was as follows: Total cost of work, $5.93 per yard; cost of concrete proper, $4.96 per yard. Considering the comparatively small volume in the culvert, this is cheap.

Twelve-foot concrete culvert at Doe Creek. —This is a full centered arch built under an open trestle 25 ft. high. It is on a new extension, where there was very little interference from trains; hence unloading material could be done without serious interruption. A solid-rock foundation was secured about 2½ ft. below the surface, the excavation being entirely earth. Stone was brought to the site in drop-bottom cars and dumped through the trestle into bins constructed between the trestle bents. Sand was unloaded into bins similarly constructed. A cement house was built several feet above the surface, and the cement was sent down a chute from the cars to this house. In one corner of the house a hole was cut large enough to drop sacks of cement through. Under this hole wheelbarrows were run, and the cement was dropped into them as needed and wheeled down a slight decline to the mixing boards. A trench pump was placed on an elevated platform and pumped water from the creek into barrels, which were placed at an elevation sufficient to deliver water to the mixing boards by gravity. Mixing boards were placed at each end of the culvert. No negro labor was employed. The foreman was paid $2.50 per day; two carpenters, $2 each per day; white laborers, $1.25 each per day; and the gang paid their own board. The average cost per day labor was $1.47. This was a green crew, which had done only one job of concrete previous to this and that was a different style of structure. The proportion of cement to stone was 1 to 6.1. The total cost of finished work was $5.88 per yard, while the cost of concrete proper was $5.16. The cost of building forms here was larger than it should have been—due to unfamiliarity of the carpenters with the work to be done. Had this item been about the average, the cost of the concrete would have been quite low. This record is good evidence that while concrete can be done with a small percentage of skilled labor, yet intelligent labor is greatly to be desired. White labor was obtained here at a very low figure, and it is quite likely that in other sections more would have to be paid to secure it; but with such a gang well trained, with a foreman thoroughly acquainted with concrete, better work would be done by using white labor exclusively.

Ten-foot culvert, Paducah & Memphis Division.—This is a full-centered arch culvert built under an open trestle 22 ft. high. The average cost of labor per day was $1.59, which is higher than usual, due to working carpenters on mixing and placing. The proportion of cement to stone was 1 to 5.8. The cost of material in the forms was also high, as new material was mostly used. The total cost of the work was $7.13 per yard, while the cost of concrete proper was $5.86 per yard.

Abutment walls, bridge, Columbia Branch. —At this crossing there was a pile trestle 40 ft. long which required renewal, and it was decided to build concrete abutments and put in 24-in. I-beams, 24 ft. clear span. The main walls were so located as to miss bents of the trestle, and the wings were interfered with at only two points. Three of the wings were flared at angles of 30 deg. to the axis of the culvert, while the fourth wing was flared 45 deg. in order not to interfere with the natural channel of the stream. Bins for the sand and stone were constructed on the slope of the bank, the lower ends of the bins being close to the mixing boards. At the head of the bin a portion of the bank was dug out under the track, and long stringers were put in to carry the track. The rock was then dumped from cars into this opening and from there shoveled into the bins. A cement house was built near the surface, and the cement was sent down a chute from the cars. The forms were simpler than in any of the arch structures heretofore described, and the erecting was done at less cost. However, as the cost of the lumber was higher, it about balanced the labor reduction. As the concrete here was all in straight walls and as the larger portion of the entire volume was concentrated in a small area, with plenty of room for gangways, mixing boards, etc., cheaper work was done than on an arch culvert or a structure where less concrete was put in. However, the cost was no less than some of the more difficult structures. The gang which did the work was green and this was the first concrete they had put in. The organization of the gang was the same as that for Doe Creek. A portion of the excavation here was probably included by the foreman in the item of mixing and placing. The mixture was also richer than usual, being 1 of cement to 5.7 of stone. At Doe Creek the price of mixing and placing was $1.22 per cubic yard, while here it was $1.69—which, on its face, seems to show a decided increase in the efficiency of a gang after practice on only one job. This shows the importance of keeping well-trained concrete laborers on the same kind of work continuously.

Open drain, Jasper Branch.—The old structure at this place was 12 ft., span pile trestle. As it required renewal, it was decided to replace it with a cedar-covered drain, with concrete side walls. The small volume of concrete, the expense of moving to the work, etc., ran the cost up, the total for concrete proper being $6.41, notwithstanding the aggregate used was cheap on account of using slag instead of crushed stone.

Another class of railroad structures where concrete can be employed economically is in foundations for track scales. On table No. 1 are shown the details of cost of several. No itemized statement of the cost of forms, unloading material, drainage work, etc., was kept on these structures; but the total cost, including all these items, is such as to show that concrete is well adapted for the purpose, both in economy and efficiency.

Retaining wall, Lookout Mountain.—Room for storing and handling material at this point was restricted and necessitated additional labor in handling; otherwise the conditions were favorable for cheap work, the structure being a simple one, having its mass concentrated in a small area. Slag was used principally as the aggregate, and old material was used for the forms, thus reducing the cost of mterial. The cost of the entire work was $5.75 per cubic yard. The laborers were negroes, but were directed by an intelligent and experienced white foreman.

A number of rim walls for turntable pits

STATEMENT OF COSTS OF CONCRETE STRUCTURES ON THE NASHVILLE, CHATTANOOGA & ST. LOUIS.

| Items. | Culverts, 5-ft.; N. W. Div. | Culverts, 16-ft.; N. W. Div. | Culverts, 7 ft. 8-in.; Chatta. Div. | Culverts, 12-ft.; Chatta. Div. | Culverts, 12-ft.; Doe Cr.-McMinn Br. | Culverts, 10-ft.; P. & M. Div. | Walls—Abutm't; Col. Branch. | Walls—Side, for drain; Jasper Br. | Retaining; Lookout Mount. | Foundation track scales, Chatta-nooga. | Foundation track scales, Bartow. | Foundation track scales, Lex-ington. | Rim walls turntable. Waverly. | Rim walls turntable. Atlanta, Ga. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cubic yards | 210 | 986 | 199 | 292 | 406 | 354 | 310 | 99 | 282 | 78 | 71 | 72 | 41 | 258 |
| Labor costs: Excavation | $316.30 | $639.05 | $251.75 | $131.15 | $140.50 | $212.20 | $80.00 | $50.00 | $181.05 | $44.70 | $65.70 | $90.55 | ..... | ..... |
| Unloading material. | 48.00 | *..... | 33.55 | 54.00 | 65.15 | 63.70 | *..... | *..... | *..... | *..... | 21.40 | *..... | *..... | *..... |
| Building forms | 225.25 | 407.70 | 65.50 | 136.80 | 295.20 | 217.80 | 109.90 | 40.00 | 308.90 | *..... | *..... | *..... | *..... | *..... |
| Mixing and placing. | 334.35 | 1,240.75 | 345.15 | 396.05 | 495.70 | 597.10 | 597.90 | 334.85 | 385.30 | *..... | 123.65 | 184.15 | *..... | *..... |
| Back filling.† | 102.95 | 262.85 | 51.70 | 148.60 | 136.25 | 111.45 | 21.00 | *..... | *..... | *..... | *..... | *..... | *..... | *..... |
| Not classified | 106.75 | 360.25 | 59.65 | ..... | ..... | 45.85 | ..... | ..... | ..... | 172.70 | 58.15 | 73.25 | 170.25 | 832.15 |
| Totals: Labor | $1,133.60 | $2,910.60 | $807.30 | $866.60 | $1,132.80 | $1,248.10 | $808.80 | $424.85 | $875.25 | $217.40 | $268.90 | $347.95 | $170.25 | $832.15 |
| Average per yd. | 5.40 | 2.97 | 4.05 | 2.97 | 2.79 | 3.53 | 2.61 | 4.29 | 3.10 | 2.79 | 3.79 | 4.83 | 4.15 | 3.22 |
| Number of days labor | 702 | 1,994 | 607 | 726 | 768 | 784 | 573 | 226 | 599 | 128 | 131 | 224 | 134 | 553 |
| Average per day | $1.61 | $1.46 | $1.33 | $1.19 | $1.47 | $1.59 | $1.43 | $1.88 | $1.46 | $1.69 | $2.05 | $1.55 | $1.27 | $1.50 |
| Material: | | | | | | | | | | | | | | |
| Cement, sacks | 862 | 3,749 | 727 | 1,179 | 1,611 | 1,512 | 1,352 | 375 | 1,117 | 300 | 293 | 400 | 170 | 1,062 |
| Value | $456.85 | $1,986.95 | $385.31 | $532.05 | $853.85 | $801.35 | $716.55 | $165.00 | $558.50 | $161.70 | $155.30 | $212.00 | $81.55 | $434.60 |
| Sand, cu. yd. | 90 | 468 | 99 | 134 | 188 | 158 | 145 | 45 | 126 | 40 | 32 | 40 | 22 | 120 |
| Value | $36.00 | $140.40 | $39.60 | $53.60 | $75.20 | $63.20 | $58.00 | $18.00 | $50.40 | $16.00 | $12.80 | $12.00 | $8.80 | $48.00 |
| Stone, cu. yd. | 181 | 936 | 181 | 260 | 375 | 333 | 230 | ..... | 42 | 75 | .. | 78 | 37 | 30 |
| Value | $108.60 | $567.80 | $101.45 | $156.00 | $187.50 | $166.50 | $138.00 | ..... | $21.00 | $37.50 | ..... | $46.80 | $22.20 | $18.00 |
| Slag, cu. yd | ... | ... | ... | ... | ... | ... | 62 | 90 | 208 | .. | 64 | .. | .. | 205 |
| Value | ..... | ..... | ..... | ..... | ..... | ..... | $12.40 | $18.00 | $41.60 | ..... | $12.80 | ..... | ..... | $41.00 |
| Lumber—value | $166.35 | $543.35 | $86.35 | $125.00 | $121.50 | $167.05 | $171.80 | $9.00 | $75.00 | $20.00 | $35.70 | $24.40 | $12.55 | $45.00 |
| Miscellaneous | $20.00 | $30.00 | ..... | $15.00 | $77.15 | ..... | ..... | ..... | ..... | ..... | ..... | $18.25 | ..... | ..... |
| Totals—Material. | $787.80 | $3,268.50 | $612.71 | $866.65 | $1,253.05 | $1,275.25 | $1,096.75 | $210.00 | $746.50 | $235.20 | $216.60 | $313.45 | $125.10 | $636.60 |
| Average per yd. | 3.75 | 3.30 | 3.08 | 2.96 | 3.09 | 3.60 | 3.53 | 2.12 | 2.65 | 3.01 | 3.05 | 4.35 | 3.05 | 2.47 |
| Grand Totals: | | | | | | | | | | | | | | |
| Labor and material. | $1,921.40 | $6,179.10 | $1,420.01 | $1,733.25 | $2,385.85 | $2,523.35 | $1,905.55 | $634.85 | $1,621.75 | $452.60 | $485.50 | $661.40 | $295.35 | $1,468.75 |
| Average per yd. | 9.15 | 6.27 | 7.13 | 5.93 | 5.88 | 7.13 | 6.14 | 6.41 | 5.75 | 5.80 | 6.84 | 9.18 | 7.20 | 5.69 |

*Separate costs of items thus marked were not kept. †And tearing down molds.

have also been built of concrete. Table No. 1 gives data of two such structures. The small volume of the work done at Waverly, Tenn., only a portion of the rim being constructed, made the cost quite high. At Atlanta, Ga., a complete rim was built, slag being used as the aggregate; and the total cost here was only $5.69 per cubic yard. The new table put in at this point was 70 ft. long and replaced an old one 54 ft. long. As the rim was built on the outside of the old masonry walls, the space to work in was small; and had masonry been put in, it would have been much more expensive. It was built inside a 40-stall roundhouse, and the turntable was used all the time the new rim was being built.

## The St. Louis, Kansas City & Colorado.

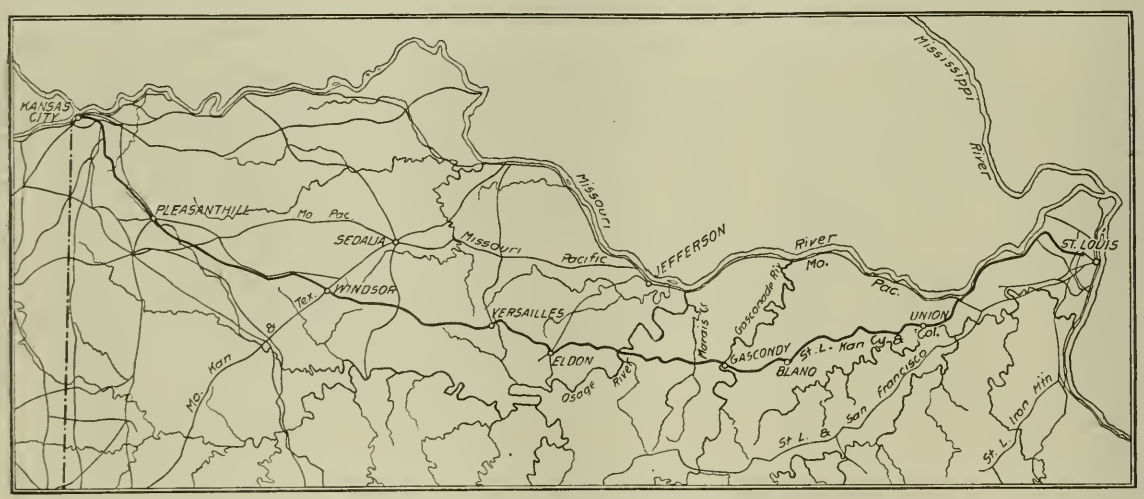
BY J. L. CAMPBELL, M. AM. SOC. C. E.*

The St. Louis, Kansas City & Colorado Railroad Company was chartered in 1884 to build a line from St. Louis west to Kansas City. The road was built as far as Union, Mo., 60 miles west from St. Louis, and this mileage was operated up to 1901. In 1901 an extension west to Bland, 40 miles, was opened, and in 1902 a further extension of 14.5 miles to the Gasconade river was completed and construction was begun between that point and Versailles, Mo., 177 miles west from St. Louis. Soon after its re-organization, the Chicago, Rock Island & Pacific in the early part of 1902 began a period of remarkable development and expansion, and one of the first lines acquired was the St. Louis, Kansas City & Colorado. It forms the connecting link between the lines of the Rock Island running east, west, north and south from Kansas City, and the Frisco System at St. Louis and is an essential part of the Southwestern Grand Division of the Rock Island System. The road runs almost due west from St. Louis over the rough broken country south of the Missouri river and is one of the heaviest pieces of railroad building west of the Mississippi.

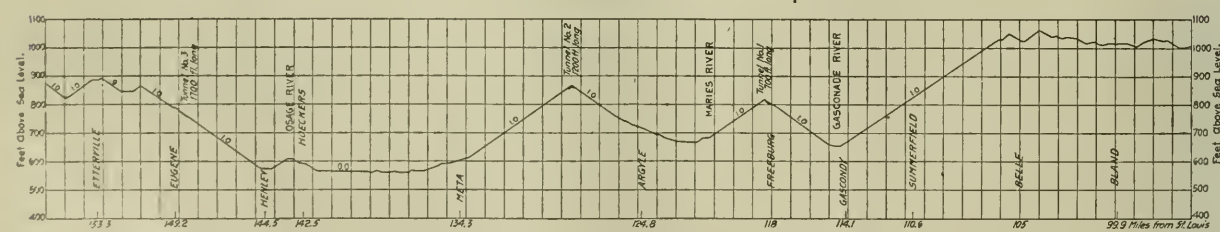
When the Rock Island took over the property grading was practically completed as far as Eldon, 159 miles from St. Louis, and on this section the maximum grade had been fixed at 1 per cent. in both directions, compensated .04, with maximum curves of 6 deg. There remained 138 miles to be built through a rolling country and the Gasconade Railway Construction Company was incorporated by the Rock Island officers to carry out this work for the railroad. Mr. John F. Stevens, Second Vice-President of C., R. I. & P. Ry., is president of this construction company, and Mr. W. L. Darling, Chief Engineer of the C., R. I. & P., is vice-president. Work on the partially completed extension and the new construction was carried on with energy after the transfer of the property and track laying was completed into Kansas City last July. Regular trains are now running between that city and St. Louis.

Because of the importance of the new line and the probable future development of a heavy traffic, the location and construction have been along advanced lines and on an exceptionally permanent basis for a new road. In round numbers the grading involved 12,000,000 cu. yds. of pay quantities; an average of 40,000 yds. per mile for the 300 miles. There are four tunnels, 400 ft., 700 ft., 1,200 ft. and 1,700 ft. long, respectively, and all but the second are lined with concrete. The roadbed is unbroken except where necessary to put in bridges for large waterways. Where the grade line gave sufficient clearance all drainage was carried under through concrete masonry arches and there are about 500 of these, varying from 2-ft. to 36-ft. span. For all openings larger than 36 ft., steel bridges have been put in. There are 55 of these structures having spans of from 30 ft. to 375 ft. and placed on concrete abutments and piers ranging in height from 10 ft. to 106 ft. from foundation to coping. The largest bridge, over the Gasconade river, is 1,800 ft. long. Throughout the entire length of 240 miles of new construction there are only three wooden bridges, one of which is a temporary structure at Kansas City, which will shortly be replaced with a steel bridge. The extended use of concrete arch culverts in the new construction has resulted in having an average of only one open floor bridge to every five miles of road and this on a line crossing the drainage at right angles for the entire distance of 240 miles through a region where the annual rainfall is 40 in. About 75,000 cu. yds. of concrete and 4,750 tons of steel have been used in the culverts and bridges.

The roadbed is 18 ft. wide over the shoulder on embankments and 20 ft. and 24 ft. wide in rock and earth cuts, respectively. East of Versailles the old roadbed was narrower than this and six steam shovels were worked on the reconstruction for two years in order to bring the whole line up to standard. The road is laid with 80-lb. rail on rock ballast.




Map of Central Missouri, showing the St. Louis, Kansas City & Colorado.




Profile of Heaviest Grades on the Line between Eldon and Bland, St. L., K. C. & C.

In locating and building the western end of the line from Eldon to Kansas City the maximum grade was fixed at .8 per cent., compensated .03, with 3 deg. curves. On this section a probable density of traffic of one freight train an hour one way was assumed and the following values for the physical characteristics of the line affecting the cost of operation were taken: Cost of distance, $7.20 per foot plus the cost of construction of the distance saved; curvature, $90 per degree; rise and fall, within 25 ft., $42 per foot; rise and fall between 25 ft. and 50 ft. $168 per ft.; rise and fall on limiting grades, $672 per foot; grade crossing with another steam road, $42,000.

These values were used in determining the details of the location after the general route and characteristics of the line had

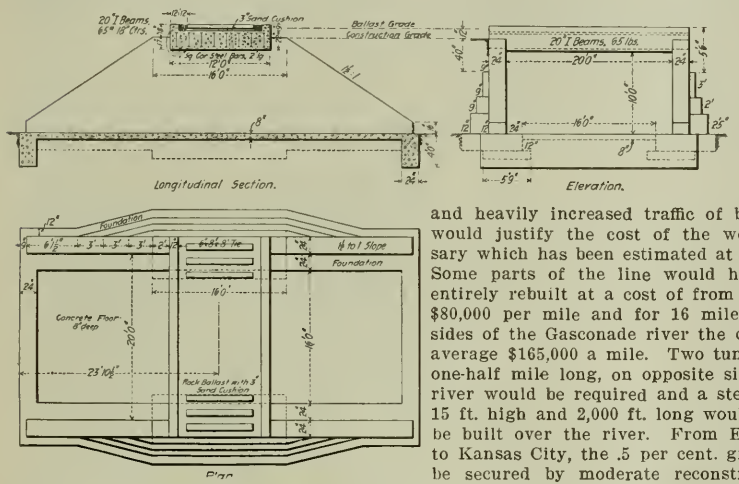
*Chief Engineer, Gasconade Railway Construction Company.

Embankment 110 Feet High, St. L., K. C. & C.

Summit Cut at Belle, Mo., Looking East.

been fixed. If the location from St. Louis to Eldon, surveyed before the Rock Island bought the line, had been determined by the values above specified, a much better alinement would have been secured on the eastern division at an expenditure which, though large, would have been justifiable. The maximum curvature might possibly have been reduced from 6 deg. to 4 deg. but anything less than the 1 per cent. ruling grade which was used would not be justified by the amount of traffic now in sight.

The maximum grade of 1 per cent. on the eastern division starts in a cut 50 ft. deep at the summit at Belle and continues down 9 miles to the Gasconade river, which is crossed 90 ft. above low water. The cost of this portion of the line was approximately $60,000 a mile. Twenty miles below the Gasconade crossing, the main line of the 'Frisco (now a part of the Rock Island) crosses the same stream with 2 per cent. grades and 10 deg. curves. It is feasible to build a connecting line across from the 'Frisco to the St. Louis, Kansas City & Colorado, west of the Gasconade river, and to combine the traffic of both roads from that point into St. Louis. Surveys have been made for a .5 per cent. grade line with 3 deg. curves from St. Louis by reconstructing the existing line and building the connecting link to the 'Frisco, but these surveys have shown that the work could not be done without a very heavy expense. The elimination of distance, rise and fall and curvature on such a line would be 9 miles, 350 ft. and 3,800 deg. respectively. Only the combined and heavily increased traffic of both roads would justify the cost of the work necessary which has been estimated at $8,500,000. Some parts of the line would have to be entirely rebuilt at a cost of from $70,000 to $80,000 per mile and for 16 miles on both sides of the Gasconade river the cost would average $165,000 a mile. Two tunnels, each one-half mile long, on opposite sides of the river would be required and a steel viaduct 15 ft. high and 2,000 ft. long would have to be built over the river. From Eldon west to Kansas City, the .5 per cent. grade could be secured by moderate reconstruction of the present line, with two or three exceptions. These improvements are, of course, only possibilities, but in time the increased business may require the changes to be made. The accompanying map and the profile of the line from Bland to Eldon show the relative positions of the two roads and the topography of the country along the Gasconade and Osage rivers.



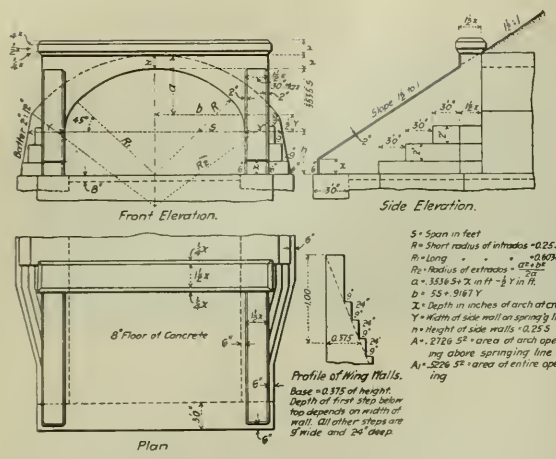

Concrete and I-Beam Solid Bridge Floor.

*Grading.*—On account of the uniformly heavy character of the work, a large part of the grading has been done by steam shovels and 30 of these machines have been employed almost constantly since the construction began. The material excavated consists chiefly of clay, shale, limestone and a conglomerate of clay and disintegrated limestone. Ordinarily, the shale lies beneath the limestone with a strata of clay on the surface. This combination of material is most unsatisfactory for building the roadbed, particularly for making high embankments. In some places along the road embankments 100 ft. high have been made and the great weight of these banks, which are composed of this composite material, combined with the extreme wet weather conditions which prevailed during construction, has caused a great amount of settlement. In some cases serious slides extending 100 ft. and more beyond the slope stakes have occurred. Another cause of the sliding banks is the method used in building them. Most of the high embankments were made by building a pole trestle up to the required grade across the valleys along the center line of the right of way and dumping over the sides the material excavated from adjacent cuts. Banks built up in this manner grow from a central core and the slopes are always loose and more unstable than the center. The bank, therefore, has a tendency to slip out on both sides and the trestle buried in the core aggravates the trouble. It is almost impossible to calculate the additional amounts required to compensate for the settlement which finally takes place, but in doing work on such a large scale, dumping from trestles is the most practicable and expeditious method in the end.

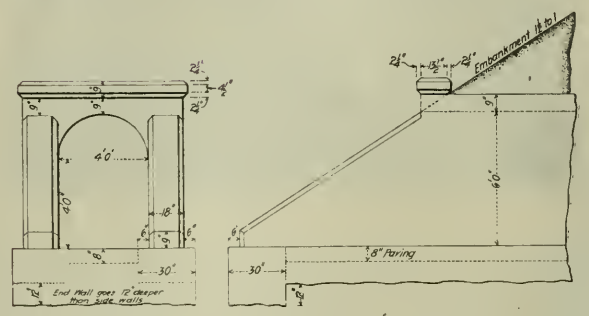
In many of the deep cuts, the limestone is deep under the surface and is overlaid with many feet of clay which is more or less saturated with water. At a number of places this clay has slipped down to slopes of 1 to 3 and 1 to 4 and is still sliding. In two of the worst cuts, after the roadbed had been graded ready for track but before the track was laid, the clay ran in to a depth of 5 ft. above grade. The track was cribbed through this mud and a large force of men put to work cleaning out the slide. The exceptionally wet season following the

Concrete and I-Beam Solid Floor Road Crossing.

Road Crossing after Grade Was Raised 8 Feet.


Front Elevation.
Side Elevation.
8" Floor of Concrete
Plan
Profile of Wing Walls.
S = Span in feet
R = Short radius of intrados = 0.25 S
R1 = Long " " = 0.6036 S
R2 = Radius of extrados = S + 0.5 R / 20
a = .3336 S + X, in ft = ½ Y in ft.
b = .55 S + 9.67 Y
X = Depth in inches of arch at crown
Y = Width at side wall on spring'g line
n = Height of side walls = 0.25 S
A = .2726 S² = area of arch opening above springing line
A1 = .5226 S² = area of entire opening

Standard Concrete Elliptical Arch Culvert.




Standard Concrete Arch Cattle-pass.

grading was probably the cause of most of the trouble, and there is little likelihood of further interruption of traffic from this cause.

*Waterways.*—All drainage areas were determined by actual measurement except in the case of the large streams where the catchment areas were scaled from maps of the United States land and geological surveys. The extreme flood discharge per square mile in cubic feet per second was calculated from the formula $Q = \frac{17\sqrt{8{,}000}}{A}$ in which A is the area of the catchment basin in square miles. This is approximately the same formula as that proposed by Mr. J. P. Frizell. Having determined the maximum discharge, the next step was to fix the maximum permissible velocity of flow through the waterway opening which would depend, within reasonable limits, on the character and height of the embankment in the case of a culvert and the nature of the banks and surroundings in the case of a bridge. Low earth banks should, in any case, have a waterway with a sectional area large enough to carry off the full flow at a moderate velocity as fast as the water can reach the opening. A high rock fill will permit of a higher velocity of flow and some backing up of the water. The sectional areas for openings on this work were calculated to give a flow of 7 ft. per second for large streams and up to as high as 15 ft. per second for small culverts under high solid banks. Although the past spring has been exceptionally wet with several rainfalls exceeding 4 in. of water an hour in no case has there been an overflow or washout. Most of the culverts at such times ran full and some ran under a head of 2 or 3 ft.

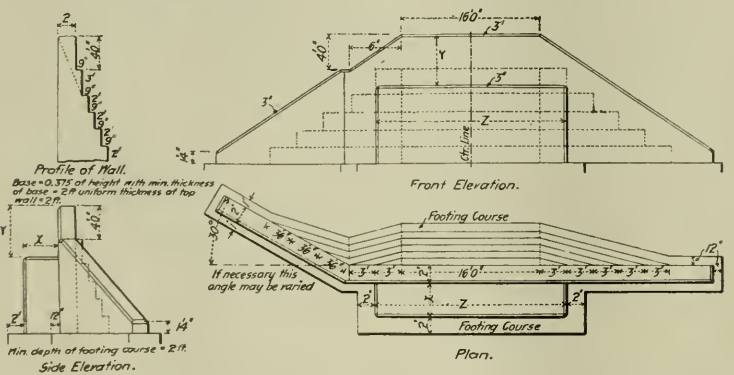
All of the concrete arch culverts of from 5 to 40 ft. span are of one general design, as shown in the drawings, and the dimensions are proportional to the span in each case. The intrados of the arch is semi-elliptical, struck with two radii and having a rise equal to .3535 S, while the extrados is formed by a circular arc. The floor of the culvert is 8 in. of concrete, protected at the ends with a 3-ft. sill extending well down into the bed of the stream. For spans between 2 ft. and 4 ft. a circular arch culvert with side walls 12 in. high was used. The discharge apron in both the large and small culverts is carried out to the ends of the wing walls, which are given a uniform slope of 1½ to 1.

*Steel Bridges.*—The longest bridges on the line are those over the Osage river and the Gasconade river. This latter spans the valley and the channel of the river and is 1,800 ft. long. It is a deck bridge composed of 30-ft. and 60-ft. plate girder approach spans supported on steel towers with four legs resting on concrete pedestals; two 130-ft. truss spans; one 250-ft. channel truss span and one 60-ft. plate girder end span. The substructure consists of concrete piers sunk to rock foundation for the main spans and concrete pedestals resting on piles for each of the legs of the steel towers supporting the viaduct spans. In view of the ultimate possibility of decay of the pile foundation for these pedestals, the footings were proportioned to limit the load to one ton per square foot. A better construction might have been to omit the piling altogether. The elevation of the rail above low water over the channel is 90 ft.

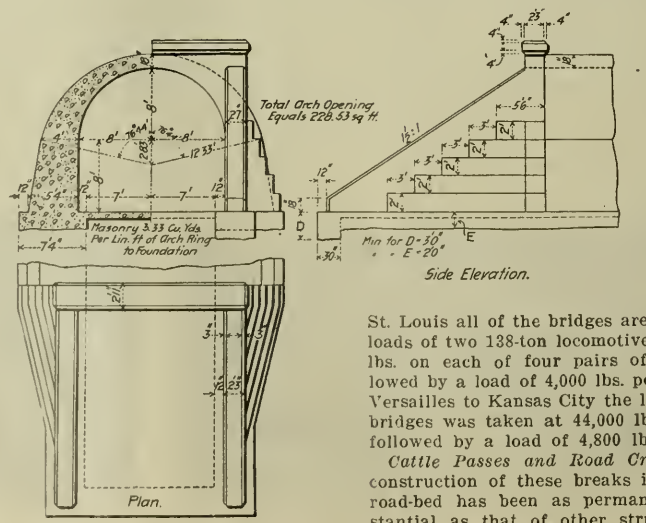
The Osage river bridge is about 1,500 ft. long and crosses the valley about 50 ft. above the ground and 70 ft. above low water. The channel span is a through Petit truss 375 ft. long, and with this exception the bridge is similar in every way to that over the Gasconade. The concrete pier under the east end of this span was sunk to rock 36 ft. below low water with a pneumatic caisson, and is 106 ft. high from foundation to coping. One of the illustrations shows the traveler and falsework used in erecting this bridge.

All of the bridges west of Versailles are deck plate girders with the exception of two crossings of steam railroads which are through girders. Between Versailles and St. Louis all of the bridges are designed for loads of two 138-ton locomotives with 40,000 lbs. on each of four pairs of drivers, followed by a load of 4,000 lbs. per foot. From Versailles to Kansas City the loading for all bridges was taken at 44,000 lbs. on drivers followed by a load of 4,800 lbs. per foot.

*Cattle Passes and Road Crossings.*—The construction of these breaks in the line of road-bed has been as permanent and substantial as that of other structures. The drawings show the standard concrete-arch




Standard Concrete Abutment and Wing Walls.


Total Arch Opening Equals 228.53 sq ft.
Masonry 3.33 Cu. Yds. Per Lin. Ft. of Arch Ring to Foundation
Min for D-30"
" E-20"
Side Elevation.
Plan.

Standard Concrete Arch Road Crossing.

cattle pass and road crossing. The cattle pass has a circular arch of 4 ft. span and is 6 ft. high from floor to crown. It is paved with 8 in. of concrete and is quite similar in design to the small culverts used. The road crossing has a circular arch of 16 ft. span with side walls 8 ft. high.

Still another form of concrete work shown in the drawings is the concrete and I-beam span. This can be used for openings where the height of sub-grade is not sufficient to allow the required depth of filling over the crown of a circular or elliptical arch. It is built with the usual abutments, and on these is supported a concrete monolith slab 22 in. deep containing eight 20-in., 65-lb. I-beams, together with corrugated steel reinforcing bars laid close to the bottom surface. The top of this monolith is troughed to a depth of 9 in. and a layer of sand 3 in. deep is spread over the concrete to act as a cushion. The ties are laid on this sand and filled around with rock ballast flush with the top of the sides. One of the photographs shows one of these spans which was put in and afterwards the grade was raised 8 ft. on account of a railroad crossing beyond. An arch was built up over the flat span and the filling put in above the arch without disturbing the original span. The wing walls were built up and cut to accommodate the increased height of the bank.

*Tunnels.*—The aggregate length of the four tunnels on the line is 4,000 ft. They were all excavated through rock and with the exception of two bad slides due to faulty blasting, no special difficulties were encountered. Three of the tunnels are lined throughout with concrete 18 in. thick. The dimensions of all are the same, being 18 ft. wide and 22 ft. high from top of rail to crown. When the material was soft and dangerous a temporary timber lining was built in as shown on the drawings, and the permanent lining put in afterwards without disturbing it. Expansion joints were provided for the concrete lining where necessary.

Main Span of Deck Bridge over the Gasconade River.

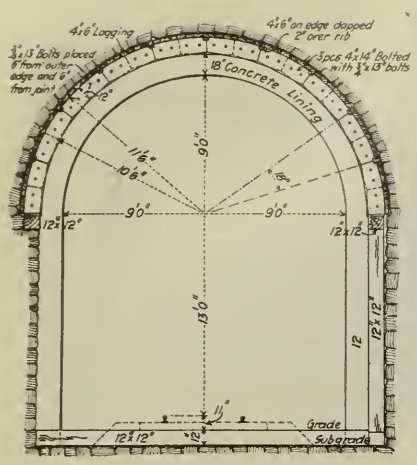
*Concrete.*—The standard mixture of concrete used in all work on the line was one sack of 95 lbs. of Portland cement, 3 cu. ft. of sand and 5 cu. ft. of gravel or broken stone. Iola cement was used more than any other brand chiefly because of its availability. The stone used was a good quality of limestone broken to 2 in. and less, and mixed as it came from the crusher without screening. All concrete was mixed quite wet and a flat spade was worked in between the forms and the mixture as the concrete was laid. Perfect mortar faces showing all of the grain of the wood in the forms were obtained in this way. Oiled paper was tried as a facing on one of the important bridge piers to prevent the concrete taking an impression of the forms, but the paper wrinkled and the results were not satisfactory.

Regular tests of all cements used were made at the Chief Engineer's office in St. Louis and the average of all tests was more than 500 lbs. for neat briquettes after seven days ageing. Tests were also made to determine the effects of setting concrete in freezing weather, on the use of salt in mixing during cold weather and on retaining the crusher dust in the broken stone. The results show that concrete was damaged by freezing and by the use of salt. Salt is worse than useless because it will not prevent freezing when the temperature is low enough to damage the concrete in setting. Stone dust added to the cement mortar increases its strength.

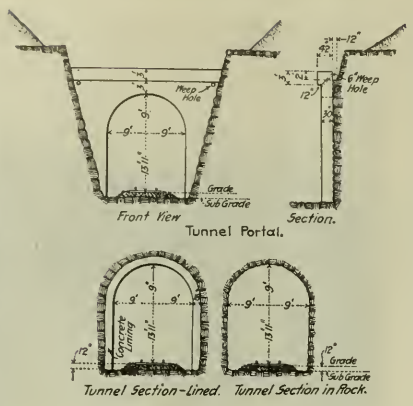
*Track.*—The track is laid with Am. Soc. C. E. standard 80-lb. rail, with Continuous rail joints and Harvey grip nuts. All curves are eased on Crandall's spiral, the length of easement being 100 ft. for each degree of curve per 100 ft. on the western division where the roadbed was graded accordingly. On the eastern division where easement was not provided for in the grading, the length of easement was made uniformly 120 ft. The track is being ballasted by the railroad company's own forces with gravel and broken stone, and this work is about 70 per cent. completed. Gravel is being loaded from streams along the line by teams trapping into Rodger ballast cars run out on spurs built down along the banks, and by an "orange peel" bucket dredge which has a capacity of 1,000 cu. yds. a day.

*Crusher Plant.*—The western end of the line will be ballasted with rock obtained from an elaborate crusher plant located 25 miles east of Kansas City. This plant has only recently been put in operation and has a capacity of 1,000 cu. yds. in 10 hours. The quarry is 300 ft. wide and 1,000 ft. long, and it is spanned with a Lidgerwood cableway with a span of 1,150 ft. carried on two traveling towers 103.5 ft. high. These towers run on a set of seven parallel rails running across each end of the quarry. A double transfer track runs across the center

Erecting Main Span of Osage River Bridge.




Concrete and Timber Lining for Standard Tunnel Section.




Details of Standard Tunnels.

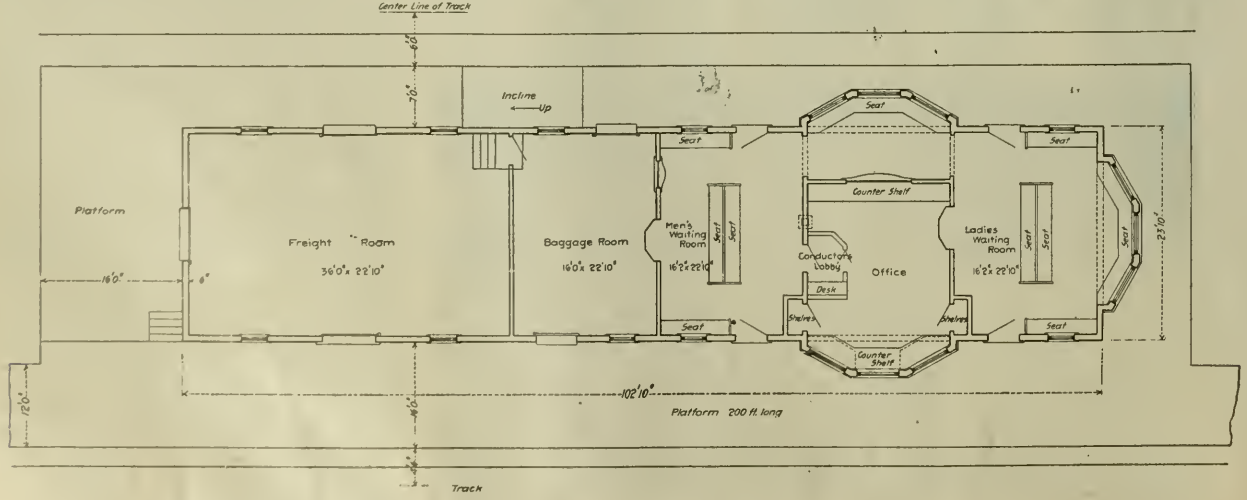
of the quarry, and at one a loading chute or hopper is mounted over both tracks. Stone is taken from out of the ground and loaded into 5-yd. steel skip buckets hung from the cableway. These are then run over the chute on the transfer tracks and dumped. The transfer tracks are on a 4 per cent. grade and at the lower end beyond the quarry they terminate over the hopper supplying the stone crushers. Two Austin 6-yd. dump cars run on these tracks and they are attached to an endless cable which passes around a friction drum at the upper end. As a loaded car runs down from the loading chute it draws the empty car up under the cableway without additional power. In order to bring the two cars alternately over the crusher hopper without using a switch, the transfer tracks begin to converge at a point about 100 ft. away from the crusher and the inside rails cross on a No. 7 frog about 50 ft. away. From the frog on down, the inside rail of one track approaches the outside rail of the other track until they lie side by side with each other and only about 5 in. apart. The cars are dumped automatically and one man at the friction drum controls all their movements.

In the crusher house there is an Austin No. 7½ tandem crusher and a No. 5 crusher which deliver the broken stone on to a bucket conveyor which carries it up to the screens over the storage bins. One loading track runs under the storage bin and another runs alongside of it so that two cars can be loaded at one time if necessary. These tracks give ample storage capacity for cars and operate by gravity so that cars can be dropped down as needed by one brakeman without the use of an engine.

*Water Supply.*—There are 16 water stations on the line exclusive of St. Louis and Kansas City. Water is pumped from streams at three stations, from deep wells at four stations, from artificial reservoirs at four stations, and at three stations the tanks are kept full by a gravity supply from reservoirs. At Union, water is drawn into the tank from the town water mains. The most interesting feature of this part of the construction work is the artificial reservoirs that have been built. These range in area from 10 to 25 acres, are from 16 to 23 ft. deep and have a storage capacity of from 20 million to 55 million gallons of water. The dams are all made of earth with carefully built puddle cores and slopes of 2 to 1 and 1½ to 1. With the exception of the dam at Windsor all water slopes are paved with stone. All of the spillways, except one, are cut through solid rock around the ends of the dams or are in solid masonry outlets through the dam. They have been carefully designed and proportioned from known areas of watershed and maximum rainfall, and the depth of the discharge stream is limited by giving the proper area of cross-section to the opening.

In the case of the reservoir at Windsor, a highway immediately below the dam made it desirable not to divert the water from its natural channel and accordingly a 15-ft. concrete arch was built through the dam and a heavy concrete floor laid in the barrel. The floor and wings of the arch were extended in under the reservoir a few feet and a square well was built up to the flow line of the reservoir by carrying up the head wall, the wing walls and a cross wall to close the front opening of the wings. Concrete pillars 4 ft. high were built up on the four corners of this well, thereby making four weirs each 15 ft. long. The length of these weirs was determined by limiting the depth of water flowing over to 4 ft. and applying the Francis weir formula for discharge. The maximum depth flowing over up to the present time has only been 18 in. The well walls are 2 ft. thick and are reinforced with steel rods. There has been no leakage through the concrete except at one point where there is a slight trickling.

Water Tank and 40-Pocket Coal Chute at Eldon, Mo.




Plan of Combination Freight and Passenger Station for Small Towns.

This reservoir has a watershed of 1¼ sq. miles, and the depth under normal conditions is 16 ft. An overflow essentially similar to the one described has also been constructed in the dam at the Medford reservoir at which place the railroad embankment, properly widened and strengthened, forms the dam.

The drainage area of the reservoir at Pleasant Hill is so small, being only 210 acres, that the capacity (55,000,000 gallons) was made correspondingly large in order to retain the greater part of the run-off in wet seasons and all of it in dry seasons. It is now approximately half full and is slowly rising, as there are two springs discharging into it which flow constantly and which during a dry season will almost compensate for losses by evaporation.

In the three gravity reservoirs at Argyle, Henley and Pleasant Hill, the water is conveyed under the dam to the water tanks (situated from a half mile to 1½ miles away) through concrete intakes in the reservoirs and cast-iron pipes running under the dams to the tanks. Just below the dams there are concrete valve chambers containing two gate valves and a blow-off pipe for cleaning out the supply mains. Automatic check valves are provided at the tanks which stop the flow of water when the tanks are full. No attendant is needed and the cost of operation is reduced to nothing.

The water tanks are standard 50,000 gallon wooden tubs mounted on steel towers 25 ft. high. They are set 25 ft. inside the station ground limits opposite the standpipes and are connected to the latter by 14-in. cast iron pipes. The standpipes are of the Sheffield pattern with 12-in. spouts and are set between the main line and the passing track, 250 ft. from the center of the depot building. The high elevation of the tank and the large standpipes give a flow of water with the valve wide open that is greater than can pass through the ordinary opening in the top of the tender. At all of the water stations where water is pumped, Fairbanks-Morse gasolene engine pumps have been installed. These pumps are of 8, 10 and 15 h.p., depending on the work to be done and the minimum capacity of the plants is 6,000 gallons an hour.

The whole scheme of water supply for this line is probably unsurpassed by that of any other road in the Mississippi valley both as to quantity and quality. The stations have been arranged so that the distance between tanks varies from 12 to 22 miles.

*Coal Chutes.*—Five coal chutes have been built along the line. The chute at Eldon has 40 pockets, 20 on each side, and those at Union, Belle, Windsor and Pleasant Hill have 20 pockets on one side only. These chutes are designed to haul full car loads up 20 per cent. inclines by means of 25 h.p. Otto gasolene engines, and the coal is dumped into storage bins feeding the service pockets. One of the illustrations shows the water tanks and coal pocket at Eldon.

*Station Buildings.*—The station buildings along the road are much in advance of those usually built on new lines. Two of the stations are shown in the photographs and one of the drawings shows a plan of the standard station for small towns. At points where suitable houses cannot be rented the stations are built with living rooms in the second story for the agent.

*Shops.*—No shops have yet been built but ultimately engine terminal facilities will be provided at St. Louis. For the present the Rock Island shops at Kansas City will be used for repairs to rolling stock.

*Contractors.*—Reichardt & McCarthy did the grading from Union to Belle, 45 miles. H. F. Balch & Co. graded the road from Belle to Versailles, 72 miles, and Stubbs, Flick, Johnson Construction Co. finished the grading from Versailles to Kansas City. A. J. Tullock and the American Bridge Company built and erected the bridges. J. H. Roberts laid the track from the Osage river to Kansas City, and the railroad company's own forces laid the remainder of the track, did the ballasting and built the reservoirs. Fairbanks, Morse & Co. built the water stations, John Volk & Co. built the coal chutes, and A. J. Gorg erected the station buildings.

Station at Eldon, Mo.

Standard No. 1 Station at Windsor, Mo.

## International Engineering Congress.

(*Continued from page 450.*)

SECTION E—MECHANICAL ENGINEERING.

Col. H. S. Haines presided over the meetings of this section. On the first day the discussion was on the paper by Mr. J. O. Handy, chief chemist of the Pittsburg Testing Laboratory, on the Purification of Water for the Production of Steam. This paper considered methods of purification under two classes, mechanical and chemical, and particularly with reference to feed-waters for locomotive boilers. A number of written discussions were read dealing with the efficiency of the stirring apparatus used in the continuous method of chemical purification and the tendency of feed-water to cause foaming when it is treated with alkaline reagents.

Mr. A. McGill, Ottawa, Can., referred to the difficulty of maintaining a perfect solution containing no floating particles in the tanks. These floating particles become incrusted with a hard insoluble coating, and the only method of breaking them up before entering the boiler is by prolonged and violent mechanical agitation. This breaks up the coated particles and allows the chemical reagents to act on the impurities, so that they can be precipitated in the settling tank in the form of a sludge. The chief cause of foaming with water treated with alkalines is the lowering of the surface tension of the liquid by the solution of soda salts. Caustic soda produces the most foaming action, and silicate of soda, carbonate of soda, sulphate of soda and chloride of soda produce lesser amounts in that order for a given strength of solution. All boiler water under pressure is in a turbulent state, and when the throttle is opened the pressure is momentarily lowered, the superheated gases in the water immediately lift the water to an amount depending on the resistance of the surface tension, and any substance in solution which lowers the surface tension will cause foaming. The only relief from waters containing large amounts of soda, lime and magnesium appears to be by the use of some salt of barium. Crystallized barium hydrate costs about $30 a ton, and for bad water about 15.2 lbs. of the hydrate is required per 1,000 gallons.

Mr. F. B. Leopold, Chicago, Ill., in a written communication, took up the comparative advantages of the continuous and intermittent processes for treating feed-water chemically. The intermittent system is to be preferred (1) for plants having a capacity of less than 50,000 gallons of water per day and situated where economy of space is no object. (2) For plants of any capacity when in charge of unskilled labor and space permits. (3) For plants of any capacity regardless of supervision when the water is variable in character, as for example river water. (4) For plants where the consumption is variable or considerable elasticity in the output is desired. This type of plant is generally used in industrial works. The cost of installation of small plants working on the intermittent system is less than for continuous plants, and the cost of attendance is also much less. In a continuous plant the regulating devices are easily deranged in small installations, and when treating variable water they must be manipulated constantly to provide the proper quantities of reagents, and to do it properly the tanks would have to be completely emptied. To do this would require several hours; but, on the other hand, with the intermittent system each tank is treated individually to meet its requirements and changes in the character of the water can be provided for immediately and with absolute accuracy by supplying just the right quantities of reagents. Where large quantities are used during short periods of time, a continuous plant must be installed with a capacity equal to the maximum demand for water. An intermittent plant, however, has one tank of settled water always in reserve to carry over the maximum demand. The size of the plant can therefore be determined by the average demand.

Continuous plants are used to advantage: (1) Where space is limited. (2) Where the water softening plant is located at a point some distance from the point where the water is to be used and the output must be pumped. (3) Where the water to be purified is constant in analysis as many well

waters are. (4) Where the water to be purified can only be supplied at about the rate of purification. (5) Where the plant is in direct charge of an operator with some technical and chemical knowledge.

Continuous plants are particularly adapted to installations where the water supply just about equals the consumption. Under these conditions, except in the case of very large plants, an intermittent system would require a number of extra tanks, and the cost of installation and attendance would in most cases be much greater than for the continuous system. For railroad water purifying plants the continuous system is probably the most satisfactory and economical, because the conditions are generally similar to those outlined above.

*Adjustable Stay-bolts.*—Mr. O. Busse, Locomotive Superintendent, Danish State Railways, Copenhagen, read a short paper on this subject. He said in part:

"Tube-sheets in locomotive fire-boxes are stretched by the frequent rolling of the tubes, and if a tube-sheet is fastened to the crown-sheet, which again is stayed to the outer shell of the boiler, the stretching of the tube-sheet will cause a bending in the flange which in time will lead to fractures. Several forms of stay-bolts have been tried which are intended to allow the tube-sheet to stretch, but most of them are useful only when there is no steam in the boiler. As soon as steam pressure is raised the top of the fire-box will be pressed in just as far as the stretching of the tube-sheet had brought it before, and fracture of the flange will commence.

Much ignorance exists as to the effect of expansion in boiler tubes in plates. The writer made a stay-bolt supplied with an extension which passed through a gland screwed in a socket and acting on a lever with a proportion of 1 to 6. By means of this device it was possible to measure the displacement of the fire-box sheets. A few minutes after the fire was lighted the pointer showed 3 mm., answering to a displacement of the sheet of 0.5 mm., and afterwards it slowly rose to 5 mm., where it remained stationary until steam pressure began to rise. With a steam pressure of 21 lbs. the pointer indicated 3 mm. or 0.5 mm. displacement, and then fell slowly back to 1 mm., when the full pressure of 185 lbs. was reached. After the boiler had cooled down the plates resumed their normal position. This experiment showed that it is not necessary to use flexible top-stays to equalize the expansion due to heat; but it is only necessary to take up the extension of the tube-sheet caused by rolling the tubes.

A new arrangement designed by the writer and introduced on the locomotives of the Danish State Railways, not only allows for the stretching of the tube-sheet during the heating of the fire-box, but also gives a means of shortening the stays in proportion to the stretch of the tube-sheet every time the tubes are rolled when the locomotive is in the shop for repairs. This form of stay is used in the first row or first and second rows of stay-bolts. The bolts are screwed into the top-sheet and are free to move in a socket which is secured in the outer shell of the boiler. A nut rests on this socket, by means of which the stay-bolts may be shortened up each time the tubes are rolled. To prevent leakage around the bolt and socket, a cap is screwed on top the socket with a millboard washer underneath. To allow for the stretching sideways in these stays the nut is made with a spherical bearing surface. Where it is not possible to get the side stays at right angles to the plates the stay-bolts are riveted over after they are screwed into the fire-box sheets, and for this purpose the outer end of the stay on which the holding on is done is provided with a long threaded nut.

The Paris, Lyons & Mediterranean is using stay-bolts very similar to these, but they are only applied to boilers with flat crown-sheets.

Abstracts of the discussion of papers in the other sections will be continued in a subsequent issue.

## New Compound Locomotives in Bavaria.

BY CHARLES R. KING.

It is interesting to note how surely, if slowly, the main features in American locomotive construction are incorporated in the practice of the railroads of the European Continent. In the boilers, for instance, the old smoke-box has long been completely replaced by the cylindrical smoke-box and the circular flue sheet. More recently conical boiler rings, and wide fire-boxes, with or without such conical rings, have had many applications, and the various American plans for supporting the boiler on its frame have been imitated. The American system of riveting the plates has in many instances been employed. Boiler accessories of American origin have an extended application. The cab for the enginemen has been slowly modeled after the American prototype but with improvements thereon. In the engine itself, piston-valves for both high and low-pressure cylinders have recently had extended applications and American experience in regard to these valves is still closely watched. Large groups of cylinders cast in two pieces are now assembled in the American way. In the rolling gear, four-wheel trucks or pilots have become universal and the American lateral swing frame has been given a very fair trial in the eastern countries of Europe, and now, in the last few months bar frames have been adopted. In the use of steel castings, also, for various parts of the motion and wheel-work American practice is much followed. A mere detail, but which affects greatly the superficial appearance of the locomotive, is the abandonment of wheel-covers and "splashers" by many progressive railroads of southeast and central Europe. This has been due to the raising of the boiler very high according to the American precedent.

But one detail of the American locomotive which, if adopted, would retrograde European advance by 60 years or more, is the old-fashioned Stephenson or "Howe" valve-motion and its antiquated eccentric gear. The Walschaerts' (Belgian) gear, although originated many years ago, represents all that modern science can do for an excellent distribution combined with every-day practicability. Even where American "notions" have been finally adopted it has nearly always been with a very distinct improvement of detail. The American locomotive is always considered the pioneer, and in its advance towards those improvements in construction necessitated by its size alone, it is hardly to be expected to possess the refinements of detail or combine the elegance of design which is so much considered in countries where fine calculations and shop labor are neither of them such expensive items as in the United States.

The locomotives here illustrated represent, save for the bar-frames, the most approved and latest practice of Continental Europe. They have four cylinders, compounded, and all placed in the line of the smoke-box saddle with which, and the valve-boxes, they are cast in two separate pieces and bolted together at the middle line. The inside high-pressure cylinders drive on the crank-axle of the forward pair of drivers and the outside low-pressure cylinders drive on crank-pins outside of the same pair of wheels, the angle formed between each of the cranks of the same group being, of course, 90 deg. This disposition of the cylinders (due, originally, to Monsieur E. Sauvage, of the Chemin de Fer du Nord, France, as exemplified in his compound locomotive exhibited at Paris in the year 1889) does not combine that advantage of dividing the motor stresses which it was first sought to obtain in the compound locomotives of Mr. Webb or of the later French locomotives of the "Nord"—which only differed from Webb's by the addition of a fourth cylinder. But the Sauvage arrangement is now at last definitely adopted in Europe as being the most practical of the two methods of construction since the principal objection to the excessive fatigue in a single driving axle has been met by the provision of a stronger type of crank-axle with an oblique arm between the two half-webs of the cranks. In the locomotive illustrated the crank pins are hollow and the oblique arm is of a rectangular section. The forgings for the crank axles are usually obtained from Krupp's. At Krupp's these may be seen forged from an ingot of nickel steel, the mass being first shaped in one plane, and then, when completed, simply given a quarter twist at one end to obtain the angle of 90 deg. for the crank pins. This type of axle renders it possible to forge the faces of the crank-arms or half-webs, which is an impossibility with ordinary double-cheek cranks. With these latter it is usual at Krupp's to forge a solid block for each "throw" and to form the two cheeks by running a circular saw into the block as far as the bored-out portion near the future crank pin. The oblique-type axle is also largely used on the Continent for locomotives of the so-called "French" type, i.e., Webb modification.

The foregoing details will be of interest to those American builders who may find it an advantage to construct engines with inside cylinders, the inside cranks and the valve

Four-Cylinder Compound 4-4-2 Locomotive for the Bavarian State Railroads.

gear of Walschaerts' being the only important difference to which the American maker is not accustomed.

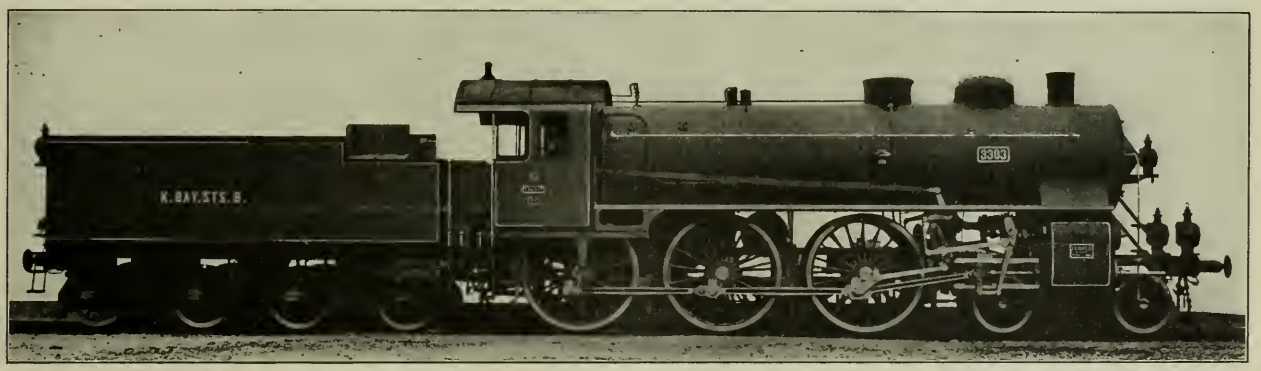
In these new locomotives each cylinder is provided with a piston-valve giving internal admission, those of the high pressure, inside the frames, being driven indirectly from the rocking shaft worked by the upper end of the advance lever. The customary practice of allowing a later cut-off in the low pressure cylinders is possible with this arrangement, but not at the will of the engineman as is the case when two sets of valve gears are used. In some countries (Saxony for instance) two sets of valve gears were originally employed, with separate reversing gears for each, for locomotives having Webb's first arrangement, but after ascertaining the most economical ratio of cut-off for the low pressure cylinders the double reversing gear was abandoned. Likewise all over the European Continent, excepting in France, one set of valve gears for four valves is now considered to be the best practice. In Austria the valve travel is the same for all four valves, but the h.p. and l.p. cylinders have a volume ratio of 1 to 3. In Italy the ideal arrangement has been made a great success: that is, of only two valves for four cylinders yet with the cut-off *variable between the two groups of cylinders* and only one reversing screw, so that the engine is practically as simple in use as a single expansion locomotive.

The especial feature to be noted in this latest type of compound, similarly with the greater part of Continental locomotives, is the lightness of all the parts in the motion. There is more of utility to be learned from these details than the mere quotation of principal dimensions, which usually teach nothing. The necessity for producing very powerful locomotives with a minimum of useless dead-weight in the revolving or reciprocating parts is due on the European continent to the small weight which is permitted upon the axles—about 16 metric tons per axle in France and Germany and 14½ tons in Austria and Italy. In consequence, every part is made with the lowest weight that it is possible to scheme, and while in the United States and England the metal is "run" into a locomotive without the necessity to closely consider every pound of it, the elimination of mere dead weight is, on the contrary, always of the greatest importance with Continental locomotive designers. The locomotives under consideration are limited to 16 tons per axle. The finish of all the working parts is such that could not be excelled elsewhere. The boiler pressure is 205 lbs. and 235 lbs. per sq. in. for the six-connected and four-connected respectively, and the boiler work is very thorough, as evidenced by the tightness of the joints even at the mud ring, whereas some nearly new American locomotives in Europe have been seen standing in a pool of water caused by leaky joints while the actual boiler pressure was not half those quoted.

The forged bar-frames of these locomotives are finely milled and slotted over every inch of their surface equal to the finish of the best American motion-work, and the whole of the connections to the frames are fitted with the closest accuracy. This expensive work may be criticized—as to its absolute necessity, but it is the regular Continental practice to finish elaborately. Even the tires are scrape finished to a brilliant surface that, in common with all the machinery, is kept up in service and contributes some to the sense of order, method and cleanliness of the men to whom the locomotives are entrusted. Considered as a whole, with a view to harmony of design these beautiful new machines have, for the time being, no rival in Europe. There is not a single part in them that is superfluous, as was too commonly the case with Continental locomotives of 10 years ago. There are no outside steam pipes as in French locomotives, and yet the steam pipe has a minimum length to reach the high-pressure cylinders. The sand-box, always unsightly upon any locomotive boiler, is rather less hideous here than the American sand-helmet. The chimney can be extended whenever the constructive gage permits this upon favorable stretches of line; but the extension is fixed and cannot be regulated from the footplate. The smoke-box door is novel, being of cast-iron. A cast-steel bracket bolted to its lower contour carries the headlight. In the 6-10 series (European denomination) the front-end frame struts are of American type (round section), but in the "4-10 connected" series the front ends of the frames are stiffened with flat plates with handsome effect—a compromise with the usual plate-frame ends. The boiler center stands about 9 ft. 6 in. from the rail level, and access to the high smoke-box door and front end, from the ground, is provided by four cast-iron steps threaded upon a vertical hand rail on each side of the engine. Cast-iron treads carried on wrought iron rods is the form of construction employed for the other steps. The arrangement of the link radius rod, and its short extension to the lifting link, is novel and well-designed, and by it all torsional stresses are very simply avoided. Wherever an oil cup is necessary it is milled in the rod itself. Brakes are provided for all the wheels in both types of locomotive, the blocks of the front truck wheels being operated direct by the air-brake cylinders.

In the cab there is ample working space, although the fire-box occupies a large part with its sloping back plate. The throttle handle is of the low-reach pivoted pattern, with the common European traversing movement, yet provided with the American spring latch and a finely-notched quadrant. There are wind-screens fixed vertically outside of the cab for use whenever it is necessary to look around the cab sides. Gates are provided between the engine and tender. The tenders are extra large, carrying seven tons of coal and 21 cubic meters of water (21 tons). They have side fillers at the front end so that the fireman can handle the crane hydrant from the footplate and see the height of the water in the tank at all times. The tender trucks are of German standard construction with plate frames. In common with nearly all Continental locomotives these are fitted with tachographs of the Hausshalter model, showing the speeds attained and recording them. The use of a tachometer of great precision is held to be of first importance by European railroads where individual guessing at train speeds would not be tolerated. The "clock" is fixed in the engineer's side of the cab and is operated by the rear driver on the right-hand side in both types of locomotive.

These engines were designed and built by the firm of J. A. Maffei, of Muenchen, Bavaria, to conditions laid down by the chief of traction of the Bayerische Staatseisenbahnen at Muenchen. Ten have already been built and have just been put into service, and 25 more are on order. The maximum gradients of the Bavarian State Railways run up to 1 per cent., and as the country is, in general, hilly the definite type selected for the second order will undoubtedly be the 6-10 connected engine, which is better suited for the light axle loads permitted and for heavy trains. The 4-10, or "Atlantic" pattern, can traverse minimum curves of 180 meters radius, and the 6-10 connected type is also required to pass curves of an equally short radius, the rigid wheel base of each locomotive being 4½ meters. The six-connected engine has drivers 187.0 mm. in diameter, and the four-connected engine drivers are 2 meters in diameter. The latter engine with a boiler pressure of 16 atmospheres has a calculated tractive effort of 5,300 kilograms, while the six-connected engine, with the lower pressure of 14 atmospheres and cylinders 5 millimeters less in diameter, has a tractive effort of 6 metric tons. The high-pressure cylinders are 340 mm. and 335 mm. diameter in the two engines respectively, and the low-pressure cylinders are 570 mm. in diameter in both, the piston-stroke of each being the same, i.e., 640 mm. Both types of engines have an equal grate area of 3.28 square meters, but there is a little difference in the fire-box heating-surface, viz.: 14 square meters for the six-connected engine and 14½ square meters for the four-connected engine. This latter has a total heating-surface of 205½ sq. meters (191




Four-Cylinder Compound 4-6-0 Locomotive for the Bavarian State Railroads.

meters from 283 tubes), and the six-connected engine has a total of 210 square meters of heating surface (196 square meters from 283 tubes). The four-connected engine weighs empty, in metric measure, 61½ tons, and the six-connected engine 62.2 tons. Both weigh about 68½ metric tons in full working order. The first has, beneath its driving tires, a load of 32 tons, while the six-connected has 47.8 metric tons available for adhesion. (A metric ton is about 10 per cent. more than the American standard.) The tenders both weigh 26 tons empty and 54 tons full. The heavier of the two engines therefore weighs with its tender, when full, 135 U. S. tons. These engines are to burn the usual German soft coal from Westphalia.

## Cost of Ditching Cuts and Widening Embankments.*

There is not only little published bearing directly on this subject, but statistics regarding costs of work actually done are seldom available, where all the details connected with the work, such as length of haul, kind and condition of material, number of men employed, number of yards removed, lost time through various causes, wages of men, yards handled per train, etc., are known, or, if available to a few, such statistics are not worked up into such shape that they can be presented in a complete and simple form to aid in properly determining the best method to pursue in any particular case.

With a view of placing such information in a convenient form, and also to enable one to see at a glance the effect on the cost per yard of various changes in the number of men, etc., two diagrams (Figs. 1 and 2) have been prepared, one showing the estimated cost per cubic yard for a haul varying from nothing to 7,500 ft., and the other from nothing up to 15 miles. The latter (Fig. 2) can be used to advantage only in determining whether it is cheaper to make a long haul from the point where ditching is being done, than to waste the material obtained from ditching and obtain the material for widening banks from a more convenient location. The former being to a larger scale, shows the relative cost by various methods in better shape, and is, consequently, the one considered in this discussion. Both diagrams are based on the same unit prices, and have been prepared from estimates, after consulting "Trautwine's Pocket-Book," Gillette's "Earthwork and Its Cost," Camp's "Notes on Track," and Fratman's "Railway Track and Track Work," the results being compared with actual costs where such have been available with all conditions known. As it is seldom that ditches are cross-sectioned, in order to know beforehand the exact number of yards to be removed, it is not expected that the diagrams will assist very much in estimating what the cost of ditching a certain cut will be, but if they are fairly accurate they should show very closely how the work can be handled to the best advantage after the estimate is made, and their careful study may give suggestions of value.

In order to make this report as concise as possible, the detailed estimates from which diagrams were prepared are omitted, but are included in an appendix, so that the work may be checked in detail.

By examining this diagram (Fig. 1) it will be seen that the cheapest method of ditching where the material is to be used in widening embankments, and where such work is not done by simply casting across one track, is by a machine ditcher, provided the machine is so designed that it can load and dump 5 cu. yds. in not to exceed 2½ minutes, exclusive of running time, and can be operated by three men besides the train crew, and if the conditions are such that such a machine can be used up to a haul of some 1,200 or 1,300 ft. in very fair digging, or up to some 1,900 ft. in bad, wet digging. From this point on a properly designed machine ditcher, so arranged that it can load a full train of material, used in conjunction with a plow and cable or other method for quick unloading, can be worked most economically. In both these cases of machine ditchers, it is assumed that the machines will be used enough each year to bring the cost for interest and depreciation down to the estimate given in the appendix, the number of yards handled having to be greater than estimated in case a more expensive machine is used than estimated on. Some further notes in regard to machine ditchers are given near the close of this report.

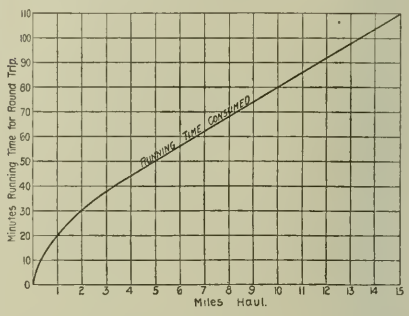
In case a machine ditcher is not available, a study of the diagram will show the relative cost per yard by various methods, provided the traffic is such that the actual working time of work train is only about six hours out of 10 hours the men are assumed to work each day. In discussing the diagram, each method will be considered separately as follows:

*By Team Work.*—On light work, banks can be widened very economically with teams and scrapers. This method can also be used to widen the base of heavy embankments, the filling being afterwards completed by work train or other means. The filling being compacted by the movements of the teams over it is less liable to settlement and unites closer to the old bank than by other methods. Work of this kind is usually let by contract, the price being from 14 cents to 25 cents per yard.

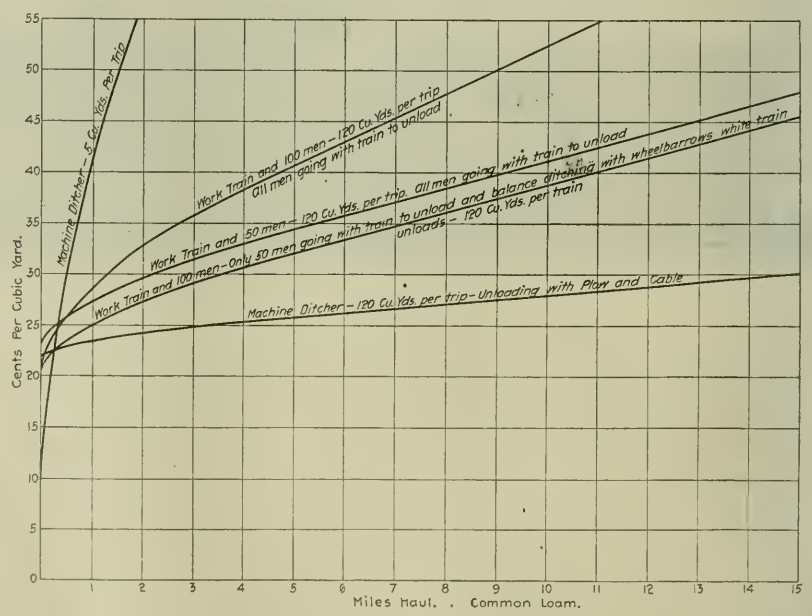
*By Casting.*—The cost of ditching by casting may in fair digging be taken at 10 cents per cubic yard, where one cast will place the material in a suitable final location. If necessary to use one platform by which the material can be raised 6 ft. with the first and 4 ft. with the last handling, in order to place it far enough from the edge of the cut, the cost for such material will be increased about 6 cents per yard, or a total of 16 cents per cubic yard. A description of a simple portable platform is given under the heading "By Work Train and Hand Loading." In both of these cases the material cannot ordinarily be used to advantage in widening embankments.

*By Wheelbarrows.*—By this method the material excavated may be used to widen embankments, if conditions are favorable, and the cost is practically a constant to which a uniform addition is made varying directly with the length of haul. For fair digging it will be noted that casting is cheaper than any wheelbarrow work, and that casting with one platform is about the same cost as wheeling 125 ft. with wheelbarrows. If the material is merely to be carried across three or more tracks, where the traffic is so heavy that it is not desirable to lay gangways across the tracks, on account of safety, very fair results can be obtained by constructing boxes with two handles, similar to the handles on push or hand cars, on each end, and have two men carry each box across. This method, however, is more expensive than wheeling.

*By Push Cars.*—As it is necessary to protect push car work by flagmen the greatest economy by this method will be obtained by working as many men with two flagmen as can be worked to advantage. This is indicated by the three dotted lines showing 4,




Estimated Time for Round Trip of Work Train.


Cents Per Cubic Yard.
Machine Ditcher—5 Cu. Yds. per Trip
Work Train and 100 men—120 Cu. Yds. per trip All men going with train to unload
Work Train and 50 men—120 Cu. Yds. per trip. All men going with train to unload and balance ditching with wheelbarrows while train unloads—120 Cu. Yds. per train
Work Train and 100 men—Only 50 men going with train to unload and balance ditching with wheelbarrows while train unloads—120 Cu. Yds. per train
Machine Ditcher—120 Cu. Yds. per trip—Unloading with Plow and Cable
Miles Haul. Common Loam.

Estimated Cost of Digging Ditches by Various Methods up to 15 Miles Haul.

*Extracts from a committee report to the St. Louis meeting of the Roadmasters' and Maintenance-of-Way Association.

10 and 16 men actually ditching under the protection of two flagmen. It is here assumed that 20 per cent. of the time is lost on account of the traffic, but that this 20 per cent. covers the time spent in trimming up the cut. On the diagram the three dotted lines indicate cost per yard if the men shovel the material off the car, while the three full lines indicate the cost if the car is so arranged that the material can be dumped, by placing an entirely separate box, open at one side, on the bed of the car, or some other suitable method. By such an arrangement, the cost per yard can be reduced some 3 to 4½ cents over shoveling the material off the cars.

*By Work Trains and Hand Loading.*—The diagram is plainly marked showing the method covered by each line, and it is only necessary to call attention to the fact that where only 60 cu. yds. are handled per trip, the lines are dotted lines, and full lines are used where 120 cu. yds. are handled per trip. In all cases with work train except one it is assumed that all the men employed go with the train to unload, and for this reason the cost with 50 men, handling 120 yds. per train, becomes less than with 100 men under the same conditions, after a haul of about 2,600 ft. or one-half mile has been reached. If, however, the work is properly handled the whole number of men employed (where such large numbers are used) are not sent with the train, but are kept at work at the ends of the cut ditching with wheelbarrows, or possibly casting the material, where such can be done by the use of a platform, while part of the men unload, and the cost will be reduced considerably, it being possible, by a proper arrangement, to reduce the cost to almost what machine ditchers will accomplish.

A portable platform for carrying on the work trains for use in cases where material can be thrown out of the cuts by two castings, is described in Camp's "Notes on Track." This is a device consisting of two 2-in. by 6-in. posts 12 ft. long, with two 2-in. by 6-in. horizontal pieces 10 ft. long running into the bank to support the platform of five 1-in. by 12-in. boards 5 ft. long. The posts and horizontal supports are bored at intervals to permit adjustment of the height of platform. In a deep cut, a second scaffold may be placed above the first. This device was first furnished section foremen on the Southern Railway by Mr. W. A. Fort, Supervisor, but was found to be of such value as a time saver when trains were late, that ditching trains were equipped with them. One man on the scaffold can handle about as much dirt as two men can handle in the ditch.

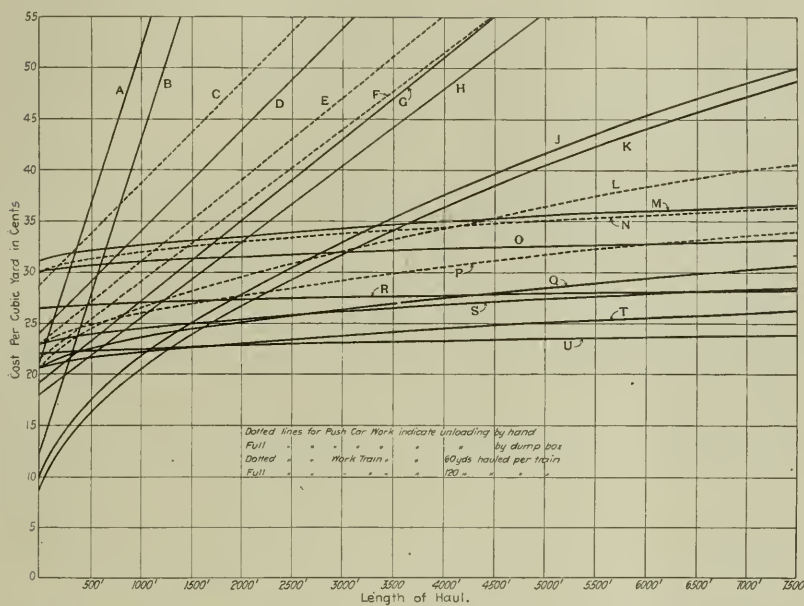
On this diagram the question of using two or more work trains with a gang of say 100 men loading, the unloading being done at a distant point by plow and cable, has not been considered, as work of such character would vary to such an extent with the local conditions, that it would necessarily have to be considered for each individual case: it may be mentioned, however, that 100 men could load 1,000 cu. yds. of material already loosened and placed conveniently for loading, in four hours actual working time, and at that rate the total cost for one train amounting to say $22 per day, would be but 2.2c. per cu. yd. In order, therefore, to keep such a gang busy, a sufficient number of trains should be used, if conditions, such as traffic, side track facilities, etc., will permit. The whole question with work trains, therefore, resolves itself into equalizing the number and disposition of men employed, with the train service in such a way that one will not over-balance the other, and both will be in accordance with the requirements in regard to length of haul, traffic conditions, etc.

*Machine Ditchers.*—Machine ditchers may be divided into two general classes: (1) Ditchers which load a scoop on one or both sides and then run to the end of the cut to dump the material, and (2) those which load a full train of material and unload by plow or by hand. The first kind can be used to advantage only where the haul is comparatively short, while the second class is economical for a long haul. The designing of a machine ditcher, or the selecting of one already built, in order to obtain the best results, requires careful study and consideration.

The requirements of a suitable machine ditcher are that it shall be able to cut the full depth necessary and close up to the ends of the ties in order to obtain a standard section; that it shall be quickly handled with the least number of men practicable; that it shall have the fewest possible parts likely to get out of order, and that it shall be capable of sloping the banks in fair shape either by a slope board or dipper under control of the engineer, the slope board probably being desirable even with the dipper. The dipper or scoop should be as large as can be handled to advantage in order to reduce the cost per yard. As in the case of steam shovel work, the engineer or the man in charge of handling the scoop or dipper, should be thoroughly competent, as the cost per yard of material will be greatly increased if the shovel work is handled slow.

In ditching with a Mahoney ditcher on the B. & O. S. W. during May and June, 1904, it was found that from 12 to 16 cu. yds. could be loaded every 30 minutes in wet or soft soil. The machine is probably not well suited for very hard digging, as the dipper is hinged to the beam, and the weight of the dipper is the only power it has to force itself into the soil. It would require about 30 seconds to move the ditcher ahead and required moving the machine three times for each car load. The crew used to operate this machine was one engine and crew, train crew and four men to operate the ditcher. This machine would not be suitable for ditching in rock cuts, where the ditch is not always the same distance from the track. The material excavated in this particular case was very wet and would have been exceedingly expensive to handle by hand. The record of cost of this work is given in the appendix.

The report is signed by T. S. Forquharson, W. J. McDermont, V. K. Hendricks, C. E. Elliott, J. Murphy.


Cost Per Cubic Yard in Cents
Length of Haul.
Dotted lines for Push Car Work indicate unloading by hand
Full " " " " " " by dump box
Dotted " " Work Train " " 60 yds hauled per train
Full " " " " " 120 " " "

*A—By wheelbarrow—digging wet and bad.*
*B—By wheelbarrow—digging dry and easy.*
*C—By push-car, shoveling off dirt, 2 flagmen and 4 ditching, 20 per cent. lost time.*
*D—By push-car with dump-box, 2 flagmen and 4 ditching, 20 per cent. lost time.*
*E—By push-car, shoveling off dirt, 2 flagmen and 10 ditching, 20 per cent. lost time.*
*F—By push-car, shoveling off dirt, 2 flagmen and 16 ditching, 20 per cent. lost time.*
*G—By push-car, with dump-box, 2 flagmen and 10 ditching, 20 per cent. lost time.*
*H—By push-car with dump-box, 2 flagmen and 16 ditching, 20 per cent. lost time.*
*J—Machine ditcher, 5 yd., bad material.*
*K—Machine ditcher, 5 yd., 40 per cent. lost time.*
*L—Work train and 50 men, 60 yd. per trip, 40 per cent. lost time; all men to unload.*
*M—Work train and 100 men, bad material, 50 men to unload; 120 yd. per trip.*
*N—Work train and 20 men, 60 yd. per trip, 40 per cent. lost time; all men to unload.*
*O—Work train and 20 men, 120 yd. per trip, 40 per cent. lost time; all men to unload.*
*P—Work train and 50 men, 60 yd. per trip, 40 per cent. lost time; all men to unload.*
*Q—Work train and 100 men, 120 yd. per trip, 40 per cent. lost time; all men to unload.*
*R—Machine ditcher, 120 yd. per trip, bad wet material.*
*S—Work train and 50 men, 120 yd. per trip, 40 per cent. lost time; all men to unload.*
*T—Work train and 100 men, 120 yd. per trip, 40 per cent. lost time; 50 men to ditch with barrows.*
*U—Machine ditcher, 120 yd. per trip, 40 per cent. lost time; unloading with plow and cable.*

Cost of Ditching by Various Methods up to 7,500 Feet Haul.

APPENDIX.

For the purpose of determining the actual cost of hauling by train, a diagram is made a part of this appendix, showing the number of minutes actual running time estimated to be consumed for the round trip for the various lengths of haul. By determining the cost per minute of the train and crew, and any other men who go with the train, the cost per yard for actual hauling can be determined from this diagram. It is assumed that this time diagram will apply to any train, whether it carries but 5 cu. yds. per trip or 120 cu. yds. per trip, although the short trains can, of course, be handled more quickly than the heavier ones.

The details of the estimated cost per cubic

yard for handling work by the various methods considered is as follows:

*By Wheelbarrows.*

For common loam, the cost is taken at:

| | |
|---|---|
| Loosening and loading on barrows | 9.8 cts. |
| Leveling earth on embankments | .7 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Total | 12.2 cts. |

To this fixed charge, a constant per 1,000 ft. haul is to be added as follows:

| | Per 1,000 ft. |
|---|---|
| Repairs to gangways | 1.0 cts. |
| Wheeling material | 30.0 " |
| Total | 31.0 cts. |

In handling bad, wet material, it is assumed that the fixed charge will be increased 60 per cent., or 7.3c. per cu. yd., while the cost of wheeling remains the same.

*By Push Cars.*

If material is unloaded by shovel, the cost, exclusive of flagmen, is taken as follows:

| | |
|---|---|
| Loosening and loading on push cars | 9.8 cts. |
| Leveling earth on embankments | .7 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Unloading push car | 3.7 " |
| | 15.9 cts. |
| 20% lost time | 3.2 " |
| Total cost, per yard | 19.1 cts. |

To this fixed charge a constant is to be added to cover the cost of hauling, amounting to 33.4c. per cu. yd. per 5,000 ft. haul. As this amount covers the actual cost without including flagmen, the cost per yard will be increased by one-half the total amount given above, if two men out of the gang of six are kept flagging while four men do the ditching. In case ten men do ditching while two men flag, the increase over the above figures will be one-fifth of these figures; and if 16 men ditch and two flag, the increase will be one-eighth over above cost.

If a dumping box, or some similar arrangement, is used on the bed of the push cars to unload quickly, the cost, exclusive of flagmen, is estimated as follows:

| | |
|---|---|
| Loosening and loading on push cars | 9.8 cts. |
| Leveling earth on embankments | 1.5 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Unloading dump box | .3 " |
| | 13.3 cts. |
| 20% lost time | 2.6 " |
| Total | 15.9 cts. |

To this fixed charge should be added a constant amounting to 33.4c. per yard for 5,000 ft. haul to cover the cost of time consumed hauling. If two men are kept flagging, while either 4, 10 or 16 men are ditching, the portion of the above cost to be added is as given in the case of push cars unloaded by shovel.

*By Work Train and Hand Labor.*

The cost for train and crew, coal, etc., is taken at $22 per day for work train, and the actual working time is taken at six hours per day, allowing for 40 per cent. of the working hours to be lost time.

With 20 men on train, the cost for handling common earth is estimated as follows:

| | |
|---|---|
| Loading (40% lost time used in loosening, trimming, etc.) | 11.2 cts. |
| Unloading | 3.8 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Cost of train loading | 7.3 " |
| Cost of train unloading | 4.6 " |
| Total | 30.1 cts. |

To this fixed amount, the cost of train and crew, together with laborers during the time traveling to and from the place of unloading, is taken from the diagram showing time consumed in round trip of work train, the variable, of course, being twice as much per cubic yard if 60 yds. are hauled per train per trip, as it is in case 120 yds. are hauled per trip.

With 50 men on train, the estimate is as follows:

| | |
|---|---|
| Loading (40% lost time used in loosening, trimming, etc.) | 11.2 cts. |
| Unloading | 3.8 " |
| Leveling embankments | 1.5 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Cost of train loading | 2.9 " |
| Cost of train unloading | 1.8 " |
| Total | 22.9 cts. |

The variable to be added to cover the time of train crew and men traveling to and from the place of unloading is taken from the diagram, as in the case of 20 men with the train.

With 100 men on the train, the cost is estimated as follows:

| | |
|---|---|
| Loading (40 per cent. lost time used in loosening, trimming, etc.) | 11.2 cts. |
| Unloading | 3.8 " |
| Leveling embankments | 1.5 " |
| Repairs to tools | .2 " |
| Superintendence and water carriers | 1.5 " |
| Cost of train loading | 1.3 " |
| Cost of train unloading | .9 " |
| Total | 20.6 cts. |

The variable to be added to cover time consumed in running to and from place of unloading is obtained in the same manner as in the case of 20 men with work train.

*By Machine Ditcher Hauling 5 yds. Per Trip.*

It is assumed that all expenses connected with the train, including crew, fuel, etc., amount to $22 per day, and that there is an additional expense of $6 per day on account of labor handling scoops, making the total cost $28 per day, and that but six hours actual time is worked per day, which makes the cost per minute 7.78c., or 1.6c. per yard per minute with 5 yds. hauled per train.

It is assumed that 5 yds. can be loaded in 2½ minutes in fair digging, exclusive of running time to dump, making the cost 4 cents per yard. The estimated total cost is, therefore:

| | |
|---|---|
| Loading and dumping | 4.0 cts. |
| Leveling embankments | 1.5 " |
| Superintendence and water carriers | 1.0 " |
| Interest, depreciation and repairs | 2.0 " |
| Total | 8.5 cts. |

To this fixed charge, a variable amount is added to cover the lost time running to and from the place of unloading, which variable is taken from the diagram showing running time consumed in making round trip. The interest, depreciation and repairs is based on the supposition that the loading device, spreader, etc., costs $1,000 and loads 10,000 cu. yds. per year, the interest and repairs each being taken at 5 per cent. per annum and depreciation at 10 per cent. per annum

If the ditching is being done in bad, wet material, the cost of loading and dumping is supposed to be increased 30 per cent., which would make a uniform increase in the cost per yard of all lengths hauled of 2 cents per yard over the cost in fair digging.

As a confirmation of the estimated cost by this method, reference is made to the paper by R. S. Stanley, Roadmaster of the C. R. I. & P. R. R., presented to this Association at its meeting in Kansas City, October, 1903, in which he states on page 89 of the Proceedings that earth can be handled at an expense of from 8c. to 28c. per yard, using a Mart ditching machine, and on page 90, from 6c. to 15c. per yard with a 500-ft. to 800-ft. haul by the American Steel Foundry Company's machine.

*Machine Ditcher Loading a Full Train.*

A somewhat greater shovel crew is required for a machine ditcher of this class than of the class mentioned above, and it is assumed that the shovel crew wages amount to $10 per day, making a total of $32 for train and crew, which, if actually working only six hours per day, would be $5.32 per hour, or 9 cents per minute. It is assumed also that a train hauling 60 yds. can be unloaded in 15 minutes with plow and cable, making the unloading cost practically 2.2c. per yard, and that a train hauling 120 yds. can be unloaded in 20 minutes, at a cost of about 1.5c. per yard. It is further assumed that it requires 1⅔ minutes to load 1 cu. yd. in fair digging, which would make the cost per yard 15 cents for loading. The estimated cost, therefore, with 120 yds. loaded per train, is as follows:

| | |
|---|---|
| Loading cars | 15.0 cts. |
| Unloading cars | 1.5 " |
| Switching | 1.0 " |
| Leveling embankment | 1.5 " |
| Superintendence and water carriers | 1.0 " |
| Interest, depreciation and repairs | 2.0 " |
| Total | 22.0 cts. |

The cost for interest, depreciation and repairs is based on an original cost of $2,000 for the machine ditcher, and the supposition that 20,000 yds. per year will be handled. In case only 60 yds. is handled per train instead of 120 yds., the cost of unloading will be 2.2c. instead of 1.5c., all other items being the same, which would make a total cost per yard of 22.7c. In case the material excavated is wet and very hard to handle, it is assumed that the cost of actual loading will be increased 30 per cent. over the above figures, equaling 4.5c. per yard additional.

In confirmation of the above estimates, the following statement of the actual cost of ditching on the Illinois Division of the B. & O. S-W. R. R. with a Mahoney ditching machine during last May and June is given:

*May 11 to May 28, 1904.*

| | |
|---|---|
| Total number of days worked | 10 |
| Total number of yards loaded and unloaded | 1,245 |
| 8 days haul was 7 miles and 2 days haul was 2 miles, making an average of 6 miles. | |
| Total cost of loading, including work train | $241.67 |
| Total cost, unloading, including work train | 55.66 |
| Cost per cu. yd. loading | 19.4 cts. |
| Cost per cu. yd. unloading, | 4.5 " |
| Total cost per cu. yd. | 23.9 " |
| Total delays in 10 days | 32 hr. 10 min. |

*June 1 to June 23, 1904.*

| | |
|---|---|
| Total number of days worked | 10.5 |
| Total number of yards loaded and unloaded | 1,245 |
| Average haul, miles | 1.75 |
| Total cost of loading | $274.88 |
| Total cost of unloading | $57.64 |
| Cost per cubic yard loading | 22.0 cts. |
| Cost per cubic yard unloading | 4.6 " |
| Total cost per cubic yard | 26.6 " |
| Total delays during 10.5 days | 23 hrs. 10 mins. |

## Comments on the Per Diem Rules.

BY ARTHUR HALE.

(*Concluded from page 431.*)

10.—"The junction report for each day shall be made to car owners on the prescribed form (D) as promptly as possible after the receipt of the interchange report for that day."

The junction report enjoined by this rule is the original junction report adopted by the Car Accountants' Association so many years ago. This was the first car service agreement between American railroads and is practically the only railroad agreement that we have never changed, as it was only confirmed by the adoption of the present per diem rules. The car service rules of the American Railway Association are comparatively juvenile when compared to the junction card arrangement and were never so generally effective.

11.—"Within thirty days after the end of each calendar month, car owners shall be furnished with a per diem report for that month, on the prescribed form, showing the number of days each car has been in service upon the road making the report."

Under this rule the per diem report for each month is absolutely independent of any past performance, and the number of days a car is used by the road in question is reported at the expiration of that month. This rule was based on the experience of 1888. Under the first set of rules the junc-

tion card was made the vehicle for settling per diem and the amount due was not reported until the car had left the line. This resulted in such delay to junction reports that it was speedily given up and attempts to revive it in 1902 were successfully resisted. One argument in favor of closing the reports at the end of each month, was that if the per diem report on each car were held until the car was delivered, there would never be any per diem paid on cars held permanently.

12.—"The settling of amounts accruing for the use of cars and reclaims under rule 5, shall be made monthly without regard to reclaims pending under rules 13, 14 and 15."

This rule, as originally passed, provided for the prompt settling of the regular per diem, even if there were a question as to reclaims, but it has now been amended so that switching reclaims are also settled promptly without regard to other reclaims. It might be noted that the word "reclaim," which was hit upon in the formulation of Rule 5, is intended to cover practically all adjustments of per diem necessitated by special agreements and unforeseen circumstances. This word coinage has been singularly successful and "reclaim," seems to be fully established in American railroad language.

The same may be said of the terms "per diem" and "penalty." It is rather curious that these three definitions which have met with such general acquiescence, were made in the body of the rules and not in the series of definitions. Sundry attempts were made to incorporate these terms in the definitions, but it was found to be easier, if not clearer, to incorporate these definitions in the rules, as was finally done. Care was taken, however, not to incorporate rules in the definitions.

13.—"When reclaims are made for allowances, under rules 13, 14 and 15, or on account of special conditions, they must be made by the designated transportation officer of the road from which the allowance is reclaimed."

This rule was introduced from a fear that the traffic departments would attempt to interfere with the per diem system. The rule has probably done no harm, but, it is duobtful whether it is necessary, as the traffic departments of the railroads have in general left per diem severely alone. The only case on record of general interference by the traffic department was occasioned by the refusal of a certain private car line, owned largely by railroads, to place its cars under per diem. It was feared by some of the traffic departments that this arrangement would give this line an advantage in enabling it to hold refrigerators on certain railroads where refrigerator traffic originates. To meet this supposed cut in the rates, the traffic departments of a number of railroads secured an arrangement under which the competing refrigerator cars of these roads should be held freely for this traffic. If it were found that under the old mileage rate the payments on such originating roads would be less than under the per diem rates, reclaim for the difference in the amounts was to be entertained by the car owners.

It appears that practically no refrigerators are unduly held for traffic, and there are few instances where these reclaims are made. In point of fact, the private line in question held on to the mileage rate for revenue only, and the suspicion of rate cutting was wholly unwarranted.

14.—"A road failing to receive promptly from a connection, cars upon which it has laid no embargo, shall be responsible to the connection for the per diem on cars held for delivery, including the home cars of such connection.

"If such a failure to receive shall continue for more than three days, the delinquent line shall thereafter be responsible in addition for the per diem on all cars wherever in transit, which are thus held back for delivery.

"It shall be the duty of a connection intending to reclaim such per diem allowance, to notify the delinquent line daily of the total number of cars so held for it, and, when required, to furnish the initials and numbers of the cars."

15.—"When a road gives notice to a connection that for any reason it cannot accept cars in any specified traffic, thereby instituting an embargo, it should receive cars already loaded with such traffic at the time such notice is issued. If it does not receive such cars, the road holding them may reclaim per diem from the road placing the embargo for the number of days such cars are held, not exceeding the duration of the embargo. After the date of such notice, a road must not load or reconsign cars in such traffic to the road issuing the notice. All such notices must be given by telegraph by the embargoing road, to its immediate connection and by it transmitted as may be necessary."

These are new rules, which, like the other new rules, have made some trouble, but they have stood so far without amendment, although at certain switching centers they have been modified.

The idea of the rule is, of course, to keep a pressure on the road which is to dispose of the lading and through this road to keep a pressure on the consignee, so as to compel an embargo or improved facilities. At certain large switching centers it has been found better to let the trunk line hold back cars which cannot be delivered to congested industries, charging the regular car service, and where this has been practicable, agreements have been made by which Rules 14 and 15 do not apply.

The rules were very difficult to formulate and the credit for them as they stand is due to the late Mr. Drew, who was at that time Superintendent of Car Service of the Chicago, Rock Island & Pacific, more largely than to any one else. An attempt was being made to cover, under one rule, cars held under embargo, and cars held without embargo, and Mr. Drew called attention to the fact that the situation would be much simplified if two rules were made, one which would put a penalty on the refusal to accept cars on which an embargo had not been placed, and second, relieving of all responsibility a railroad which had laid a proper embargo. The result of this suggestion was the formulation of the two present rules. They are the first attempt to regulate generally the embargo as between railroads. The embargo has now been recognized as a necessity, which justifies its advocacy, as a necessary transportation expedient, by the late William P. Shinn many years ago.

Without the recognition and definition of the embargo, it is hard to see how any per diem system could be made a permanent success, and with the recognition of the embargo system, it would seem that there should be some penalty among railroads which neglect to place embargoes against freight which they cannot handle.

16.—"These rules shall not apply to private cars."

When the per diem rules were adopted, dissatisfaction was expressed in certain quarters that they made no provision for private cars. Since that time the private car question has been energetically investigated by a master hand, and it is safe to say that the dissatisfaction with the per diem rules in this respect has diminished.

The private car question is not one question, but means different things to different people. In some parts of the country it is the refrigerator question; in other parts the stock car question; in other parts the coal and coke car question, and so on. Is anyone bold enough to propose one solution for all these private car questions?

Again, no one claims that railroads when dealing with parties not railroads should agree with each other as to the prices they should pay. We find no one designating a uniform rate to be paid private parties for the lease or purchase of steel rails, locomotives, or real estate. There is a consensus of opinion that, as between railroads, a uniform rate should be in effect, and that a per diem rate; but exactly why all railroads should pay private parties and corporations the same price for box, stock, refrigerator and gondola cars is not evident. Very possibly too much is now paid for certain cars, but that does not prove that the present per diem rate ought to be extended to all private equipment.

This rule has, however, had one unfortunate result. A prominent railroad has transferred all its refrigerator cars to a so-called private car company and is charging a mileage rate for them. This has caused a good deal of dissatisfaction and has elicited threats of similar action by other railroads; but when it has been seriously proposed to meet this action by increasing the per diem on refrigerator cars to a paying basis, say 40 cents a day, there has been no general acquiescence among the railroads, although it has been hoped that if such an arrangement were adopted, it might result in putting all refrigerator cars, railroad and private, on one basis.

There is one practical difficulty in the way of paying per diem on private cars. In case such cars are not needed for business, the railroad on which they are held will object to paying per diem for them; and most of the owners of private cars have no tracks sufficient to hold them when they are not in use.

17.—"To interpret these rules and to settle disputes arising under them, an Arbitration Committee of five members shall be appointed by the Committee on Car Service. Three members of the Arbitration Committee shall be a quorum.

"In case any question or dispute arises under these rules, it may be submitted to the Arbitration Committee through the secretary of the association in abstract. The abstracts shall briefly set forth the points at issue and each party's interpretation of the rules upon which the claim is based. The Arbitration Committee shall base its decision upon the rules and the abstract submitted, and its decision shall be final. Should one of the parties refuse to furnish the necessary information, the Arbitration Committee shall use its judgment as to whether or not it can properly decide. All decisions shall be reported to the Association through the Committee on Car Service.

"In case a question shall arise not covered by the rules, the roads disagreeing may by mutual consent submit such questions to the Arbitration Committee.

"The Committee on Car Service may appoint a secretary for the Arbitration Committee, who shall be paid by the Association. The other expenses of the Arbitration Committee shall be divided equally between each of the parties to the dispute and the Association. The minimum charge to each road shall be ten dollars, payable in advance. The expenses shall first be paid by the Association and then billed to the parties concerned by the treasurer of the Association."

This rule, covering the arbitration of disputes, was modeled after the arbitration rule of the Master Car Builders' Association. The Arbitration Committee, at its first meeting, fully intended to follow the Master Car Builders in their practice, under which decisions are only made on actual cases, and no hypothetical cases are entertained. The committee, however, received such a flood of questions of general interest from so many railroads that it felt obliged to answer a number of cases which strictly were hypothetical. In answering these questions, the committee called them "Interpretations," and the interpretations are printed in the rules. A jurist

would consider such a course very dangerous, but in point of fact these interpretations have saved much more trouble than they have caused.

*Definitions.*

These definitions were adopted as much for the elucidation of the car service rules as the per diem rules. Indeed, it was in the mind of the committee that under the per diem system it would speedily become necessary to adopt a rule covering penalty for the diversion of cars, and when the time comes, these definitions, which have been generally accepted, will be of great use.

As indicated in the comments under Rule 6, there is a general movement on foot to continue per diem and penalty when a car is diverted by a connection to a non-per diem road, but further than this, the movement toward penalty for diversion has made no progress. There are great technical difficulties in the way of the formulation of a rule prescribing a penalty for diversion, but like all technical difficulties, these can doubtless be overcome as soon as the absolute need of a penalty for the diversion of cars becomes evident. It was anticipated that under the per diem system diversions would increase, but this does not seem to be the case. Certainly there are not so many "old cases" of cars away from home two or three years as there used to be. This seems to be because the per diem and penalty rules keep foreign cars moving, and even if they move wrong, they get home after a dozen or two of trials.

*Per Diem Rules Agreement.*

The only difficulty with the per diem rules agreement is, as noted under Rule 3, that it was signed by a number of corporations which are not really railroads at all. They may be called "industrial roads," but from a car service standpoint, they are sidings just as clearly as is any 100 ft. stretch of track.

When the per diem rules were formulated, amid the declared opposition of all the belt lines and a very respectable number of long systems west and south, it never occurred to the framers of the rules that any railroad would want to sign it that should be kept out. But a number of private-siding corporations have signed the agreement and it is to be hoped that the American Railway Association will so define the term "railroad company," as to exclude railroads which are not railroads at all.

The reason per diem has come to stay and that there has been no serious effort to overthrow it, is that it has brought about an improved movement of foreign cars on most of our railroads and an improved movement of home cars on some railroads. In other words, it has secured a sensible increase in the work done by the freight cars of the railroad companies. This is not done in a mysterious way, but simply by making it profitable for railroads to educate their men in car handling, to utilize all their engines in handling cars and to buy or build more engines so as to handle cars more promptly. Just what this increase in the number of miles per day made by freight cars has been, cannot as yet be said, but it is certainly enough to justify and preserve the per diem system.

## The Locomotive Boiler Water Changing Plant of the Pittsburg & Lake Erie.*

This plant has been in successful operation since November, 1903, and by it the foul water is removed from locomotive boilers; the heat is saved, and used in heating the water for refilling, and the boiler is refilled with water having a temperature of about 300 deg. F.; the whole operation requiring from 20 to 35 minutes, depending on the size of the boiler. If the condition of the boiler at the commencement of the operation showed steam pressure of 100 to 125 lbs. per sq. in., and if the fire were banked, which is desirable, the steam pressure during the process will not have fallen below about 75 lbs. per sq. in. This water change is made without allowing any steam to escape into the atmosphere, and also without discharging any water on to the floor of the roundhouse or into the pits. While this work is being done the temperature changes in the boiler are very slight, being not more than 30 deg.; from 350 deg. F. to 320 deg. F.

On many roads there exist conditions which make it desirable to change the water much oftener than it is necessary to remove the plugs to wash out mud or scale. The list of these roads includes those that use water having alkaline and other soluble compounds that are not precipitated in the form of scale in the boilers; others that use waters that make a small quantity of scale that does not cement or adhere to the metal; and lastly the rapidly increasing number that have awakened to the importance and economy of purifying the water, by removing all scale-forming solids, and mud in suspension, before the water is delivered to the locomotive boilers. In all these cases there is a concentration of the soluble compounds in the boiler as the evaporation continues, which results in foaming, priming, etc. The necessity for changing the water may vary from once after each trip each way over a division, where bad alkaline waters are used, to once each round trip, or once in each two, five, 10 or 15 days, depending on the condition of the water used and the amount evaporated.

The condition of the water on the P. & L. E., where treated water is used, is such that it is necessary to remove the plugs for washing only once in from 20 to 45 days. During this time the water is changed whenever necessary, or on an average of about once each five days. The benefits resulting from the use of treated water, in comparison with the conditions existing when the locomotive feed water was used in the raw condition as pumped from the rivers are clearly shown by a few facts taken from the records. Comparing results in August, 1902, with those of August, 1904, raw water having been used during the former and treated water during the latter period:

*a.* Number of trains given up on the road on account of leaking boilers during August, 1902, 27; number given up for the same cause in August, 1904, two.

*b.* Number of trains that had to reduce the loading by setting off cars on account of boilers leaking during August, 1902, 13; August, 1904, none.

*c.* Number of through trains, during August, 1902, with delays of one hour or more, that had locomotives changed at McKees Rocks, on account of boilers leaking, 31; for August, 1904, three.

Other results attained show enormous advantages in favor of using purified water, in the increased life of flues and of fireboxes, etc., and in the reduction of boilermakers' wages, in the increased service obtained from the locomotives and the reduction of fuel necessary on account of the removal of scale.

In using the plant herein described locomotives requiring a change of water have their fires cleaned in the usual way and are sent to the roundhouse preferably with

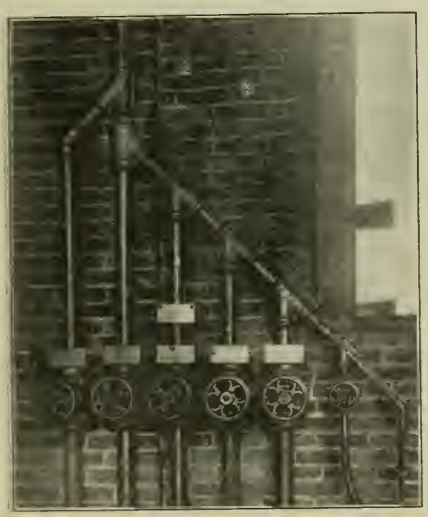


Fig. 1—Manifold and Connections.

Fig. 2—Flexible-Pipe Truck in Use.

*A paper presented to the October meeting of the Western Railway Club by A. R. Raymer, Assistant Chief Engineer of the Pittsburg & Lake Erie.

fires banked and steam pressure at about 100 to 125 lbs. Blow-off cocks have been placed in the left side of the fire-box near the bottom. An overhead 2½-in. blow-off pipe is located between engine pits, with a pipe coupling about 6½ ft. above the floor opposite the blow-off cock in boiler. The other end of the blow-off pipe connects with a manifold on the wall of roundhouse, shown in Fig. 1. A flexible pipe with necessary joints, gage, drip cock, and extension pipes for reaching blow-off cocks, when located in front of boilers, is mounted on a light truck for convenience of operation (Fig. 2.) This flexible-pipe truck is placed in position opposite the blow-off cock, and connected therewith, and also with the blow-off pipe overhead, after which the valves are opened and the water in the boiler is forced out by the steam pressure in 10 to 20 minutes. When all of the water is blown from the boiler the blow-off valve in the manifold is closed and the "superheated" water (at a temperature of 300 deg. F. and with a pressure of 125 lbs.) is admitted by opening a valve in the same manifold and the boiler is quickly refilled with pure water forced into the boiler through the blow-off cock, after which the valves are closed and the flexible pipe disconnected and removed. There remains in the boiler a steam pressure of about 75 lbs. after foul water is fully removed and the pure water is forced in against this pressure.

The manifolds are placed on the roundhouse wall, one for each of as many pits as it may be desired to serve; pipe mains are laid under the floor in an accessible trench, one for each branch of the manifold. It has been found desirable to have the manifolds include the following service pipes: Live steam (at about 150 lbs. pressure); blow-off pipe; superheated water; hot water (at a temperature of about 200 deg. F.—the hot well temperature—and a pressure of about 125 lbs.); cold water (at supply temperature, say about 50 deg. F., and at about 90 lbs. pressure); test water (at supply temperature and at any desired pressure up to 300 lbs. per sq. in.).

The live steam is used for heating up empty, cold boilers. This can be safely done in about 10 minutes' time, in which time the temperature is changed from cold conditions up to about 300 deg. F. The action of the steam on the empty boiler shell is uniform throughout its mass; it consequently causes no unequal expansion, and therefore no bad results. Live steam is also used for increasing the temperature and pressure in a boiler full of water and under low steam pressure.

The blow-off pipe from the manifold is used to convey blown-off water and steam to the blow-off tank, described later.

Superheated water is used for refilling boilers when water is changed for filling empty boilers after they have been warmed up by use of live steam.

Hot water is used for filling boilers "whistle full" when a hydrostatic test is to be applied by "test water" at proper pressure. Hot water is also used to cool down boiler shells quickly and safely. Say a boiler has 100 lbs. steam and it is desired to have it empty and cool as quickly as possible. The water is blown out of the boiler and the steam is allowed to follow until the pressure is not more than 10 to 15 lbs. (The temperature of the metal will still be up to about 300 deg.) The valves are then changed and hot water is forced in, which cools the shell gradually, after which cold water may be mixed with the hot water for further cooling.

Cold water is used for removing mud, scale, etc., when necessary, by the old method of washing.

Test water is used as described above for producing hydrostatic pressure in the boiler. It is furnished by a pump set to the pressure wanted, which pressure can be held as long as may be desired. As this test pressure is on the manifold, it and the flexible piping up to the blow-off cock are tested each time test pressure is used.

Fig. 3 is a diagrammatic view of the plant. The blow-off pipe, B, attached to blow-off cock A conveys water and steam from boilers to blow-off tank, T, which tank is closed and furnished with a pipe, E, to convey steam to condenser, F, and if in excess, to the atmosphere. There will, therefore, be atmospheric pressure in the blow-off tank, T; consequently the superheated water and steam blown from the boilers will immediately on arrival at the blow-off tank drop to a temperature of 212 deg. and all heat above that amount will pass in steam through pipe E to the condenser.

A hot well is located near, and below, the condenser. It is kept full of pure water from the supply by means of a float valve, G. This supply water for the hot well flows through a coil in the blow-off tank, thereby extracting considerable heat from the foul water left therein, reducing its temperature below 212 deg. A centrifugal pump, H, draws water from the hot well, and circulates it through the condenser, F, and back to the hot well, thereby condensing the steam and transferring the heat to the water in the hot well. The water of condensation also flows from the condenser to the hot well, or to the sewer as may be desired.

A hot water pump, J, is located below the hot well level and draws water from it and forces it by pipe K to the hot water valve in the manifold, and by pipe C through a live steam heater, L, to the "superheated" valve in manifold. This pump is set for a constant pressure of 125 lbs. and is controlled by a steam pressure regulator. The test pump, P, is of the usual steam pressure regulated type easily adjusted for the pressures wanted, up to 300 lbs. per sq. in.

Few persons who have not made this work a special study will appreciate the amount of heat lost when an ordinary locomotive boiler is blown off and no attempt made to save it. An ordinary freight locomotive boiler will hold about 2,500 gals. of water when in working condition. This amount of water when at steam pressure of 100 lbs. has in it an amount of available heat *above* 212 deg. F. equal to 2,600,000 B. T. U. and nearly an equal amount in the metal of the boiler shell and connected parts. The amount of heat blown off from a boiler of this kind at 100 lbs. pressure will evaporate about 2,700 lbs. of water at 212 deg. F., and this amount of heat along with that saved from the foul water is sufficient to raise the refilling water from an initial temperature of say 60 deg. F. up to 200 deg. F. In delivering this refilling water to the boiler at say 300 deg. F. the additional heat above that of the hot well, which is at about 200 deg., is furnished by live steam from stationary boilers. No one will question the economy of drawing heat from a modern power house with stokers and high efficiency boilers, rather than trying to heat up locomotive boilers in the old way by smoky fires, with expensive draft obtained by the use of compressed air or steam.

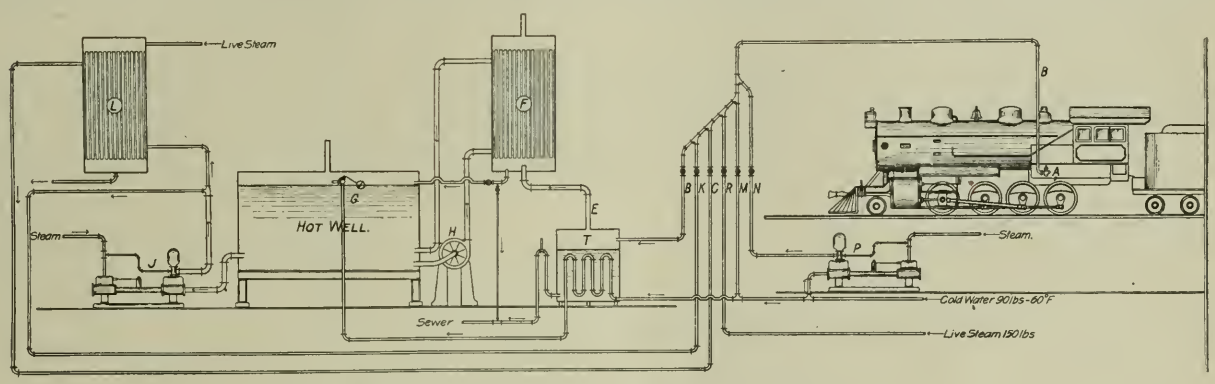



Fig. 3—Diagram of Connections for Boiler Water Changing Plant.

Some of the different kinds of service rendered by this plant, taken from actual practice, are shown in the following:

Locomotive No. 302, P. & L. E. Atlantic type passenger, with 115 lbs. steam and no fire, was emptied, and 18 minutes' work done on the empty boiler; afterwards boiler was filled, fired up and engine left roundhouse, all in 80 minutes, following being the log:

8.55 p.m. commenced blowing off. The boiler pressure was 115 lbs.; no fire.

9.18 p.m. water all out; pressure 80 lbs.

9.21 p.m. steam all out; pressure 0.

Work was done on boiler from 9.21 to 9.39.

9.39 p.m. commenced filling with superheated water.

9.48 p.m. boiler showed 1½ gages water; pressure 50 lbs.

9.46 p.m. fire started.

9.48 p.m. commenced delivering live steam into boiler.

10.01 p.m. shut off live steam; boiler pressure then was 85 lbs.

10.15 p.m. locomotive left roundhouse with 140 lbs. steam.

*Water Change.*—Heavy freight locomotive, P. & L. E. No. 174. Fire was banked with steam pressure at 112 lbs., water change

was made in 37 minutes, and steam pressure did not fall below 50 lbs.

4 p.m. commenced to blow off water; boiler pressure 112 lbs.

4.24 p.m. water all out; boiler pressure 90 lbs.; continued blowing steam.

4.26 p.m. stopped blowing; boiler pressure 50 lbs.

4.27 p.m. commenced filling with superheated water.

4.37 p.m. boiler showed two gages, and pressure of 75 lbs.

At 4.40 locomotive left roundhouse.

Passenger engine No. 95, 4-4-0 type, was emptied for boiler work at 3.11 p.m.; work was finished at 4.45 p.m. Boiler was still warm but empty and under no pressure. Live steam was turned into it at 4.45 p.m. for six minutes, in which time pressure rose to 70 lbs. At 4.52 p.m. superheated water was started and in six minutes boiler had 2½ gages; pressure was now 58 lbs. Fire was started at 4.58 and live steam was again turned on at 4.59 into boiler full of water at 58 lbs., and at 5.04 the pressure was 100 lbs. The locomotive left roundhouse at 5.05 p.m.

Locomotive No. 792 (L. S. & M. S.) from shop:

9.33 a.m. cold and empty, live steam started.

9.43 a.m. boiler pressure was 55 lbs. with no water, excepting water of condensation in it.

9.44 a.m. superheated water was started.

9.56 a.m. boiler showed two gages water.

9.56 a.m. fire was started.

9.57 a.m. live steam again turned on.

10.05 a.m. boiler showed 90 lbs. steam, and engine left roundhouse.

Locomotive No. 89—No fire; steam pressure was 120 lbs. Engine was needed and it was found necessary to pack throttle valve before allowing it to go out.

11.30 a.m., pressure 120 lbs., commenced blowing off water.

11.50 a.m., pressure 70 lbs., water was all out.

11.57 a.m., pressure was zero, boiler was empty.

Work on empty boiler was done from 11.57 to 12.03.

12.03 commenced heating with live steam.

12.08 p.m. cut off steam; boiler pressure was 60 lbs.

12.09 p.m. commenced filling with superheated water.

12.16 p.m. boiler showed 2½ gages of water, and pressure was 70 lbs.

In 46 minutes the pressure in boiler was reduced from 120 lbs. to zero; six minutes' work was done on boiler, and it was filled and heated up to 70 lbs. steam pressure.

Locomotive No. 167—Arrived at roundhouse with 95 lbs. steam, and no fire. Engine was marked up for repair shop. Water was blown out and the steam pressure was allowed to drop to 65 lbs. in 25 minutes, after which the locomotive was moved to repair shop by its own steam at this pressure.

Locomotive No. 165, 2-8-0 class, was heated up from empty cold condition by use of live steam to allow locomotive to be moved to another stall.

9.23 a.m., cold; no water in boiler.

9.48 a.m., steam pressure was 123 lbs., at which time the steam was shut off.

At 9.53 locomotive was moved, and when in new stall pressure was 90 lbs.

*Water Change.*—Passenger locomotive No. 301—Atlantic type. Fire was banked; steam pressure 100 lbs. Two gages water before commencing. Water was changed in 37 minutes and pressure did not drop below 75 lbs.

The pumps, the blow-off tank, the condensers and all of the plant, excepting the parts located in the roundhouse, are under the care of the power house men. One man in the roundhouse at 18 cents per hour does the work of changing water in boilers, heating and filling boilers, testing, etc., and he can handle two locomotives an hour if they are delivered to him so that he can operate on two or more at one time. At McKees Rocks roundhouse there are 10 stalls equipped for the use of this plant, and four trucks are used in making the connections to the boilers.

In conclusion, some of the advantages resulting from the use of the above plant have been found to be as follows:

1. Work of filling and emptying boilers and of changing the water is done without causing destructive strains in them.

2. The roundhouse work on boilers is more economically done in regard to labor, fuel and time.

3. Locomotives can be, and are, maintained in better condition, as work can be done when needed on parts of the boiler not accessible without removal of the contents.

4. The roundhouse conditions can be much improved. The floor will be cleaner and dryer, and the air will be free from smoke and steam, much to the benefit of the employees and of the structure.

5. Great economy resulting from the amount of heat saved from the water and steam blown out of boilers and used in heating water for other boilers.

6. Convenience of method of making hydrostatic tests of boiler strength, and the thoroughness of the operation results in the boilers being maintained in safer condition.

7. On account of the quick service in roundhouse work, passenger locomotives are run on schedules, with shorter time at terminals, thereby increasing the amount of work that can be done by the locomotives.

## The Circum-Baikal Railroad.

The opening of the Circum-Baikal Railroad took place Sept. 23. The building of it has been one of the most notable feats in railroad construction. Probably no work of such difficulty was ever so quickly executed—some two years ahead of the time set before the war. Its importance to the Russians cannot easily be exaggerated, and its opening (doubtless it cannot be called completed yet) so early in the season immensely strengthens the position of the Russian army in Manchuria; which cannot only be reinforced but supplied for the winter before winter sets in, which in that terrible climate limits materially the efficiency of a railroad; though, the snow-fall being light on most parts of the line, there is less hindrance from blockades than we are accustomed to here. The new railroad is strongly occupied by troops, and is worked strictly as a military line. So far, only freight trains run over it, passengers crossing by the ferry in a fraction of the time required by rail, the distance by lake being less than 40 miles, against 250 by rail.

## Three-Phase Alternating Current for Electric Railways.

During a discussion at the International Electrical Congress held at St. Louis, Sept. 13, Mr. A. Zelewsky, Chief Engineer of Ganz & Company, Budapest, Hungary, called attention to some of the advantages of the three-phase system for electric railway service. Extracts from his remarks follow:

It is generally stated that the series motor, the torque and speed of which are in intimate connection, is the most suitable machine for traction and transportation, while the polyphase induction motor, the behavior of which is rightly compared and made almost identical with the d. c. shunt motor, does not meet the requirements of railroad service. At the present time, railroads are operated principally by steam, which means the use of heavy locomotives and trains. When introducing electric power, we still have to deal with this condition and have also to build locomotives of large capacity. Attempts were made at starting single motor cars at short intervals, but this did not satisfy the requirements of the traveling world, which wants to be transported with the smallest possible number of stops; only for local traffic, therefore, is that method satisfactory.

It is impossible to think seriously of railroad service with heavy trains, without keeping strictly accurate time as laid out in the time-tables. The fundamental requirements of safety and reliability compel us to do so. I doubt very much whether it is possible to meet these requirements with a motor, the speed of which depends upon the voltage and upon the torque demanded, and which, therefore, is sensitive to any grade of the road and any change in the load, if artificial means for the regulation of the speed are not applied.

The regulation of speed, with single-phase series motors, not considering the parallel and series connection of two motors which is proper to both the d. c. and a. c. systems, can be effected by the insertion of either inductive or ohmic resistance or by the application of a transformer with variable ratio, which, however, will lower the power factor. But the motorman has to be very careful and pay the greatest attention to the controller in order to maintain the schedule. The speed of the polyphase railroad system, however, is almost independent of the pressure and load, and, therefore, within the limits of the capacity of the locomotives, trains of any weight on roads of any grade, can be propelled with the same speed, since the small retardation due to the slip at higher loads is easily within the elasticity of the time-table.

With high-speed locomotives, the resistance of the air rises considerably so that the ratio between the operating torque and the torque which is necessary to accelerate the train is not so unfavorable as with street railways. The requirements, therefore, to design an induction motor with sufficient high starting torque, can be easily met. Since polyphase induction motors operate with full torque up to almost synchronous speed, whereas the series motor can develop the maximum torque, only during a fraction of the accelerating period, it follows that in the first case the train accelerates in the shorter time, or in the same time, and with less jolting. Furthermore, the adhesive weight of the locomotive during acceleration is more fully utilized than with the corresponding series motors.

Although the application of water rheostats for starting, speed regulation, etc., somewhat lowers the efficiency of the system, this is of little importance on the main line roads. On the other hand, the starting apparatus, which is generally the most delicate point in all of the traction systems, is, on account of being a water rheostat, almost indestructible. Another great advantage of this system is the ability to send back energy to the power house on the descending parts of the road.

From the point of design and construction, motors for railway service should be as light as possible and the space between the tracks should be occupied by as much active material as possible. It is difficult to find space for the commutator when using single-phase

series motors. The conditions are still worse when we consider that the use of a transformer is necessary, the weight of which can again be considered as not entirely active on account of the variable torque which does not allow the transformer to operate at full efficiency all the time.

Not only have extensive experiments to prove the adaptability of the polyphase induction motor system for railway work been made, but such a railway system almost 70 miles long exists and has been in actual and continuous operation for more than two years, and the results are so satisfactory that a considerable extension of the system is only a question of a short time. The normal output of the locomotives in this system is 1,200 h.p., but they can carry a considerable overload, so that even the heaviest trains can be hauled on this very mountainous road. In Canada a combined polyphase and direct current railway system is to be built by Ganz & Company for local and interurban service.

## Preliminary Railroad Surveys by the Stadia Method.

BY J. A. MACDONALD.

In making preliminary location surveys for railroads, the stadia method enables the surveying party to go over the field much more rapidly and in most cases is a much cheaper method for that reason than using a level. Locating engineers, however, seem to have a decided preference for using a level for this work, chiefly because of the more accurate data obtained. It would seem to be a useless refinement to go over the ground with a level taking precise but tedious readings at every station when these levels may only be furnishing rough data to the engineer from which the final location can be determined. In a level country or on gently undulating ground, the final location can often be determined with no preliminary observations, and the levels for the sub-grade fixed from one survey but usually all of the work of the preliminary survey must be done over once and often many times before the line is finally located. The stadia method is a simple and rapid way of obtaining all of the necessary data with sufficient accuracy for the purpose intended since both the topography and the bearing of the tangent can be found with one setting of the instrument.

The instrument best suited for a stadia survey is an accurate transit with a full vertical circle rigidly attached to the axis of the telescope and graduated to 30 seconds from 0 deg. to 90 deg. in both directions. The horizontal vernier arm should have a level attachment with a sensitiveness corresponding to the angle read by the verniers, for it is upon this level that dependence must be placed for the accuracy of the vertical readings and not upon the levels mounted on the horizontal vernier plate.

The stations in a stadia survey need not be placed exactly one chain apart but can be taken 200 ft., 500 ft. or even 1,000 ft. apart if the ground is level. After setting up the instrument on a station and getting the back sight the telescope can be circled around and all of the topography to the left side of the line taken. The rodman can be signaled to place his rod where wanted and the angles of elevation of all hills and valleys within 1,000 ft. should be obtained. Three observations are sufficient for most cases, one between 0 deg. and 90 deg., one at or about 90 deg. and one between 90 deg. and 100 deg. The elevation and distance of the next station should then be taken and finally three more observations recorded for the topography of the ground to the right of the line, one between 180 deg. and 270 deg., one at 270 deg. and one between 270 deg. and 360 deg. The azimuth or deflection of the tangent can be deduced from the offsets. Progressing in this way, the topography of the country through which the road is to pass can be plotted with reasonable accuracy, and the chief engineer with the data at hand can determine the exact location from the plot so made.

When working in the field with a stadia, a stadia rule, or even better, graphic diagrams should be carried for making the corrections for differences in elevation between the transit and the stadia rod or $\frac{1}{2}$ sin 2 (observed angle) and corrections for distance, $\cos^2 \theta$. The constant of the instrument, f + c, may or may not be reduced to sine and cosine for small angles of elevation. The stadia rules are more convenient to handle than tables and the graphic diagrams are even easier to read. Any good draftsman can easily prepare a diagram for $\cos^2 \theta$ and $\frac{\sin 2\theta}{2}$ from which corrections can be read direct for any observed angles.

The most difficult part of a stadia survey is keeping notes in handy form. No note books can be obtained which are ruled up especially for stadia work but anyone can prepare such a book with little trouble. A convenient form is to have the facing pages ruled as below.

Page 4 ..... Observer ..... Recorder ..... Date ..... Page 5

| Station Number | Deflection Angle | Degree of Curve | Bearing of Tangent | Points Taken | Azimuths | Distances | Corrections | Vertical Angles | Computed Difference of Elevation | Elevations | Observations & Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
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Ruling for Note Book for Stadia Surveys.

Both the left hand and right hand pages are used and no room is left for the sketch which should accompany the field notes. This, however, may be put on the two following pages and the notes continued after the sketch. Since the stadia reading must be corrected for differences in elevation it is better to enter the observed vertical angles and afterwards check the corrections with tables. In the distance column the corrected distance can be entered with the observed distances.

## Foreign Railroad Notes.

The London "tuppeny" tubes, as the new electrical underground railroads are called, have hardly met with the favor expected. All three of them had fewer passengers in the first half of this year than last. The decrease was very slight, but notable because the number of omnibus passengers increased meanwhile.

The Prussian State Railroads lately asked for bids for 660,000 pine, oak and beech ties, in 670 different lots. Pretty much all the dealers, home and foreign, in such materials were on hand. Higher prices had been expected because low water in Russian rivers had prevented the arrival of what has usually been a large part of the supply; but, in fact, the bids were lower than at the last previous letting, which is attributed to the fact that a certain German forest had been so nearly destroyed by caterpillars that it must all be felled at once. The prices varied not only for different woods, but for the place of delivery. Pine ties at Hamburg were offered at 72½ to 87½ cents each; at Breslau, 52 to 63 cents.

## The Railway Signal Association.

The annual meeting of this Association was held at St. Louis October 11 and 12. President J. C. Mock in the chair. President Mock in his opening address recommended the republication of the Proceedings of the Association from the beginning and the establishment of a permanent headquarters. The principal discussion was on a set of standard specifications for mechanical interlocking material and construction, reported by the committee on standards, of which Mr. C. A. Christofferson (C. G. W.) is chairman. A report of this discussion must be deferred to a future issue.

The committee on circuits for manual block systems, C. H. Morrison (Erie), chairman, made a report recommending (1) the use of the staff system on single track and (2) the controlled manual on double track, and embodying condensed descriptions, with drawings, of the electric train staff and the controlled manual apparatus as made by the Union Switch & Signal Company. There was some criticism of the committee's recommendation of the staff, on the ground that controlled manual block signals, without the staff, are equally safe. After considerable discussion a motion to endorse the second recommendation was voted down, and the report was recommitted, with instructions to prepare a report on the merits of different methods of controlling manual signals. The Illinois Central is now using, on 238 miles of its single track lines, so-called manual controlled signals, made by the Taylor Signal Company, which, however, have no rail circuit connection and are habitually used for giving permissive signals. The main function of the machine is to provide electric locking from station to station which insures that for each clearing of a signal the signalman must have the co-operation of the man at the other end.

Mr. Balliet (L. V.), chairman of the committee on wire circuits, reported that he had been unable to gather much information concerning the life of rubber insulated and weather-proof wires for the reason that very few roads had had any experience. It would appear from the discussion that there has been so much demand for low prices that weatherproof insulation, as now offered, is of a poorer quality than in former years. The discussion branched out into all manner of questions about line wires, and a resolve was offered that line wires should be at least as large as No. 10 B. & S. or No. 12 B. W. G., where poles are more than 132 ft. apart, but as a number of members are satisfied with smaller wires there was opposition to the motion and it was lost.

Dr. Black, of Milwaukee, who read a paper on tests of colored signal glasses at the September meeting, read a further paper on the subject at St. Louis.

The secretary's report showed a membership of 329 and the treasurer's report a balance on hand of $855. The old officers were re-elected except that H. S. Balliet (L. V.), of South Bethlehem, Pa., was chosen Secretary and Treasurer in place of B. B. Adams. It was voted that the next annual meeting be held at Niagara Falls.

## Prevention of Collisions.

[*From The New York Evening Post.*]

The terrible collision near Warrensburg, Mo., last week was almost precisely like that at New Market, Tenn., two weeks before; and the two together resulted in the death of between 80 and 90 passengers. During the first six months of 1904 no less than 388 persons have been killed on American railroads. It is a black record. The potential causes of railroad wrecks are constant. The engineer forgets an order. The conductor has a copy of the same order, but he forgets it, or is unable to prevent the engineer's error. A train is directed to wait for two other trains, and it waits for only one of them, then going on to its destruction. There is nothing mysterious about the causes of these collisions which now agitate the public mind.

About 15 per cent. of the railroad mileage of the country has the block system, the well-approved method under which the number of collisions is enormously reduced; but on the other 85 per cent. passengers and trainmen—particularly trainmen—are added to the death list month after month and year after year with distressing regularity. If the people are to make their indignation effective, attention must be concentrated on one class of accidents—collisions. Collisions constitute the great bulk of the disasters which give American railroading so bad a reputation abroad.

There is practically only one remedy—the block system. All railroad managers know this. They put the block system in force on their busiest lines, thus justifying the assertion of the Interstate Commerce Commission, in its last annual report, that this is the only recourse. The only reason for the absence of so simple a safeguard is the cost; but this plea is greatly overworked. One prominent railroad manager said, not long ago, that the block system had been introduced on several hundred miles of his road at an increase in the pay rolls of the telegraph operators and signalmen of only 3 per cent. This was not one of the largest trunk lines, and the protection afforded was less complete than that which we find on some of the eastern trunk lines and on the well-equipped railroads of England; but it did greatly reduce the collisions and the death lists.

The block system means that no train starts on any part of the road until the line is ascertained to be clear of all other trains *for a known distance*. Without the block system, trains running in the same direction can be kept safely apart only by holding them a certain number of minutes at stations, and by the use of the discredited red flag; while on a single-track line the avoidance of collisions between trains running toward each other depends upon unerring adherence to the time-table, perfect care and vigilance, unfailing memory of rules, time-tables, and the superiority of different classes of trains, and attention to diverse distracting duties under the most trying circumstances of weather and overwork. The block system, on the other hand, makes all trains of equal importance (as regards safety), makes the "danger points" fixed instead of variable, and does away with errors from defective watches, misreading of time-tables or written papers, and forgetting telegrams.

Consideration of the block system does not (at present) require notice of such refinements as the automatic stop used in the subway to check a careless moto man. Neither can there be much profit in considering, just now, the question of overwork of trainmen, or of the influence of the trade unions. The majority of collisions are due to the error or neglect of men in good health and not overworked. The Government bulletins are full of cases of collisions where those responsible are reported as having good past records.

It is fair to say that in some quarters progress in adopting the block system has been delayed by the desire to wait for the invention of more perfect apparatus. American railroad officers believe—though Englishmen have not yet adopted this view to any extent—that the ideal block system is the automatic. It costs very much more to install than does apparatus for the non-automatic or manual system, hence managers do not easily get the necessary appropriations. But this waiting attitude is indefensible, for the crying need is the immediate adoption of *some* block system; the use of manual signals pending the perfection or more general approval of automatic signals. One prominent trunk line whose approved standard is the automatic, has yet put in the manual system on many miles.

The dilatory policy of the railroads has now continued for so many years that they can find no fault if Congress takes radical action. The Interstate Commerce Commission, in its last annual report, laid before Congress a definite measure, and there has been no adverse criticism of it. On the contrary, the manager of one important trunk line declared his intention of preparing to comply with a law like that proposed, which contemplates complete block signaling within five years. As we said at the time, the Interstate Commerce Commission is the most appropriate body to exercise governmental supervision in this matter. With all its faults, it has done fairly well with the Federal statute of 1893, making automatic couplers and air-brakes compulsory everywhere. The people of the country have a right to require of railroads a reasonable assurance of safety, and the way to enforce this right is now quite plain. The railroads have had their chance to make a good showing; too many have neglected it, and their showing is appallingly bad. Unless the managers act of their own motion in adopting safety appliances, the only thing they have to expect is a mandatory law with heavy penalties for its violation.

## Railroad Shop Tools.

(*Continued.*)

### RADIAL DRILLS.

The accompanying illustration, Fig. 1, shows a 60-in. radial drill made by the Dreses Machine Tool Company, Cincinnati, Ohio. This machine is shown in connection with a speed variator and a constant speed motor. The outside column swings on an inside stump fixed to the base and reaching almost to the top, and it is clamped by a split band encircling part of the fixed stump and a flange on the lower end of the column. Power is transmitted to the drill spindle in the usual way by a horizontal shaft near the base, a pair of miter gears and a central shaft in the column, two spur gears on top of the column and an outside vertical shaft V carrying a sliding miter gear. This miter gear engages with the miter gear on the short shaft (see Fig. 2), on which are fixed the pinion b, and the two loose friction gears c and d. The pinion b meshes with friction gear e, and the friction gear c meshes with friction gear f on shaft h. The friction gear d engages indirectly with f by means of the intermediate pinion g journaled in the gear casing. The lever combination j operates the double friction in gears e and f, and when engaged with one or the other, changes the speed according to the proportion of the gears, which is in geometrical progression with the range of

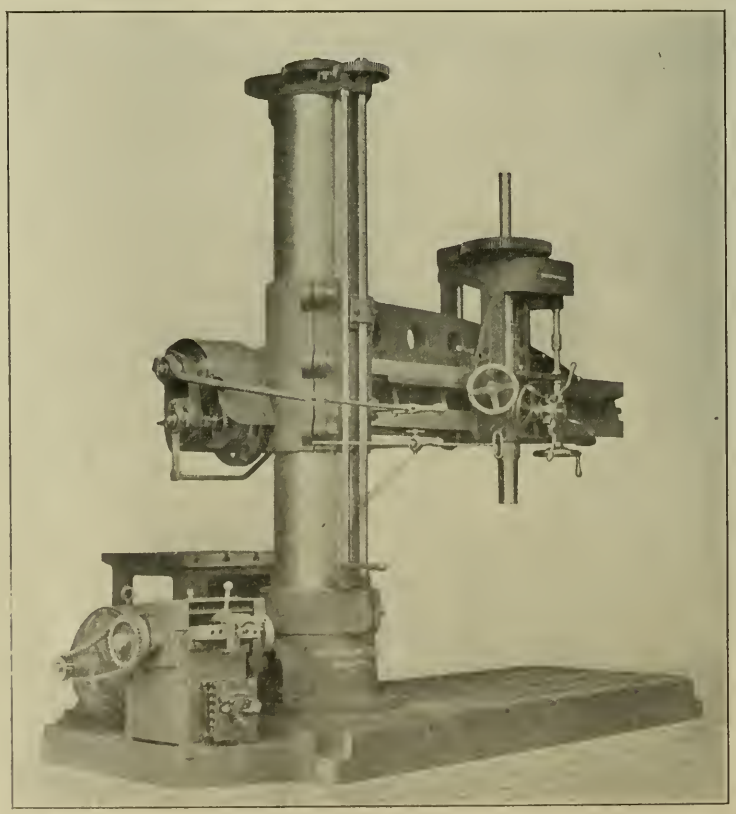


Fig. 1—The Dreses Radial Drill.

the cone pulleys. The double friction between the gears c and d is operated by the lever combination K, and when engaged with c the spindle turns to the right. When engaged with d, because of the intermediate gear g, the spindle reverses faster in the same ratio as the different diameters of the two gears c and d. By clutching d to shaft a, a slow forward speed and fast reverse is obtained by engaging the friction between e and f alternatively. By clutching f to h and operating the friction between c and

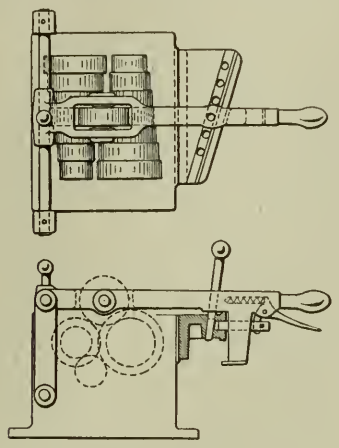


Fig. 3—Main Drive Variable Speed Mechanism.

d a fast forward and a slightly increased reverse speed of the spindle can be had.

The power feed for the drill spindle is geared. It has six changes and is varied by shifting the knurled knob on the feed rod, which engages the proper gear by a key and feather gear.

The speed variator has two shafts with seven gears on each shaft proportioned for seven speeds in geometrical progression. These gears do not mesh with each other, but are fixed to the shafts, except the largest driven one on the variable speed shaft, which is connected by a pawl and ratchet arrangement. This ratchet gear and the smallest gear on the driving or constant speed shaft are connected through an idler pinion which causes the driven shaft to run always at the slowest speed. When the speed of the variable speed shaft is increased the ratchet fixed on this shaft runs ahead of the pawl in the loose gear. The lever with the handle shown in front of the speed variator swings in the rear on a bridle and it is arranged so that it can be shifted either lengthwise or crosswise. It carries a single gear wheel which meshes with the different gears on the two shafts. The latch with the plunger below the handle, locks the handle vertically and the knobbed pin locks it horizontally, as shown in Fig. 3. The holes for locking, in the index plate, are drilled to correspond to the correct positions of the intermediate gear in mesh with the cone gears. These cannot be engaged unless the intermediate gear is in the correct position. In order to take up the shock of rapidly changing from low to high speeds, and *vice versa*, a frictional connection between the drill shaft and the variator is introduced. This friction is similar to a planer friction, and is adjusted so as to carry the heaviest load of the machine, but no more.

Fig. 4 shows a combined radial drilling and tapping machine made by the Newton Machine Tool Company, Philadelphia, Pa. The radial arm of this machine measures 6 ft. from the center of the

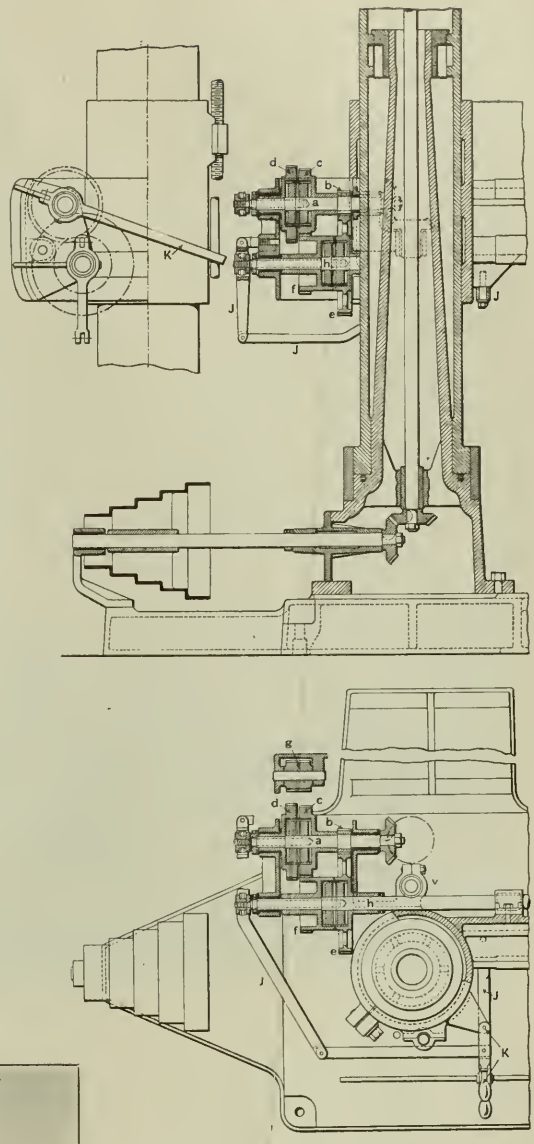



Fig. 2—Details of Mechanism for Obtaining Additional Spindle Speeds.

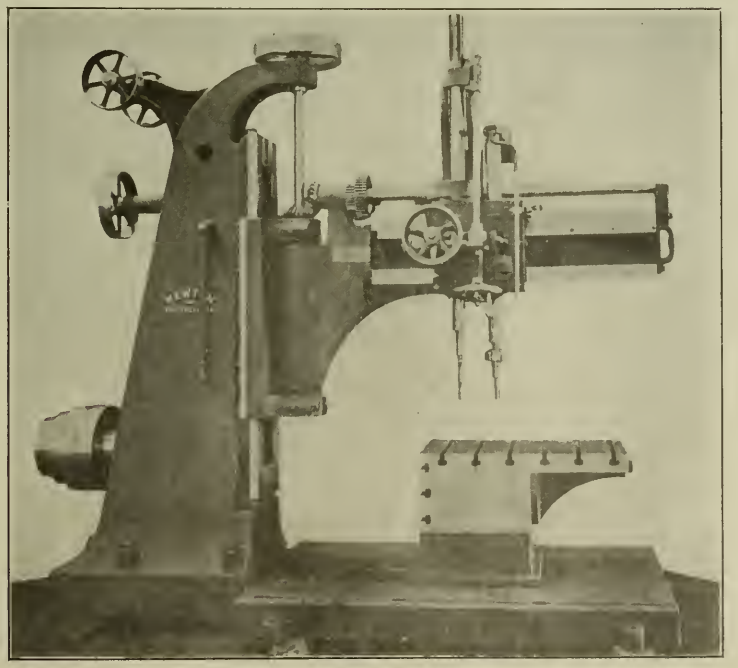


Fig. 4—The Newton Radial Drill.

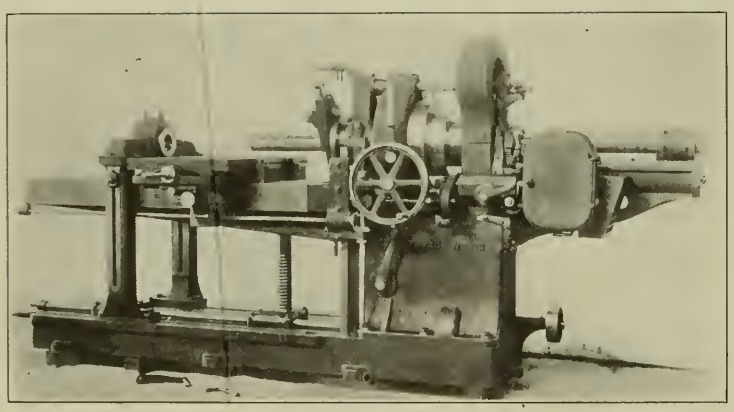
trunnion. Two spindles are provided, one for drilling and one for tapping. These spindles are $2^{13}/_{16}$ in. in diameter; they are counterbalanced and both have an automatic feed of 17 in. Three changes of feed are provided for the drilling spindle, which is driven through a worm and worm wheel by a three-step cone with back gears. These gears are on the horizontal driving shaft on the radial arm. The tapping spindle is geared to the main spindle with a reduction of 2¼ to 1 for tapping, and the reverse speed for backing out the tap is the same as the speed of the drilling spindle. When not in use the tapping spindle remains idle. The movements of the tapping spindle are controlled by a clutch which is operated by the lever shown in front of the saddle. The advantage of this tool over the radial drill with tapping attachment is, that it is not necessary to change the speed of the machine, or in other words, to throw in the back gears for tapping after the hole is drilled, since the reduction of the speed is obtained by the gearing. By having two spindles, the necessity of changing the drill and placing the tap-

ping head in the spindle is also obviated. One revolution of the hand wheel, which is used to traverse the carriage, will bring the tapping spindle directly in line with the hole drilled. This adjustment of the tapping spindle is controlled by an index point on the hand wheel shafting. The maximum distance between the end of the spindles and the base of the machine is 74 in. and the over-all dimensions of the base are 4 ft. x 9 ft. A work table 21 in. wide x 39 in. long is provided, and it is arranged with a swivel bearing so that holes may be drilled at an angle.

*(To be continued.)*

## Exhibit of the Gisholt Machine Company at the World's Fair, St. Louis.

The exhibit of the Gisholt Machine Company, Madison, Wis., at the World's Fair, St. Louis, consists of three sizes of standard turret lathes; one big-bore turret lathe having a swing of 24 in. and a 5-in. hole in the spindle; three sizes of vertical boring mills; one 60-in. horizontal drilling and boring machine, and one Gisholt Universal tool grinder. The newest tool among these is the 60-in. horizontal boring and drilling machine shown in the accompanying illustration. Double friction back gears are provided in the headstock and the boring bar, which is of hammered crucible steel, is ground with a taper socket to hold supplementary boring bars of small sizes. The feed mechanism is the same as that used on Gisholt turret lathes. It consists essentially of a coarse pitch screw geared to the spindle and gives a positive feed. No extra attachment is required for screw cutting. Generating levers are placed on both sides of the machine so that it can be controlled from any point. By the movement of a lever convenient to the operator, the table can be raised or lowered by power and accurately adjusted at any required height. The cross table has a compound movement and is fitted with a cross feed when desired. Both the transverse and longitudinal screws for moving the cross table are fitted with micrometer index dials reading to .001 in. The yoke for the table is cast with a box section and is clamped to the table instead of being bolted with bolts sliding in T slots. It carries double bushings for the support of the boring bar.



The Gisholt Horizontal Drilling and Boring Machine.

An engineman while his freight train was being made up in Ferrara left it in charge of the fireman, who, it seems, knew how to start but not how to stop it, and it ran away with him down the main track and into an express train entering Ferrara, killing 7 and wounding 16.

## The American Street Railway Association Convention.

The twenty-third annual meeting of the American Street Railway Association was held in the reading room of the Transportation Building at the World's Fair, St. Louis, October 12th and 13th. President W. Caryl Ely, of Buffalo, N. Y., called the meeting to order and introduced Hon. David R. Francis, President of the Louisiana Purchase Exposition, who addressed the convention. After referring to the wonderful growth and expansion of electric railways, President Francis related the history of the intramural railway project. The original plan was to have the road built and operated by the street car companies as a joint project, the cars from their city lines to run over it. This was abandoned, and the exposition management had about concluded that the crowds could be handled by automobiles. President Francis did not concur with this idea and undertook to have an intramural road built and operated by the exposition authorities, in which plan he was successful. The road carries on an average of 55,000 persons daily—about 55 per cent. of the paid admissions to the grounds—and is one of the best sources of revenue that the exposition management has.

If it had not been for the electric street railways it never would have been possible to have had such an exposition, as it would otherwise have been impossible to bring the crowds to the grounds. One of the great problems of the management was this matter of conveyance of the people to and from the grounds. The street railways met the situation with entire success, and what is of greatest importance, they appear to have the good will of the community and of the thousands of strangers who are their patrons.

Following President Francis, Prof. W. E. Goldsborough, of Purdue University, Chief of the Department of Electricity, told the members of the things of particular interest to street railway men at the exposition. After enumerating the different exhibits he spoke of the work of the Electric Railway Test Commission, which is doing a large amount of experimental work in testing modern electric railway apparatus and in determining various factors which bear on the operation of street railway equipments, which have as yet not been fully investigated. It covers the operation of the braking system, both by air storage and compressors on cars. Also the matter of the reactance of rails, or the resistance due to the flow of an alternating current through a rail. The commission has on the north side of the Transportation Building two tracks 1,400 ft. long, with three modern equipments for test purposes. The commission intends conducting a series of experiments on an 8-mile tangent in Indiana, in which the cars will be run at high speed to determine wind pressures. The pressure on the body will be determined, and different shaped vestibules tried on both ends of the cars. It is hoped to attain speeds of 70, 80 and even 90 miles an hour.

Mayor Wells, of St. Louis, who had been detained, was next presented and addressed the convention briefly, extending the welcome of the city, and touching on the growth of the latter and the important part the street railways had had therein.

President Ely then delivered his address. He congratulated the Association upon having selected the World's Fair as its place of meeting because of the opportunities it offered of viewing the highest results of the inventive genius and progressive labor of man in the development of transportation of all kinds as well as in the arts, sciences, trades and manufactures. He reviewed the work of the past year in the electric railroad world, referring to the electrification plans of the New York Central and the Pennsylvania, and the operation of single-phase alternating-current motors on the Schenectady Street Railway by the General Electric Company. Speaking of the electrification of the Manhattan elevated system of New York he said: "The electrification of the Manhattan Elevated Railway system, which was finally completed in June, 1903, in which month the last steam train was taken off, has during the past year enabled a direct comparison to be made between the operation of the system by electricity and steam. It has been determined that the substitution of electricity has increased the carrying capacity of the road 33 per cent. as indicated by the actual increase in car-mileage; the passenger traffic has been increased 30 per cent.; the operating expenses have decreased from 55 per cent. of the gross receipts in 1901 to 45 per cent. in 1903, and all obnoxious vapors, smoke, steam and cinders incidental to steam locomotive operation have been eliminated from the streets traversed by the railroads of the system. The wisdom of the enormous expenditure of money necessary to make the change has been fully demonstrated by the benefits which have accrued not only to the people of the city but to the intelligent management which at such great cost made the change."

He also spoke of the New York subways and the advantages they would afford, as well as the methods of operating them and keeping them in condition. He next quoted from a paper by Mr. Frank J. Sprague read before the recent session of the International Electrical Congress in which the writer dwelt on the many advantages that have resulted from the general use of electric street railways, and discussed somewhat whether or not the electric motor would replace the steam locomotive.

Mr. Ely referred to the growing feeling that the form and scope of the Association work required remodeling, one of the results of which, growing out of the discussion at Saratoga in 1903, has been the formation of a Manufacturers' Association, to relieve the Street Railway Association of the onerous duty of providing for exhibits. The Manufacturers' Association also provides for the entertainment of the members, with the knowledge and approval of the Executive Committee. He said in conclusion:

"A careful inspection of the proceedings of the conventions of the last few years reveals the fact that the most of the time of each convention has been occupied with the reading and discussion of papers embracing

subjects which for the most part relate to the small technicalities of the business, nearly all of which might have been profitably committed to proper auxiliary and subsidiary organizations. Broad fields of co-operative effort in the most important lines of our work have remained almost untouched. It becomes immediately apparent upon investigation and discussion of the situation that we might profitably enter upon the discussion of the greater questions affecting our welfare. The confusion of laws throughout the country affecting our corporations is a matter to which we might well devote attention. There are also such great questions as taxation, municipal ownership of street railways, franchise rights and obligations, statutory laws affecting our class of companies, municipal laws and ordinances, and other questions of importance to which your minds will readily refer. The collection and preservation of data tending to throw light upon the problems of great importance that confront us is also a matter deserving of attention, and in this regard it would seem that through the medium of the secretary's office and of appropriate standing committees an invaluable collection of data could be made and permanently preserved in such form as to be conveniently accessible to any member of the association upon merely making request of the secretary. If the work of the secretary's office should be made continuous there would thus grow up in time a vast repository of valuable statistical and historical information, readily available as a matter of right to every member. This branch of the work alone, if properly prosecuted, would render membership in this association so valuable that it is difficult to understand how any street railway corporation would feel justified in remaining outside of this association. It is our duty to keep in step with the changes in conditions that confront and surround us; we must be in synchronism with the spirit of things; we must not hesitate to make necessary and beneficial changes nor should we be deterred by our consideration of the past.

"It is undeniable that notwithstanding the fact that the intelligent and broad-minded policies that to-day characterize the operation of the great properties represented in this association, and notwithstanding the fact that inestimable advantages have been and are being thereby conferred upon the entire public within your individual spheres of action, there exists to-day a tremendous amount of misunderstanding of your labors and the effect thereof upon individuals and communities. Intelligence must replace ignorance; darkness must give way to the light. There are to-day no matters or things really in difference between yourselves on the one hand, and the public on the other. With right understanding there will come about perfect accord. The remnants of old suspicions founded upon misconception and misunderstanding must be swept away. It is only by a general diffusion of information concerning our properties and our work that public appreciation may be obtained. Let us bury all questions of prerogative, precedence and personal advantage and unite in a vigorous and persistent effort to bring out of present conditions such a state of organization and work as will not only meet with the intelligent and hearty approval of all those comprised in our different organizations, but will also put us in closer touch with the public whom we serve, and tend to the creation of such a condition of things as will enable us best to work out legitimate ends and purposes."

A resolution was offered proposing to rescind that part of the resolution adopted at the Saratoga meeting which requested the technical press to refrain from the daily publication of proceedings. This was at the close of the first day's meeting, and on motion action was deferred until the following day. At the opening of Thursday's session this resolution was amended by substituting for "proceedings" the words "verbal reports of discussion," and was adopted.

The Secretary reported the addition of nine new members during the year and the loss by suspension and withdrawal of 19, leaving a membership of 196. The balance in the treasury was $7,646.

The recommendation of the Executive Committee, that the Association amend its by-laws to provide for an increase in the size of the Executive Committee sufficient to accommodate as members, the presidents of such auxiliary organizations engaged in street railway work as may be approved and fostered by the American Street Railway Association, and that the Executive Committee be empowered to act in the matter to bring about its accomplishment, was adopted.

The committee on rules for the government of conductors and motormen reported a rearrangement of the standard code in order to provide for the insertion of such special rules as might be required by various companies, in their proper places under the different headings. The committee directed its efforts toward making the interurban rules conform, as nearly as conditions would permit, with the standards adopted by the American Railway Association.

Mr. Vreeland offered a resolution to empower the President to appoint a committee of nine members, whose duty shall be to increase the membership of the association. There are at the present time over 600 street railway companies operating in the territory covered by the association, of which only 196 are members. The resolution was adopted.

The discussion of papers followed. The paper on "Steam Turbines" by Mr. Richard H. Rice was the first presented. An abstract of this paper, under the title "Small Curtis Turbines," was printed last week.

Mr. C. O. Mailloux (New York) offered some interesting information in regard to turbines, the result of observations made during a European trip last summer. He was prejudiced at the outset, believing that the steam turbine was unsuited to driving direct-current generators because of its speed, but what he saw in European practice had changed his views. He had seen 250-k.w. units running at 2,500 r.p.m. and smaller units running at 3,000 and 4,000 r.p.m. He was glad to see a line of small turbines for direct connection being developed in this country, that is turbines without gears. He thought it better to allow higher generator speeds and connect directly, rather than to use gearing. One use to which small turbines are being put in Europe is driving centrifugal pumps for boiler feed. They have great advantages because of the absence of reciprocating motion, the feed being absolutely steady. In reply to a question about danger to the turbine from water in the steam, he told of a case of a mine installation where a 250-k.w. low-pressure turbine was driven by the exhaust steam from a 1,500-h.p. hoisting engine, through an accumulator, and though the plant had been running two years there was no record of difficulty, although the steam could not be very dry.

Mr. S. M. Hopkins (Columbus, Ohio,) told of a case of a 500-k.w. turbine which temporarily had to be run, taking steam from a long line. As the steam entered the line superheated, no provision was made for draining the line. The condensation in the line was so great that a reciprocating engine also taking steam from it could be started only with the greatest difficulty. But the turbine never gave any trouble, even with considerable quantities of water going through it. Describing some comparative tests between two 500-k.w. turbines and two tandem-compound Green-Wheelock engines with a cylinder ratio of 6 to 1, taking steam from the same boilers and under the same conditions of superheat, he said they figured the B. T. U. per electrical horse-power and found that the engines showed the higher efficiency. The tests included one-third load, half load, full load and 50 per cent. overload; but after comparing the results and taking the whole proposition into consideration, he regarded the turbine as the superior generating unit. All guarantees for turbines are based on water consumption alone, and also include clauses regarding certain degrees of superheat. The idea was to apply the superheat to the engine also and see if it would be as valuable as to the turbine. The results showed it to be even more so, but there was considerable trouble in lubricating the engine cylinders, particularly the high-pressure. But the results of the tests yielded the conclusion that in buying apparatus they should not be misled by guarantees in regard to superheat.

It appeared from the testimony of some members that trouble had been experienced from water where superheated steam was used. Mr. Mailloux explained that it was mechanical entrainment due to defective design of piping or boilers, or to the operation of the latter, and could be remedied by the use of a receiver near the turbine, or a separator. Referring to the matter of steam economy of the turbine, he said that the makers do not claim the highest economy under all conditions; that they recognize that it is more efficient in the lower stages. A prominent English engineer had proposed using the reciprocating engine for the higher pressure stages, say 200 lbs., expanding down to 10 or 15 lbs. gage, and using a low-pressure turbine with condenser; that the turbine under these circumstances would be enabled to develop as much power as the engine at the higher pressure. Again, regarding economy of operation, there are other factors beside fuel economy entering into the case. What is wanted is the total cost reduced and in that equation enter many things, like space, maintenance, repairs, etc.; and the bulk of evidence up to the present time indicates that the turbine will make up in other things for a slight discrepancy against it in steam consumption. There was a steam engine in Berlin built by one of the most distinguished firms in Switzerland, a triple expansion, four-cylinder compound engine, a 5,000-h.p. unit, which running at very nearly full load gave a performance of something less than 9 lbs. of water per i.h.p. hour with superheat up to 600 deg. F. or more. That is perhaps the world's record up to the present time, but that engine had 16 valves, complicated mechanism, and a great deal of lubrication was required. It has been stated that doubtless the cost of maintenance and the cost of the extra lubrication of the cylinder, lubrication of the valve motion, etc., and all the expenses connected with the operation of that unit make it less economical when considering the total cost per annum of producing the power. So it is an important thing to bear in mind that one of the reasons why the steam turbine appeals to us is that it simplifies the operation and reduces the maintenance of the plant in other respects than that of economy of coal. The steam turbine has only begun its development, and the more it is developed the more it will approximate the results obtained by the steam engine.

Mr. Thomas Hawken (Dover, N. H.) stated that they have two 500-k.w. units which have been in service three months and are giving the greatest satisfaction. They carry fluctuating loads and the regulation is excellent.

The coal consumption is 4 lbs. per k.w. hour. They had begun operations by cooling their lubricating oil, but water would get into it and it would saponify, resembling lard. The people supplying the oil advised that it was unnecessary to cool it for temperatures under 400 deg. and subsequent results with temperatures of 140 to 160 deg. verified the claim.

Mr. W. H. Abbott (Cleveland) said they got a deposit resembling crude vaseline in the oil chamber and had been unable to correct the difficulty, which they found rather serious.

The next paper was on "Steam Turbine Power Plants" by Mr. J. R. Ribbins. Asked if relative economy of high vacuum for turbines as deduced in his paper would not apply equally well to reciprocating engines, Mr. Ribbins stated that turbines will expand down to condenser pressure and can be designed to take advantage of a high vacuum, which engines cannot do directly.

Referring to the matter of air in the water from leaks, the question was asked if open or closed feed-water heaters would be preferable under the circumstances. Mr. Hopkins (Columbus, Ohio) told of two installations, one having an open and the other a closed heater, both using the same form of air pump, and practically no difference could be observed as to the quantity of air in the water.

Mr. E. D. Meier's paper on "The American Diesel Engine" was next presented. Mr. Meier expanded considerably the remarks made in his paper, going more into detail regarding the characteristics of this interesting engine. He said Diesel had succeeded in burning powdered coal in the cylinder of his engine, but because of the clinker, which must inevitably form where coal is burned, the thing is not of practical utility; but it was clearly demonstrated that it can be done. The principal difference between the American and European design is in the method of feeding the oil, it being necessary to devise for the former a scheme whereby the oil, such as is bought in open market, would not be carbonized in feeding. The European method is adapted only for refined oil. The largest units built at present in this country are 450 to 500 h.p. In Germany a 600-h.p. six-cylinder unit is being built for use in street railway and lighting work in Russia, and they expect to get up to 1,000 h.p. within another year. The cost of Diesel engines at present is from $60 to $70 per h.p. for the plant; but it must not be overlooked that there are no boilers, smoke-stack, coal handling machinery, ash removal, etc., to be considered.

TRANSFERS—THEIR USES AND ABUSES.

This paper, by Mr. Leon Jewell, states briefly the advantages that have resulted from the establishment of transfer systems in their effect on promoting traffic, etc. The abuses, which constitute the disadvantages and result in loss to the companies, are likewise enumerated, following which is a history of the origin and development of the transfer system of the Chicago City Railway Company, with which the writer is connected. Some interesting data on the growth of the system are offered covering a period of 20 years. The uses and abuses are summarized as follows:

*Uses.*—(a) To increase the transportation facilities, whereby passengers can be carried in different directions, by shorter and more direct routes. (b) To offer additional inducements to ride, thereby creating and developing increased traffic. (c) To better serve the traffic of each individual line. To reduce the number of direct through lines and decrease car mileage.

*Abuses.*—(a) The improper and fraudulent acts of conductors in connection with the handling of transfers. (b) The brokerage or trafficking in transfers, especially by newsboys. (c) The improper transferring and exchanging of transfers by passengers. (d) The possible increase of damage claims, arising from the operation of a transfer system.

In the discussion which ensued President Ely stated that the form of transfer in general use was so condensed and so abstruse that it was unintelligible to the average person; in fact, that in law cases that had occurred in connection with abuses of transfers, even the courts were not clear as to what the transfer slip comprehended; therefore it was hardly to be wondered at that wholesale abuse is possible. He thought a remedy might lie in the adoption of an enlarged form, so designed as to admit of a minimum possibility of misunderstanding and thereby eliminate one source of, and excuse for, present abuses. A form suggested as offering possible solution was similar to the coupon tickets of steam passenger roads.

Other members appeared to consider the transfer abuse matter pretty nearly hopeless; that it would continue to be so as long as the almost universal desire of persons to get something for nothing exists.

A resolution by Mr. Vreeland empowering the Executive Committee to employ such clerical or expert assistance as it may deem desirable, and fix the compensation therefor, was adopted.

The committee on compensation for carrying United States mails submitted a progress report and stated that it believed the conditions would soon be favorable for having the matter favorably considered by the Government.

The officers for the ensuing year are:

President, W. Caryl Ely, President International Railway Company, Buffalo, N. Y. (re-elected).

First Vice-President, Elwin C. Foster, President New Orleans Railways Co., New Orleans, La. (re-elected.)

Second Vice-President, John I. Beggs, President & General Manager the Milwaukee Railway & Electric Light Co., Milwaukee, Wis.

Third Vice-President, Richard McCullough, Assistant General Manager St. Louis Transit Co., St. Louis, Mo.

Secretary and Treasurer, Thomas C. Pennington, Treasurer Chicago City Railway Co., Chicago.

Executive Committee: Presidents, Vice-Presidents and John J. Stanley, General Manager Cleveland Electric Ry. Co., Cleveland, Ohio; Howard F. Grant, Manager Seattle Electric Co., Seattle, Wash.; C. G. Goodrich, Vice-President Twin City Rapid Transit Co., Minneapolis, Minn.; Frank G. Jones, Vice-President and General Manager Memphis Street Railway Co., Memphis, Tenn.; W. E. Harrington, General Superintendent Public Service Corporation of New Jersey, Camden, N. J.

The selection of the time and place for the next convention was left to the Executive Committee.

## An Overhead Foot Bridge for Small Stations.

The accompanying illustration is of an inexpensive foot bridge which the Engineer of the London & South-Western has recently adopted as standard for use at country stations on that road. It is 45 ft. 6 in. long, 14 ft. clear above rail level, and is 4 ft. 6 in. wide. The trusses are 4 ft. 6 in. deep and the top members and also the stairways are formed of 3½ in. x 3½ in. x ½ in. angles. The bottom members are of 4½ in. x 3½ in. x ½ in. angles, with 3 in. x 3 in. x ⅜ in. angle braces. The supports are somewhat unique, being simply four 12 in. x 6 in. I-section rolled steel joists embedded in concrete blocks and inclined from the vertical in two directions in order to neutralize the effects of moving loads and wind pressures. Each bridge weighs about eight tons only and is provided with wrought-iron hand rails and wire mesh safety guards in the panels. It forms a neat and adaptable design, and, while it has proved itself, under test, to be amply strong for full loads, its extreme lightness demonstrates that a minimum of material is used to good advantage. The cost of foundations, erection, painting, etc., all complete, does not exceed $1,000.

Overhead Footbridge for Small Stations in England.

It is reported that the Russian government has given a charter for building a railroad from Tashkend, in Central Asia, on the Asiatic Midland, northeast, nearly parallel with the Chinese border, to the Siberian Railroad near Tomsk, a distance of about 1,500 miles, with the condition that the capital for it must be raised outside of Russia. The prospects for such a line are much better than might be supposed. There are immense deserts, or semi-arid regions, to the west of it, and barren mountains and desert to the east of it; but the streams flowing down the west slopes of these mountains, before they are absorbed by the western deserts, make a considerable belt of fertile land; and already there are important settlements in the foot-hills two or three hundred miles south of the Siberian Railroad (but not so far from navigable streams which cross that railroad), attracted by good land and important mines of coal, iron and copper, the most valuable in Siberia.

RAILROAD GAZETTE

## LOCOMOTIVES AT THE WORLD'S FAIR.*

Large boilers, wide fire boxes and high pressures are the features of the locomotives at the World's Fair which are most prominent and which most clearly point the progress that has been made since 1893. These might be summed up in the simple term bigness, as that has been the dominant object in the improvements that have been made. In the never-ending quest for economy in transportation—which we translate into the term large train-load—the largest factor is saving of wages on trains, and the bigger the engine, the smaller the aggregate wages. If our engines had been improved in size alone a great advance would have been made.

This development of the steam locomotive during the past eleven years has been eminently rational, the three principal changes named being based on principles long recognized as fundamental and important. A large boiler to carry a reserve stock of heat is an essential element of economy, and the wonder is that we did not energize our ingenuity enough to adopt it twenty years ago, when Mr. Forney told us to do so. The wide fire box becomes an easy problem when we put small wheels under it. High pressure has not been so easy an attainment, but everybody now seems to appreciate it, and to see the waste of making a big and costly machine and then not getting full value out of all its parts.

High pressure has in part taken the place of compound cylinders. Compounding is still appreciated, but the Vauclain four-cylinder compound of 1892, has not swept the field as some thought probable in 1893. The only engine of this class at St. Louis is one built for the Burlington some years ago and which is shown for the splendid record that it has made with the fast mail trains of that road. This engine (No. 1587) in two years ending March, 1904, ran 137,856 miles, hauling trains averaging eight cars. The mileage named equals 6,893 miles a month, exclusive of the time the engine was in the shop. In one month it made 12,211 miles. The engine is of the well-known Atlantic type, often described; cylinders 15 in. and 25 in. x 26 in. The Baldwin works exhibits at St. Louis a two-cylinder compound, built for the Norfolk & Western, a consolidation freight engine; and the four-cylinder balanced compound for the Burlington described in the *Railroad Gazette* June 3 last.

The piston valve, which Mr. Vauclain introduced with the four-cylinder compound, has retained the favor which was accorded it and now appears in many simple engines. It is unnecessary to remark that the popularity of this valve is largely due to the universal demand for high speeds, requiring perfectly balanced valves.

The completeness of the conquest which the wide fire box has made is indicated by the fact that of the thirty-nine locomotives shown at the fair, nearly all standard gage, only three of that gage have fire boxes wholly between the wheels; and one of these is a switcher, built for a private industry. But only one of these wide fire boxes is of the extreme (Wootten) type, though that type still enjoys favor in its own country—that is, on the Reading, the Lackawanna and the Lehigh Valley. The Atlantic type (4-4-2) was made necessary by the development of the wide fire box, and now the Pacific type (4-4-2) designed for heavier trains, bids fair to become equally familiar on all large roads. Of the Atlantic type there are five engines and of the Pacific (and Prairie) four. Of the seven consolidation engines two have 5-ft. driving wheels. There are two ten wheelers and two moguls. There is a narrow gage mogul built for the Kiushu railroad of Japan, a six-wheel switching engine of moderate size and a very small four-wheel contractor's engine. The most powerful passenger engine is the four-cylinder balanced compound shown by the New York Central, designed by Mr. Cole, and weighing 200,000 lbs. This engine was described in the *Railroad Gazette*, May 13: The weight on the drivers is 110,000 lbs.; cylinders, 15 and 26x26; heating surface, 3,446 sq. ft., and grate area, 50.3 sq. ft.

The largest freight engine is the Baltimore & Ohio articulated 12-wheel Mallet, described in the *Railroad Gazette*, May 27, 1904,† and next to it comes the Atchison, Topeka & Santa Fe tandem 4-cylinder compound, described in the *Railroad Gazette*, October 9, 1903.

We all gaze in wonder at the elephantine proportions of these huge machines, and yet, for the service for which they are designed, why should they be considered large? On a two per cent. ascending grade the Atchison engine propels about 1,100 tons at a speed of five miles an hour. The articulated engine is expected to move about 1,500 tons. In other words, the Atchison engine, if hitched to a train such as an 85-ton engine, hauls on a level at 20 miles an hour it could not keep it going up a steeper grade than about 35 ft. to the mile, even at the lowest practicable speed. To take up such a grade one of the 80-car trains now becoming common on our level railroads, the leviathans will have to be made even larger yet. It may be necessary to push instead of pull such loads up a hill, in order to avoid damage to draw gear; but that cannot be called an insuperable obstacle. The desideratum is, of course, to make an engine to use on steep grades, powerful enough to take up such grades a full level-road train, and thus save remarshalling the cars. So far as anyone can now see, we are not likely to be able to carry out this idea with steam locomotives except on lines with unlimited side and head clearances.

Esthetics governs, to some extent, in engines as well as in passenger cars, but in engines, as in sky scraper buildings on narrow streets, the Goddess of Beauty has harder and harder work year by year to keep from being buried out of sight. Stacks and cabs are about the only features left in which even a half-inch frill can be retained, and these are fast giving up the fight. We shall be driven to the alternative of restoring a few of the gold stripes of former years, or else of being content with the coal-mine mole type of engine for all slow trains. In tenders, the Vanderbilt type, of which there are three at the fair, exemplifies the extreme opposite of beauty.

Everything mentioned in the foregoing notes is American, the American Locomotive Company, the Baldwin and the Rogers works comprising the short list of builders. The Lima Locomotive & Machine Works shows one of its geared engines and the Canadian Locomotive Works, of Kingston, shows a narrow gage engine built for the Prince Edward's Island railroad; and that ends the list for America. Europe is represented by the deGlehn compound imported from France by the Pennsylvania Railroad and four German engines. Of these we shall have something to say in a subsequent issue.

In saying that the St. Louis exhibit is, as a whole, an exhibit exclusively of things accomplished, we must make an exception of the four-cylinder balanced compounds, of which there are four at the fair. (Of these our readers have already been told; the de Glehn, P. R. R.; the Cole, N. Y. C.; the Vauclain, C. B. & Q. and Henschel.) These engines represent progress rather than present achievement. But the heavy and fast electric locomotive, such as the New York Central hopes to show to the world before long, and which embodies at least as significant and as earnest hopes of progress as any steam engine, is conspicuous by its absence.

*Continuation of article on the World's Fair in the issue of Sept. 23, page 353.

†The B. & O. engine has six pairs of drivers arranged in two groups of three pairs each. The high-pressure cylinders which drive the rear group are 20 in. x 32 in. and have piston valves. The low-pressure cylinders which drive the forward group are 32 in. x 32 in. and have slide valves. The exhaust from the high-pressure cylinder, in each side, passes forward through an outside pipe to the low-pressure cylinder. The locomotive is the heaviest in the world, and weighs 334,500 lbs. The boiler contains 5,586 sq. ft. of heating surface, and the grate area is 72.2 sq. ft. The Atchison engine is the 2-10-2 type and weighs 287,240 lbs., with 234,580 lbs. on the drivers. The heating surface is 4,796 sq. ft., and the grate area is 58.5 sq. ft. The cylinders are 19 in. and 32 x 32 ins. and the drivers are 57 ins. in diameter. The tractive effort is about 62,000 lbs.

## A STEAM-ELECTRIC UNDERSTUDY.

The conceded fact that we are at the dawn of important readjustments in the relation of steam and electricity as carrying powers has led to much study of the subject, both on its positive and its speculative side. But that study has borne almost exclusively on the physical aspect of the question. This is natural enough. Logically we look at the mechanics of such a question as a kind of major premise to be accepted—or, at least, fully tried out—before we exercise ulterior problems. But some of the latter have begun to enter the field of prevision. One example, the "Consolidated," is already a fact and not a hypothesis. In his annual report President Mellen, of the New Haven road, referred to the transfer of large electric properties of his company to this new corporation, the "Consolidated Railway Company," which, of course, the New Haven owns and controls. The transaction, already known to our readers, was the selection of a remote and intrinsically weak trolley company—but one holding a very liberal and expansive charter—as a basic corporation for financing, consolidating and ultimately enlarging the electric properties of the steam parent company. The process is familiar. But let us glance at some of its ulterior meanings.

Steam railroad charters as a general rule are uniform in their powers, so far as relates to their function, namely, transportation. They are still more uniform within the bounds of single States. But the electric

charters are far from uniform. They vary much not only in different States—especially as regards long and short distances—but in particular States. Some of them allow specifically transportation of passengers alone; others include freight and express service; and still others give power to sell light, power and heat to corporations and individuals, besides vague but immense power of lease, merger, purchase and consolidation with other lines. The charters have often been granted hastily, rashly and in a local frenzy of electric construction. It follows that the steam corporation, owning half a dozen electric lines and consolidating them on the basis of the most liberal charter held by any one of them, amplifies functions extremely. Potentially and probably we shall find the original steam corporation—whether it finally discards steam or not—selling light, power and heat, and in possession of such latitude of extension and merger as the Legislature never intended to grant or dreamed of granting. Legislatures can, of course, alter, amend or repeal charters; but, in practice, it is almost never done. Not without a certain prophetic insight has the State of Massachusetts adopted as a policy a limitation on electric railway companies almost tantamount to a prohibition of selling light and power.

In the category of these secondary and derived powers obtained by the steam corporation through its electric charters the most noteworthy is that of increased capitalization of the acquired lines. But as a matter of record those lines in probably four cases out of five had been overcapitalized already. To bonds watered originally, or, at least, marketed below par, has been added watered stock, and sometimes the hose has been turned on over and over again, usually on the occasion of some large merger or consolidation—as witness the case of the Rhode Island Electric. Will the steam companies resist the temptation to new electric capitalization as they take in, combine and "consolidate" their electric plants? So far as concerns the investor the query is, perhaps, not material, for the greater and stronger corporation stands behind his electric railway security. But as regards the public and its right to such "reasonable" fares as will pay fair dividends on actual cash investment, the proposition is a different one. It will be said with some truth that the new, closer and more intense relation created between the public and the steam road through electric ownership increases corporate responsiveness to public demand. In the long run this principle may work out results, but, as a rule, it will not do so rapidly.

The great steam corporation which buys in a group of electric roads can adopt one of three policies. It can (1) leave them as technically independent lines and secure its own ends either by thwarting competition and taking profit in dividends. The plan has, from the controlling corporation's viewpoint, the merit of simplicity, and, in form at any rate, of masking to some extent corporate responsibility; but it is not likely to be economical. The corporation can (2) consolidate its electric lines under a "holding" company, or (3) can merge them absolutely as part of itself, provided it has complete ownership of stock. One of these last two methods we are likely to see as steam railroad ownership of electric lines is evolved. It will give rise to some interesting questions both in general State legislation and as regards the power of State railroad commissions over returns. In effect we have one such case in Massachusetts already, where the railroad commisison treats a great holding corporation—though not a steam railroad company—merely as an individual stockholder, and insists on separate returns from its many controlled lines. It is probably a type of other instances to come as the tie between electricity and steam draws closer and supplies its new situations.

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At this writing the "deal" of the New York, New Haven & Hartford for acquiring the New York, Ontario & Western appears be still in the works, though it may be a finished product before our readers see these lines. Whatever the outcome, it will be either the climax or the anti-climax in a most important branch of President Mellen's policy. When that vigorous and experienced officer bought control of the Central New England and the Poughkeepsie Bridge several months ago the anthracite coal fields became almost necessarily an objective. His next step in his excursion westward was obviously to be an expansion of the coal traffic, to be accomplished either by a "belt" line connecting with the existing coal roads or by acquiring a coal road of his own. There can be little doubt that the reported negotiations some four months ago over the ownership of the Lehigh & Hudson River line had the coal traffic as a *motif*, and there may have been more of finesse on the part of the coal road managers in defeating that plan than has appeared on the surface. At any rate Mr. Mellen seems to have had an option on the Ontario & Western as an alternative. Whether that option finally proves to have been exercised or not, its significance is large. It includes for the New Haven an independent coal supply; the traffic arising from coal fields owned by the Ontario & Western, estimated at not less than $5,000,000 tons yearly for twenty years, besides large traffic from independent coal producers; an unbroken and pretty direct rail line from the mines to the New England cities and factory centers; and, potentially, a new link in a trunk line to the West. More remotely the "deal" bears affirmatively on the question of the New Haven's retaining its old profits in the division of Western freight rates. But, quite apart from such special features, the control of the "OW," if actually accomplished, is dramatic as a new expression of the radical Mellen policy. Even President C. P. Clark, in his most aggressive moods, never contemplated invasion of the coal fields. Yet just that thing, and presumptively in the face of the opposition of the great operating coal companies, appears to be what Mr. Mellen has done, adding a new and sensational chapter to the story of his first year's administration.

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### Opening of the New York Subway.

By the time this paper reaches the reader the establishment of real "rapid transit" on Manhattan island will be an accomplished fact, the Interborough Rapid Transit Company having announced that the running of regular trains for the public from the City Hall northward to 145th street and Broadway, nine miles, would be begun at 7 o'clock on the evening of Thursday, October 27. A simple celebration at the City Hall in the afternoon was the only public recognition of the event. This nine-mile stretch constitutes the most immediately important part of the undertaking, being the part for which there has been for ten years a pressing necessity; and it has been completed within the contract time, in spite of the numerous and varied difficulties which have beset the commission, the city authorities and the contractors. For the last two months the officers of the operating company have been constantly engaged in the arduous task of instructing the many hundreds of new trainmen in their duties. This work appears to have been done successfully. Scores of trips have been made every day, and every feature of the structure and equipment and all of the appliances were thus thoroughly tested weeks before the opening. For the present the trains on the local tracks will consist of five cars each. These will be run from 5.30 a.m. to midnight at three minute intervals, and from midnight to 5.30 a.m. at intervals of from five to ten minutes. The express trains will be made up of eight cars and will run at five minute intervals from 6.30 a.m. to 7 a.m.; from 7 a.m. to 9.30 a.m. at four minute intervals; from 9.30 a.m. to 2.30 p.m. at intervals of from five to ten minutes; from 2.30 p.m. to 4.30 p.m. at five minute intervals; from 4.30 p.m. to 8 p.m. at four minute intervals; from 8 p.m. to midnight at five and six minute intervals, and from midnight to 6.30 a.m. there will be no express trains. It will be several weeks before the Lenox avenue line will be ready for use, even as far as the Harlem river. The extension of the west side line across the flats to Spuyten Duyvil, and the line under the Harlem and into the Borough of the Bronx will not be completed for some time. The portion now opened will greatly relieve the congestion of traffic on the elevated lines during rush hours, especially on the west side.

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### September Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of September, printed in another column, contains accounts of 20 collisions, 22 derailments, and one other accident. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | | Killed. | Injured. |
|---|---|---|---|
| 6th. | Carman, Pa. | 2 | 3 |
| 6th. | Pendleton, Mo. | 8 | 39 |
| 7th. | Chagrin Falls, Ohio. | 2 | 3 |
| 7th. | Tiskilwa, Ill. | 4 | 30 |
| 10th. | Monroe, N. C. | 5 | 12 |
| 24th. | Hodges, Tenn. | 59 | 100 |
| 25th. | Lock Berlin, N. Y. | 1 | 24 |
| 27th. | Wheeler, Kan. | .. | .. |

The worst accident in this list, the Hodges collision, has already been reported. The only significant thing that has since occurred in connection with it is the order, which has been issued on the Southern Railway, to run the heaviest passenger cars in the front portion of trains. To what extent this order is applied, or how long it is to last, we do not know. To run sleeping cars in the front portion of any train which carries most of its passengers in ordinary coaches is a source of constant inconvenience, and of frequent annoyance, and the true remedy for the danger connected with the use of light cars in the front part of trains is to provide heavy cars—or cars with greater longitudinal stiffness—to take the place of the light cars. Light cars need not be thrown away, of course; for if they are sound they are as

good as ever they were, provided they are run in trains by themselves.

The next three accidents, in the order of their magnitude, are due to causes more nearly unpreventable than usually will be found in a group so close together. The Pendleton derailment is unexplained, an officer of the road reporting that diligent search revealed no fault in cars, engine or track; and the speed was not excessive. At Monroe the evidence that track bolts had been purposely removed is said to be conclusive; and the Tiskilwa wreck is chargeable primarily to a cause—brake-hose failure on a freight car—which is difficult to provide against completely. (This is not saying that the brake connections of all freight cars are as regularly and carefully inspected as they ought to be.) The accidents at Monroe and Lock Berlin are alike in that passengers who escaped with their lives from the derailment were killed by another train running into the wreck. In the Lock Berlin case this addition to the original wreck may be charged directly to the density of traffic—on a single track railroad it could not have occurred. At Monroe the trouble was that in the first wreck all of the trainmen were disabled so that a flag was not sent back; the block system would have saved the freight engine, and the lives of those on whom it fell.

Four notable train accidents occurred in Canada in September. On Thursday night, September 1, at Sintaluta, Assiniboia, the Imperial Limited ran over a misplaced switch and collided with a freight train, killing five passengers, and at Eastwood, Ontario, on the 28th, four employees were killed in a collision of freight trains. The other two accidents were at Dexter and at Medicine Hat.

The number of electric car accidents reported in the United States in the month of September was 24, killing 23 persons and injuring 142. Of the fatalities, nine were due to the explosion of a box of dynamite at Melrose, Mass., as reported in our issue of September 30, news page 105; and seven others are chargeable to the crossing accident at St. Louis, September 1, where a street car was run into by a locomotive. (*Railroad Gazette*, page 314 and news page 81.)

## Cleveland, Cincinnati, Chicago & St. Louis.

The report of the "Big Four" for the fiscal year shows a gain in gross receipts of $679,292, of which passenger earnings contributed the creditable amount of $600,387, due in part to the increased business derived from the World's Fair traffic to St. Louis. This gain from passenger traffic combined with increases in mail and passenger earnings, helped to offset a decrease of $180,434 in freight receipts. As no tables are given of the class of freight carried, it is impossible to tell in what commodities the loss in freight occurred, and the report says that the traffic was there, but that it could not be moved owing to congestion. The decrease in ton mileage was 107,668,923 tons, or 5.2 per cent., while the average haul fell from 162 miles to 156 miles, and the average train load from 333 tons to 326 tons. The steady increase in train load which started in 1893, when it was 210 tons, culminated in 1900, and since then the average has fluctuated back and forth without showing permanent gains or losses. A higher average rate (6.70 mills per ton mile) helped to offset somewhat the loss in tonnage. This figure compares with 6.44 mills in 1903 and 5.92 mills in 1902.

In spite of decreases in the maintenance of equipment and maintenance of way accounts, operating expenses for the year increased $1,060,797. This was caused by unusually heavy charges against conducting transportation, which amounted to $1,126,016 more than in 1903, the item for cost of coal alone increasing $124,264 over last year. An increase of $197,712 for injuries to persons also helped to swell the total charges against conducting transportation. This was the result of the fatal accident to a special train last October, when 16 passengers were killed and many injured. Another addition to expenses was due to the increase in charges under the per diem freight car rule resulting from freight congestion. For the first nine months of the current year the charges for balance of car service amounted to $500,000, or $200,000 above normal. The more important statistics of operation follow:

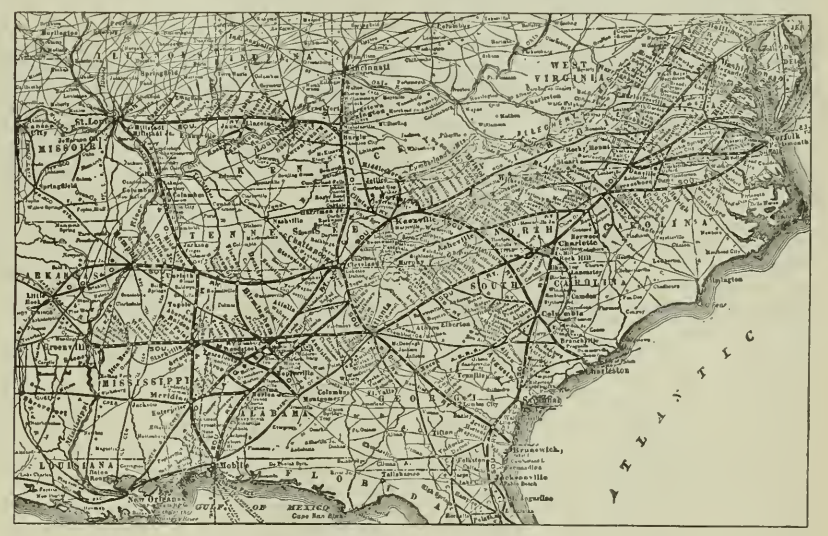
| | 1904. | 1903. |
|---|---|---|
| Average mileage worked... | 2,287 | 2,287 |
| Gross earnings ..... | $21,069,954 | $20,390,762 |
| Freight earnings ..... | 13,053,864 | 13,234,298 |
| Passenger earnings..... | 6,378,878 | 5,778,490 |
| Operating expenses ..... | 15,403,966 | 14,470,055 |
| Maintenance of way.... | 2,723,131 | 2,884,107 |
| Maintenance of equipm't. | 3,078,682 | 3,180,285 |
| Conducting transportat'n | 8,588,133 | 7,462,116 |
| General expenses ..... | 390,501 | 344,367 |
| Traffic expenses ..... | 623,519 | 599,181 |
| Net earnings ..... | 4,339,728 | 4,721,331 |
| Balance ..... | 1,472,506 | 1,877,269 |

## Southern Railway.

Gross earnings for the year ending June 30 were in round numbers $45,000,000, nearly $3,000,000 more than in 1903. The Southern as one of the first bankrupt properties reorganized by Mr. Morgan has a peculiar interest. So far it has not realized as large results as some other properties reorganized at the same time, but there has been a steady growth. The directors have been much embarrassed by the necessity of taking in a large number of lines which were not immediately paying but were necessary to secure control of territory through which they operate. In addition to this the company early started upon a policy of preferred dividends which have severely strained its resources. In the year 1904 for the first time there is a fair surplus left after dividends have been paid, and from now on it may reasonably be expected that the surplus available for dividends will each year put the railroad in a stronger position. The surplus above dividends this year amounted to $1,180,000, enabling the company to appropriate nearly $800,000 for improvements and betterments.

Each year since the reorganization of the property the annual report has told of the acquisition of considerable new mileage. This year the actual increase was but 60 miles, all told, and the increase in the average mileage operated during the year only ten miles. The extensions have been little feeders to the main line, the principal one of which is the Knoxville & Bristol in eastern Tennessee, about 40 miles long.

The locomotive roster was increased by the net addition of 125 locomotives, 139 being added and 14 being retired. Of the present locomotive equipment therefore about 12 per cent. is less than one year old. The larger capacity of the new locomotives has raised the hauling capacity of the average locomotive from 3,888 to 3,891 tons, an improvement of 8.1 per cent. The net addition of passenger train cars is 18 cars, 45 being added and 27 retired; therefore about 5 per cent. of the passenger equipment is less than one year old. The freight equipment shows a decrease of 418 cars. While 1,104 were added 1,522 were retired. The average capacity of freight cars has increased only about 1 per cent. The features of financing of the year were an issue of $15,000,000 of the authorized $16,000,000 collateral 5 per cent. gold bonds maturing in five years after April, 1904, but redeemable in two years. Over $10,000,000 of this was to retire outstanding certificates of indebtedness issued at various times since 1897; and $4,000,000 collateral trust bonds of September 1, 1901, were also retired. For new equipment acquired further issues of equipment trusts were made, aggregating about $2,700,000. The payments on outstanding trusts of about $2,000,000 made the net increase in outstanding car trusts about $700,000. As it now stands some 11,000 freight cars, 34 passenger train cars and 354 locomotives have been purchased by equipment trust arrangements aggregating a stock of about $15,000,000, of which $7,000,000 has been paid, leaving about $8,000,000 unmatured and outstanding.




Southern Railway.

The Knoxville & Ohio Railroad, which has up to this time been preserved as a separate entity, though its stock has been owned entire by the Southern Railway and the property has been operated as an integral part of the general system, was this year merged into the Southern Railway. The mortgage of the Southern Railway Company first consolidated mortgage heretofore raised on the capital of the Knoxville & Ohio was thus extended to the property itself. Of the stock of the Mobile & Ohio $700,000 was taken up this year and collateral trust certificates issued against it.

The company has evidently been improv-

ing its terminals. At New Orleans the New Orleans Belt & Terminal Co. has been consolidated with the New Orleans Terminal Co. An agreement has been made for the joint use of these facilities by the Southern and the Rock Island systems. The stock, which amounts to $2,000,000, is owned in equal proportions by the two parties and there has been issued $3,000,000 first mortgage 4 per cent. gold bonds which are guaranteed by the Southern and the St. Louis & San Francisco (Rock Island). At Charleston the Southern has united with the Atlantic Coast Line, taking over in a foreclosure sale the East Shore Terminal Co., which property consisted of terminal tracks, wharves and warehouses on the water front. In addition to this there have since been acquired water front and terminals formerly belonging to the South Carolina Terminal Co. The Southern Railway has abandoned its Mississippi river barge line, turning over the business to a separate organization known as the Monongahela River Consolidated Coal & Coke Co.

During the year there has been spent on the property besides the amount spent for equipment $5,129,000. Of this amount $641,000 was charged to income as special improvements and betterments not capitalized. The remainder, or $4,488,000, was charged to capital. The two largest single items of expenditure were about $2,000,000 for second track and revision of line from Alexandria to Orange, Va., and two other sections of second track a short distance at Asheville and at Spartanburg, together with the revision of line at other points on the Asheville division and on the St. Louis division. The other considerable item is the amount of over $1,000,000 on account of the acquisition of the Knoxville & Ohio, the Tennessee & Northern and the Knoxville & Bristol. Of the remainder of the amount charged to construction about $500,000 was for spurs and extensions, of which the principal one was the Okalona Big Creek line in Mississippi; and $300,000 more was spent for passing tracks and tracks to industrial sidings. About $100,000 was spent on terminals and the balance went for buildings, shops and warehouses.

The income account is as below:

| | 1904. | 1903 | Increase. |
|---|---|---|---|
| Gross earnings | $45,109,777 | $42,354,059 | $2,755,717 |
| Expenses | 33,115,467 | 30,989,139 | 2,126,327 |
| Net earnings | $11,994,310 | $11,364,919 | $629,390 |
| Other income | 1,395,181 | 1,211,261 | 183,919 |
| All income | $13,389,491 | $12,576,181 | $813,310 |
| Charges | 9,209,091 | 8,733,704 | 475,387 |
| Surplus | $4,180,399 | $3,842,477 | $337,922 |
| Dividends | 3,000,000 | 3,000,000 | ..... |
| Balance | $1,180,399 | $842,477 | $337,922 |
| Betterment, &c. | 773,806 | 135,000 | 638,806 |
| Balance | $406,593 | $707,477 | *$300,883 |

*Decrease.

Gross earnings increased 6.43 per cent., while expenses increased 6.77, and this increase was almost altogether in transportation expense, only about $300,000 of it being in maintenance. Maintenance of way is practically the same figure as last year. In maintenance of equipment the expenditure per locomotive was $3,024, per passenger car $956 and per freight car $69; these are very fair figures and for locomotives are more than liberal.

Transportation expense has increased $1,567,000, which amounts to about 10 per cent., while ton mileage has increased 11 per cent. and the passenger train mileage 3 per cent. In other words conducting transportation has increased about as rapidly as the amount of transportation done. This is not a bad showing, when compared, for example, with the trunk lines; that the increase is no larger is a matter of congratulation, though we should not expect to find so large increases in the south as in the west and north. In the detail of transportation expense there is one item which is conspicuously bad, namely, the increase in the expense of wrecks and loss by damage. In 1904 it reached the huge figure of nearly $2,000,000, or over 11 per cent. of the entire amount of transportation expense. The increase during the year was $453,000. This points to a condition of operation that is far from satisfactory. If this heavy wreck expense could be eliminated the general showing of conducting transportation would be satisfactory.

The increase in earnings is fairly well distributed. The passenger earnings have increased $500,000 and freight earnings $2,000,000. The increase in freight earnings is in face of a slight decline in average receipts. The freight train load is at the very low figure of 190 tons, barely above the figure of the year previous. This may be largely accounted for by the large number of branches and lines where light train mileage must be made; but it is very low and as a result the freight train earnings per train mile are $1.77, which is practically the same figure as last year. To sum up, the Southern Railway is growing with the growth of the territory which it serves. The transportation expense has been held fairly well in hand except in the item of wrecks.

## NEW PUBLICATIONS.

*The Detailed Design of a Railroad Bridge.* By William H. Burr, C. E., and Myron S. Falk, C. E. Reprinted in pamphlet form from the School of Mines Quarterly for April and July, 1904. Columbia University Book Store, New York. Price 75 cents.

The matter in this pamphlet has been prepared to take the place of much of the theory and discussion on railroad bridge design in Chapter 10 of the eighth edition of Burr's Stresses in Bridge and Roof Trusses. It will form a separate chapter in the completely re-written edition of that book which will soon be published. The design of a bridge is taken up, beginning with the assumed live loads and the determination of the live and dead load stresses in the members. This is followed by the determination of the wind stresses and the design of the detailed parts of the bridge. The bridge which has been considered is a 350-ft., single-track, through span, and the principles outlined indicate a system of rational treatment for the design of all parts of almost any type of modern trussed bridge.

*Tunneling.* By Charles Prelini, C. E. Second edition. New York: D. Van Nostrand Company. Cloth, 307 pages. Price $3.

This is a practical treatise on tunnels and modern methods of tunneling. It takes up in order the preliminary considerations of cost and tunnel location, methods of excavation, methods of timbering tunnels, lining, driving tunnels through hard rock and through soft ground, submarine tunneling, ventilation and lighting during construction, and some valuable notes and data on the cost of tunnel excavation and the time required for the work. Numerous examples of modern tunneling methods have been treated at length in the descriptions and a large number of diagrams and illustrations have been included to make clear the text. The few books which have been written on this subject are of little practical value because they are old and obsolete, but this book is an excellent one for those who have to do with tunnel construction.

## TRADE CATALOGUES.

*The Associated Expanded Metal Companies*, New York, which represents 12 different companies that make expanded metal, is distributing a catalogue containing about 65 handsomely illustrated pages 9 in. x 12 in. Full size illustrations of the standard sizes of expanded metal are shown. The method of making this material is explained and a brief but comprehensive discussion on the expanded metal system of reinforced concrete construction is given. This includes a theoretical explanation of reinforced concrete, practical tests, fire resisting qualities, the durability of steel embedded in concrete, etc. This is followed by descriptions and illustrations of different methods of construction, for floors, roofs, partitions, outside walls, etc. The use of concrete in sewers, subway construction, railroad work, etc., is also spoken of. Anyone having to do with reinforced concrete construction will find this catalogue of interest.

*The Acme Sheet Piling Company*, Chicago, in a small 12-page pamphlet describes Acme pressed-steel sheet piling and Acme combination sheet piling. The former is simple in form and the builders state that it can be driven with a heavy sledge and withdrawn with a hand lever. It is supplementary to the standard metal piling of the company, being intended for applications where heavier and stronger piling is not required. The combination piling is a new form, being an interlocking piling principally of wood, and not expensive. It is made to interlock by angles which are bolted to the plank with one leg parallel to, and a short distance from, the edge. On the opposite face of the plank to which the angle is bolted, at one edge only, a plate is held by the same bolts which secure the angle, the plate, angle-leg and plank-edge forming a channel into which the angle of the adjacent pile is slipped.

*The Lima Locomotive & Machine Company*, Lima, Ohio, sends two catalogues, Nos. 10 and 12. The yards and buildings of this company cover an area of 15 acres of ground, and the floor space in the building is about 200,000 sq. ft. The average capacity of the plant is one locomotive per day. Catalogue No. 10 describes and illustrates the leading styles and sizes of the locomotives made, and catalogue No. 12 shows the various sizes and latest designs of the Shay locomotive together with tabulated statements of their ratings and views of the engines at work. It also contains both interior and exterior views of the new works of the company. Both catalogues devote a number of pages to useful engineering data and also contain a telegraphic correspondence code.

*The De Laval Steam Turbine Company*, New York, sends its general catalogue in which is given a full detailed description of its steam turbines. It also sends its bulletins Nos. 2, 8 and 9, which are descriptive of the company's direct current turbine dynamos, train lighting with steam turbines, and a test of the De Laval centrifugal pumps.

# CONTRIBUTIONS

### Defective Train Rules.

To the Editor of the Railroad Gazette:

During the world's fair in 1893 there was an epidemic of collisions which was partly accounted for by the exceptionally heavy passenger travel. About four years ago there was another outbreak of this nature, and

now again we are having serious railroad disasters more frequently than at any time in our history. Speculating upon what the next cycle may have in store for the traveling public is a melancholy occupation. There is little comfort in the threadbare assumption that as long as there are railroads there must be just so many collisions; that it is beyond the power of human agency to anticipate, mitigate or prevent them.

Discussion of the ulterior causes which have led up to these collisions may be the means of preventing repetitions only if those in authority who read and learn of the weak rules, or unsafe practices under the rules, which brought about the accidents, will take the necessary steps to correct the defects discovered; hut, unfortunately, it is human nature to dismiss published comments on collisions, and suggestions for relief, by some such remark as "yes, the suggestion is undoubtedly a good one and if adopted would no doubt prevent many similar collisions, but we have never had an accident from that particular cause and the probability of our ever having one is too remote to make it necessary for our company to take steps to prevent it. Our men have been educated up to a higher standard of efficiency, and, besides, they are all old in the service and have had wide experience. Perhaps when business picks up we may feel warranted in spending some money in this direction. It will involve a considerable outlay."

This has been a year of disastrous floods, and it is told of at least one official who, upon reading of an account of the loss of many lives by a washout, issued unusually detailed cautionary instructions to trackmen, trainmen, enginemen, despatchers and operators. That particular road has got through the year without an accident of this nature. It will not be argued that there would have been loss of life from this cause if he had not taken such precautions; it may have just happened so; but it is an interesting query whether this officer, when he read of a recent collision which resulted in great loss of life, by reason of a conductor and engineman forgetting their orders to meet a train, became equally alarmed as to causes of collisions and took the necessary prompt steps to prevent a like accident on his road by ordering that thereafter all train orders directing trains to meet at telegraph stations must be addressed in duplicate to the operators at such stations, and that that operator must be known to have displayed his order signal at "stop" before either train is permitted to act on the order.

In another case, a freight train overlooked the signals on the engine of the first section of a passenger train; did this man order that freight trains should thereafter be regularly advised when it was found necessary to run passenger trains in sections, especially if on his road such a practice is rare and unusual? Are his local and branch trains sometimes ordered to display signals for a following section without notice being given to inferior trains? Are his despatchers in the habit of mentioning "No. 1" in train orders, as permitted by Rule 218, when that train is running in several sections? Is he depending upon Rule 96 to protect opposing trains when signals are taken down? Or is he in other ways allowing needless traps to be set to test the wits of his conductors and enginemen? In short, do officers who can see the dangers of washouts and provide against them, keep their eyes equally well open to the dangers of collisions? Collisions may be less frequent than washouts and their causes are perhaps harder to combat, but on the other hand they cause more death and distress when they do happen.

The present is a very opportune time to look into these matters. A start might be made by taking up Rule 96* for investigation. How is it understood and handled on your road? At first glance it may seem to be sound both technically and theoretically, and if flagmen always use good judgment, possibly it may be, but there are serious defects in it and it does not fully cover the ground. In two ways collisions are possible under a strict observance of and dependence upon this rule. No provision is made for notifying extra trains when signals are taken down. Under the new rules, extra trains are not represented on time-tables and cannot, therefore, be considered as classified trains. Again, if an inferior class train were to be directed to meet a superior class train, without the sections of the inferior class train being mentioned in the order (under Rule 218, this mention is not compulsory) and signals are taken down on the leading section of the inferior class train at the meeting point, before the following sections arrive there, the flagman protecting such inferior class trains might construe the rule as instructing him not to notify the superior class train that there were sections of the inferior class train, made superior by right, yet to arrive. Everyone may live up to the requirements of the rule and still a collision may occur at a station under it. Suppose that there is a station on a curve where the view is obstructed by hills, buildings or fog, and that signals are taken down at that point without advance notice being given the following section that it will be annulled from such station. This following section, if it has precedence, will come into this station on the main track and, although the order signal indicates stop, it will quite likely pull a portion of its train past the signal before stopping. Meantime, the first section, which we will now call No. 1, has reached a station beyond and there meets an inferior train. This inferior train, observing that No. 1 is not displaying signals, moves forward and also pulls into this obscured station, where the signals were taken down, on the main track and a part of its train also passes the order signal, or would have done so had it not collided with 2d No. 1. Who is at fault for the collision? When 1st No. 1 took down its signals the operator was probably notified, according to rule, and he displayed his order signal at "stop" (although the rule does not instruct him to do even this much) to advise opposing trains, but what good did it do? There was a collision under the rules before the men on either train had had an opportunity to get to the telegraph office to ascertain why the signal was at stop.

Is not the matter of taking down signals clearly one to be looked after more closely by the despatcher? Should not he advise interested trains before they arrive at the station where the section annulled is to lose right and class? If may be said that the engine of a train must not pass an order signal indicating stop until the engineman finds out why it is thus displayed; but a trip over any road will convince anyone that such a claim is nullified by every day practice. Passenger trains often pass such signals in order to pull baggage cars and coaches up to the proper place at a station to enable necessary work to be done. Freights often run past, to save a bad extra stop.

A recent collision which resulted in loss of life and damage to property occurred through dependence upon Rule 96. A freight train moving from A to Z was given right from A to E over the third section of a superior freight train moving in the opposite direction. Upon arrival at E the inferior train simply inquired as to whether the third section had arrived and, upon ascertaining that it had, proceeded toward Z and collided with the fourth section. The third section had been turned back from E and the crew of the inferior train failed to ask the operator, it appears, whether or not the third section arrived *displaying signals*. It may be that the despatcher was depending upon the operator to notify opposing trains of this fact, and the operator may have taken it for granted that the inferior train had orders that permitted it to proceed against the fourth section. How simple a matter it would have been for the despatcher to have advised this opposing train that there were four sections of the superior train between E and X and saved those precious lives. If there had been a train register at E this need not have been done. H. W. F.

*When signals displayed for a section are taken down at any point before that section arrives, the conductor will, if there be no other provision, arrange with the operator, or if there be no operator, with the switchtender, or in the absence of both, with a flagman left there for the purpose, to notify all opposing trains of the same or inferior class leaving such point that the section for which the signals were displayed has not arrived.

## Tests of Locomotives on the French State Railway.*

During the years 1901, 1902 and 1903 the French State Railway carried out an extended series of tests on five different types of locomotives, including two American-built engines which it had bought. The tests were made for the purpose of examining the efficiency of operation of the steam in the cylinders, and at the same time testing the applicability to the locomotive, of a theory of the steam engine previously developed by Mr. Nadal. It was also thought that the comparison of the performances of locomotives of such varied types could not fail to be instructive.

For the purposes of the tests the locomotives were observed when handling local and express trains in regular service. Indicator diagrams were taken at frequent intervals and the coal and water consumption noted. In comparing the results of the tests the following points were examined: The fall of pressure between the boiler and the cylinders was observed and the indicator diagrams were carefully analyzed, the apparent or indicated steam consumption being calculated and compared with the actual measured water consumption; also the form of the expansion curve was examined. The tractive effort was calculated from the diagrams and the resistance of the locomotive and tender determined.

The arrangement used for taking the indicator diagrams was simple but accurate. The motion is taken from the crosshead by a swinging arm which has its fulcrum fastened to the running board while its lower end is jointed and runs in a sleeve carried by the crosshead. Through a pivot, the motion of the arm is communicated to a sliding bar, which can be engaged with or disengaged from a second sliding bar by the spring catch. To put the indicator in operation the catch is thrown in and at the end of the stroke engages in a groove in the second bar, which then moves with the first bar, the indicator drum being worked by a cord attached to the former. A stop serves to throw out the catch and release the bar to which the cords are attached, thus stopping the drum. This apparatus was designed by Mr. Merry, a draughtsman in the service of the French State Railways, who also took all of the diagrams. A good deal depends on the skill of the operator, as there are at

*Abstract of articles by Mr. Joseph Nadal, Chief Assistant Engineer of Motive Power and Equipment, French State Rys., appearing in the Revue Generale des Chemins de Fer for May, 1903, and March, September, 1904. Translated by Lawford H. Fry.

least 17 movements to be made in taking each card. The length of time required for taking a card, from the placing of the paper to its removal, was from 15 to 20 seconds. The indicators were piped so that the boiler pressure, the steam-chest pressure and the atmospheric line could be marked on each card.

RESULTS.

*Steam Consumption.*—The dry steam consumption comprises three factors:

1. The steam consumption shown by the indicator diagrams.
2. The steam lost by cylinder condensation.
3. The steam lost by leaky piston or slide valves.

The indicated steam consumption (1) is given by the formula

$$m = V\left\{(a + e)\,g - (c + e)\,k\right\}$$

where m = weight of steam apparently admitted to the high pressure cylinder during each stroke.
V = volume of high pressure cylinder.
a = fraction of stroke at which cut-off occurs.
e = clearance volume as a fraction of the cylinder volume.
c = fraction of stroke at which compression begins.
g = the specific gravity of the steam at the point of cut-off.
k = the specific gravity of the steam when compression begins.

The amount of steam condensed at each stroke (2) is given by the formula developed by Mr. Nadal.

$$n = V\left(S + \frac{c\,\pi\,d\,s}{2}\right)\frac{l\,T}{r}$$ where

n = weight of steam condensed per stroke.
V = cylinder volume.
S = surface of the clearance space of the high pressure cylinder.
c = fraction of stroke at which cut-off occurs.
d = cylinder diameter.
s = stroke.
T = difference between the temperature of the steam at admission and that at exhaust.
r = latent heat at the admission pressure.
l = the coefficient of condensation.

This coefficient of condensation for a locomotive is $l = \frac{k}{\sqrt{n}}$ where n is the number of revolutions per second and K a coefficient which is dependent on the amount of expansion. The following table gives the values of K in metric and inch-foot-pound terms for various points of cut-off.

| Cut-off in per cent. of stroke. | K | |
|---|---|---|
| | Metric. | In.-ft.-lbs. |
| 20 per cent. | 0.62 | 0.0044 |
| 30 " " | 0.72 | 0.0051 |
| 40 " " | 0.78 | 0.0055 |
| 50 " " | 0.83 | 0.0059 |
| 60 " " | 0.87 | 0.0062 |
| 70 " " | 0.90 | 0.0064 |

The figures obtained from the tests show that the steam consumption per horse-power hour, for a constant working pressure, does not vary greatly when the cut-off and speed change for points of cut-off between 40 and 60 per cent. and speeds between 25 and 60 miles an hour. The steam consumption is, however, very sensitive to a change of pressure. For pressures of 200 to 213 pounds per sq. in. the steam consumption is from 19 to 20.7 pounds per horse-power hour. For pressures of 160 to 170 pounds the engine uses 21 to 22 pounds per hour, for 130 pounds per sq. in. 23 to 24 pounds per hour, while for pressures of from 100 to 115 pounds per inch the steam consumption rises to 25 or 26.5 pounds per hour.

*Form of the Expansion Curve.*—Of the three factors mentioned above as making up the dry steam consumption, the first two are given by the two preceding formulæ. The third factor, that is, the amount of steam lost by leakage at the slide valve can be determined by examining the expansion line of the indicator diagrams. The weight of steam apparently present in the cylinder at a given time is found by taking the point on the diagram corresponding to the given time and multiplying the corresponding cylinder and clearance volume by the density of the steam for the indicated pressure. If this is done for successive points along the expansion line of a normal diagram a slight increase in the weight of steam present will be observed. This increase is due to the fact that the normal expansion curve is nearer a hyperbolic than an adiabatic curve. Some of the steam condensed during admission is re-evaporated during expansion, thus increasing the weight of steam in the cylinder. A large increase in the weight of steam may be due either to excessive moisture in the steam during admission, so that the amount of water introduced into the cylinder and re-evaporated during expansion is abnormally large, or to leakage at the slide valve admitting steam to the cylinder after cut-off is supposed to have taken place. With these considerations in mind the diagrams obtained from the engines under test were examined. The cards from engine 2,617, which has the Bonnefond trip valve gear, show a slight increase in the weight of steam in the front end of the cylinder and a barely perceptible increase in the rear end. The flat slide valves which admit the steam and the piston valves which control the exhaust were steam tight.

For engine 2,754, fitted with Ricour piston valves, the cards show in the front end of the cylinder a slight increase in the weight of the steam, this increase being in nearly all cases less than 0.022 pounds. In the rear end the increase is never large and in some cases the amount of steam appears to diminish during expansion. This difference between the two cylinder ends may be due to one of two causes. It may be that, contrary to the assumption made in the calculations, the clearance space is not the same at both ends; or it may be that the more exposed position of the front end gives greater condensation during admission and a consequently greater re-evaporation during expansion. If the expansion curve followed exactly the hyperbolic law $pv = constant$, the increase in the weight of steam during expansion would average from about 0.009 to 0.011 pounds. This figure is very nearly the average of the increase at both ends of the cylinder. The results obtained from these two engines are exactly similar and appear to establish the form the expansion line should take when the valves do not leak.

On engine 2,802, Vauclain compound, the increase in the weight of steam during expansion is less than 0.022 pounds in the high pressure, and from 0.022 to 0.044 pounds in the low pressure cylinder. This increase is the same as was observed with the other types of engines with steam tight valves and is therefore not due to a leaky valve. The Vauclain piston valve is thus shown to be steam tight, at least during expansion, and it is during this period that any leakage is the most likely to occur.

The average of 30 cards taken on engine 3,729, de Glehn compound, shows that in the high pressure cylinder the weight of steam apparently present in the cylinder is slightly reduced during expansion. That is to say, the expansion curve is between the hyperbolic and the adiabatic curves, showing the steam has very little moisture on admission. The low pressure cylinders show a large increase in the amount of steam in the cylinder, but this is probably due to indicator faults caused by the pipe from the low pressure cylinder being too long.

The diagrams for engine 2,901, American piston valve, show an increase during expansion of about 0.055 pounds of steam, which is about three times the normal increase as observed for engines 2,617 and 2,754. As previously remarked, an abnormally large increase such as this may be due to priming, to too long an indicator connection, or to leaky slide valves. In the present case the two first causes need not be considered, as firstly the calculated steam consumption is within a few per cent. of the actual water consumption, consequently the steam cannot carry much moisture, and, secondly, the indicator piping was very nearly as short and as direct as that on engines 2,617 and 2,754. Therefore the only remaining explanation is that the slide valves were not steam tight, but admitted live steam during the expansion when cut-off should have taken place. The diagrams show that the leakage diminished as the expansion progressed and stopped before the exhaust opened. As there is no direct leakage to the exhaust the loss of steam is not large, and in the case under consideration amounted to about 6 per cent. of the steam used, or 1.76 pounds of water per horse-power hour. In calculating the apparent or indicated steam consumption for purposes of the tests, this loss of steam by leakage is taken into account by taking a point near the center of the expansion curve for the calculation of the weight of steam used.

*(To be continued.)*

## Caring for Trestles While Being Filled.

A report on this subject was made at the Chicago meeting of the Association of Railway Superintendents of Bridges and Buildings. The committee sent out to members a list of questions and some of the replies received were as follows:

*Northern Pacific.*—The report describes the filling of a pile trestle 2,000 ft. long across a lake, which was filled from the bridge by a work train, the water being about 12 ft. deep and the top of tie about 6 ft. above the water. In filling, some of these piles were crowded out from under the caps but not enough to materially affect the safety of the structure. Another fill was a trestle 80 ft. high and 1,500 ft. long, with frame bents set on pile foundations. In filling this trestle a temporary track was laid on each side of the bridge and the filling carried up to within 20 ft. of the top of the bridge, both sides being carried up as evenly as possible. It was then allowed to stand for about two years, when the balance was filled up with the work train dumping from the top of bridge. On account of the care taken in filling no difficulty was experienced by reason of vertical pressure on the horizontal timbers or lateral crowding against the vertical timbers during the process of filling. In both cases the ties and stringers were removed as soon as possible after the filling was completed, as the filling at that time had a tendency (which could be depended upon to occur in general practice), to crowd the bridge out of line; also the settling affected the surface and it was considered easier to keep the track in a good condition on the dump than it would be with the stringers in.

It has never been found necessary to reinforce bridges before commencing to fill as this work had been started before the bridges became weak enough to call for anything of

this kind. In general, stringers, ties, and guard rails should be removed and in carrying up the filling, it should be kept as nearly uniform in height as possible. If stringers in filled-in bridges are not removed until near the approach of winter, as a rule they should be left in until next season. The filling would not have a chance to settle and after the ground was frozen it would be difficult to keep the track in good surface and line if the stringers had been removed. The material used makes a difference in filling bridges. Heavy clay, which forms into lumps, does not settle and pack as closely as gravel, slag, or sandy material.

A roadmaster on this same road writes: "When filling a trestle of more than one deck, material collects on caps and other horizontal timbers and causes them to break under this pressure, and often the filling material falls upon these timbers, breaking them. The vertical pressure bends and breaks these timbers on account of material settling away from and under them. Lateral pressure seldom occurs against horizontal timbers that would cause damage or displacement. Lateral pressure is caused by slipping and sliding of the material rolling down the slopes, and its force is directed mainly against the plumb and batter posts. All posts are affected by the material slipping longitudinally or in the direction of the track where the slopes usually incline from 25 to 65 deg. If a pile trestle, single deck, with piling reasonably sound, is to be filled, no precautions are needed unless the piles are 35 ft. long and over, or with steep slopes. Extra longitudinal, and perhaps lateral, bracing is required. The usual practice is to brace, strengthen, and replace inferior timber before starting to fill; also to watch carefully during the work and rectify weak places as they show up and make such changes as may be necessary to carry work along safely. In cases of trestles of more than single deck it is a good plan to fill out to the foot of the slope by scraping with teams, and on the balance to use a steam shovel and dump cars. If double deck bridges are to be filled they should all be filled from on top. It will be necessary to strengthen the middle caps and braces, using care to overcome any injury due to slipping. The fill should be made loose, as much as possible filling the lowest places first; work should not all be done from one end. Caps and all bent timbers should remain in the fill. If the fill is made with good gravel or furnace slag the stringers may be taken out with perfect safety when the weather is favorable and on the approach of winter, provided there is gravel on hand to surface and raise the track. Settlement of material should be allowed before removing timbers.

*Southern.*—This road prepares broad, substantial foundations for bents before commencing to fill, and if more than 15 ft. high they put in additional longitudinal struts about half the distance from ground to top of bent and allow it to remain until it has to be removed to make room for workmen to pass. If the trestle is over 20 ft. high they place these struts at intervals of 10 ft. This contemplates filling from below with teams where practicable. They begin in the lowest place and fill in so as to keep the filling at uniform height at all times, except where the trestle is located on a hillside, in which case they use extreme caution to keep the filling on the lower side at all times a little higher than on the upper side. It is important that the base of the fill be started at a proper width and kept approximately at the same height, except that it is an advantage to keep the outer edges a little higher, the object being to keep the weight of the filling inclining towards the center. Retention of the moisture would also assist in the settling of the filling matter, assuming it to be earth. Timbers are removed after the spring rains, and all bents put in good repair to last, at least for two years before filling. This they think gives time for fills to settle before removing timbers, and they find it necessary to add to the original filling frequently before timbers are removed.

*Bessemer & Lake Erie.*—On this road trestles have been filled until this practice is necessarily near its finish. This filling has been done usually with a center plow and both sides were brought up uniformly, keeping the dirt at about the same height on both sides. No trouble has been occasioned by pressure in any direction. They have not found it necessary to reinforce trestles unless they should be practically unsafe before commencing to fill, and that condition is not allowed to obtain. Timber above the caps is all that is removed. It is considered unsafe to remove stringers from filled-in bridges in the fall, unless there is ample time for the filling to become solid before winter sets in. They find that the time required for a fill to settle depends very largely upon the nature of the material used. They recently filled a 3,000-ft. trestle with slag where the settlement was scarcely perceptible, but where clay was used they find it takes longer to settle. But in all cases their experience has been that there is less trouble in maintenance where fills have had ample time to settle before trains are run over them.

*Union Pacific & Oregon Short Line.*—These roads have a great deal of this work to do, especially in the mountain districts, but as a rule the openings have been neither high nor long; yardage was therefore small and the character of the earth generally dry and firm so that chances for accidents were correspondingly reduced. During the time of the writer's connection with the B. and B. department of the Union Pacific on the Wyoming division we had over 200 bridge openings filled over pipe culverts, concrete, stone, or some other form of permanent water way; and during this period, extending over a term of about 20 years, and subsequently over four years with the Oregon Short Line, no accident, however slight, has ever marked the progress of this work. The class of work which has proved most difficult in the line of trestle maintenance, during filling, is that which is built for the purpose of grade construction; however, in this case only small dump cars and engines, used by contractors, are engaged on the work, and this feature of it is generally cared for by the grading contractor. Filling in is done as a rule from one end, and fresh filling, constantly shifting, makes it most difficult to retain bents in serviceable condition.

The committee offered the following conclusions: In high fills of timber trestles, breakages of horizontal timbers are unavoidable, as they are not supported except at bearings. Points where posts are not in direct contact with sills and caps are also subject to the same conditions, and will also give way under added tons of filling material, so that under a heavy fill it is safe to assume that the posts and portions of longitudinal timbers, with the actual bearings of caps and sills in this vertical line of posts, are the only timbers not distorted and rendered worthless by the weight and settling of material in the fill. Therefore it should be borne in mind that the vertical timbers and, more strictly speaking, the plumb posts, are the only supporting timbers unaffected by the pressure of the fills, as batter posts are affected in proportion to their inclination from a vertical line. To insure stability in the structure during filling the best practice is to cut off all horizontal timbers when filling reaches a height so that they can be eliminated, as they would then be of no value in sustaining a vertical position of the bents, which (if filling is carried up evenly) would be insured by the filling matter all around the bent, and their use would only tend to throw the sill of the next bent above from its natural bearing. These timbers need not be removed until the dirt in the fill reaches them, when the necessity for their use no longer exists and their presence in their natural position would be a serious detriment to the structure, as it would be, in the fill.

(2) The precaution of getting supporting posts in a vertical line before filling is a necessary one, and more especially in the heavier fills, as the filling of trestles (say 20 ft. high or less, single deck) is much simpler since the trestle is sufficiently rigid to carry trains. The trestle is able to resist any pressure that could be exerted against it in filling, and a pile bent has the advantage of having no surface exposed to vertical pressure, which would be the reverse where frame bents are used, supported by blocking. In the latter case the bearing surface would be increased where the ground is yielding and the tendency to settle would be increased accordingly.

(3) The best results are obtained by carrying up the filling on a level, and in this way preventing the slipping of the filling, which would result in a lateral pressure and consequent displacing of bents or breaking of vertical timbers. Should this method of filling for any reason not be practical or expedient, the trestle would be kept in better position by taking off sway-braces, which would tend to obstruct the natural settlement of the filling. The least resistance presented by the structure to the natural movement of the filling material will give best results in maintaining the trestle during the filling period.

(4) The general practice is to remove bridge ties, stringers, and guard rail, leaving in the caps to rot out in the fill.

(5) Filling must be done when the frost is out of the ground, and should also be done when the dirt is dry and not in a rainy season. If a general, absolute rule is to be laid down, the best time is during summer months and not so close to the freezing-up season as to have any great amount of settlement occur. After that time, however, in low fills where the settling is slight, there is some advantage in getting timbers out, as they can catch fire and cause possible trouble. If they break, there is no chance to detect it until it could be observed in the surface of the track, and it is our experience that such a filled-in bridge is not as easy to hold in surface and line as when the track is on the dump.

(6) It is found that where practicable it is an economical plan to grade in as much by team and scraper from below as can be conveniently reached. Such filling is pretty well packed as it is made, and this appears to be the usual practice, but in high fills it is of course necessary to fill in the greater bulk of it from on top.

The general trend is, and has been for some time, towards the elimination of the timber trestle, in main line bridges particularly, and the wisdom of such action is apparent. The committee is of the opinion that the ideal condition will be attained when the timber trestle will be eliminated entirely.

The report is signed by A. H. King, Chairman; J. B. Sheldon, H. D. Cleveland, A. J. Hart, F. Ingalls, J. S. Lemond.

## Forest Park Bridge of the Wabash at St. Louis.

By A. O. CUNNINGHAM, *M. Am. Soc. C. E.**

Bridge No. 11 on the Wabash Railroad is over the entrance of the main drive into Forest Park, St. Louis, and the old bridge which stood on this site and which was erected about 20 years ago had a clear span of only 40 ft. On account of the congestion in the roadway at this point and the consequent danger to pedestrians and vehicles in passing under the bridge, the city authorities requested the railroad company to put in a new bridge with a clear span of 70 ft. and to make it an ornamental structure in keeping with the surroundings. The city agreed to pay $15,000 towards the cost of the new bridge with the understanding that the plans should meet with the approval of the Board of Public Improvements. The railroad company accepted the suggestion and proposition of the city authorities and the writer was instructed to prepare plans for a suitable structure that would meet with their approval.

The natural design to adopt for this place would have been an arch, but on account of the limited head room, such a design was not suitable. There remained, therefore, but one way to make this an ornamental bridge, and that was to devise some plan for covering over the unsightly through plate girders necessarily used with a decorative exterior finish. On account of its cheapness and durability it was decided to use concrete for this purpose, and the accompanying illustration from a photograph of the nearly completed structure shows with what graceful and pleasing effect this was done. Ornamental bronze lamp posts are still to be placed at the foot of the abutment wing walls and bronze ornaments on the sides of the newel posts at the ends of the bridge.

The new plate girders put in were 80 ft. long, and it was necessary that they should be at least 8 ft. deep. The cost of the work was limited to $25,000, and while this seems a large amount for such a comparatively small structure, yet when the amount of work necessary to lengthen out the old span is taken into consideration, including a large amount of excavation behind the old abutments, carrying the track over this opening, keeping the banks from caving in, and the removal of the old span and abutments during the operation of trains, it will be seen that the cost was, after all, low. For the sake of economy it was decided to use concrete with reinforcing rods for the abutments, using the hollow type with buttresses. This design of abutment was brought out by the writer and first used for the bridge at Monticello, Ill., which was described in the *Railroad Gazette*, Jan. 8, 1904. Corrugated bars and Red Ring brand of cement were used, the proportions of the concrete being 1 cement, 2 sand and 5 stone.

Plans were approved by the Board of Public Improvements on March 25, last, but as arrangements for payments by the city were not then completed, work on the bridge was delayed until about April 20. The contract for all of the masonry work was let to the Geisel Construction Company, St. Louis, and the American Bridge Company received the contract for the steel work, which was erected in place by the railroad company's own forces. About 2,000 cu. yds. of earth were removed from behind the old abutments and the old abutments themselves which were also removed, contained about 580 cu. yds. of rock. As this material could not be taken away by work trains on account of traffic it was necessary to cart it away and dump it outside of the park limits.

The accompanying drawings show the principal details of the construction of the bridge and abutments. The wing walls of the abutments have the same hollow cross-section with buttresses as the face walls, and are carried down with a constant slope of 1½ to 1, but instead of being carried out, straight or with a flare, they are given a spiral curve forming a recess back of the line of the face wall and ending at the bottom with a simple pedestal for the ornamental lamp posts. The reinforcement in the wing walls consists of vertical and transverse horizontal rods. Three standard through plate girders spaced 15 ft. apart and resting on bearing plates set on the abutments, support the two lines of track. These girders have solid floors supported on 15-in. I-beam floorbeams spaced 18 in. apart. The floor consists of a layer of concrete 6 in. thick in a proportion of 1 cement, 2 sand and 4 stone, reinforced with longitudinal and transverse rods, and which rests directly on the floorbeams. On this is laid stone ballast to a depth of 14 in. and the ties are bedded

New Bridge over Main Drive of Forest Park, St. Louis, Wabash Railroad.

Lowering Girders on to False Work with Wrecking Cranes.

*Bridge Engineer, Wabash Railroad.

in the ballast in the usual way. This form of solid floor is standard on the Wabash.

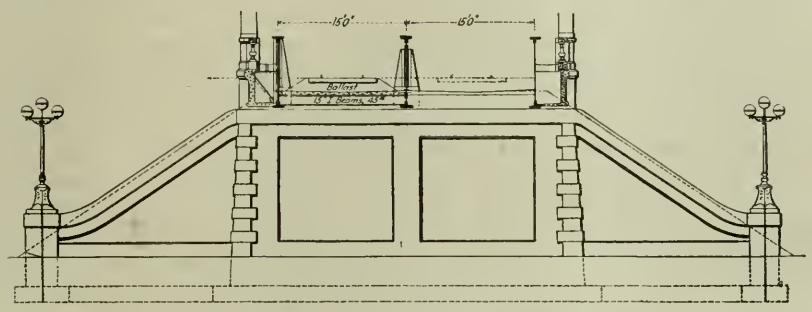
The ornamental balustrade along the sides of the bridge consists of a thin shell of concrete reinforced with longitudinal bars and supported on angle iron brackets attached to the stiffening angles on the girders. The lower part of the balustrade is paneled and ornamented only with simple cornices. It is 4 ft. 6 in. deep, 8 in. thick, and is spaced 3 ft. away from the web of the girder. Surmounting it is a row of concrete balusters 2 ft. high with a copiug also of concrete running along the top. The under side of the opening between the ornamental shell and the girder is closed with a thin shell of concrete 4 in. thick, and the top is covered over with a wooden gutter paved with tar and gravel.

The dismantling of the old bridge and the erection of the new structure was a difficult job to carry through without interruption of traffic. It is on the main line of the Wabash between the Union Station and the World's Fair grounds, and all Wabash trains both to and from the East and West were sent over it. In addition to these regular trains, the shuttle trains to and from the Union Station and the Fair Grounds were scheduled to pass over it every 15 minutes each way, and the Rock Island also ran all of its passenger and freight trains into the city over this line. About 300 trains a day, in all, used these tracks.

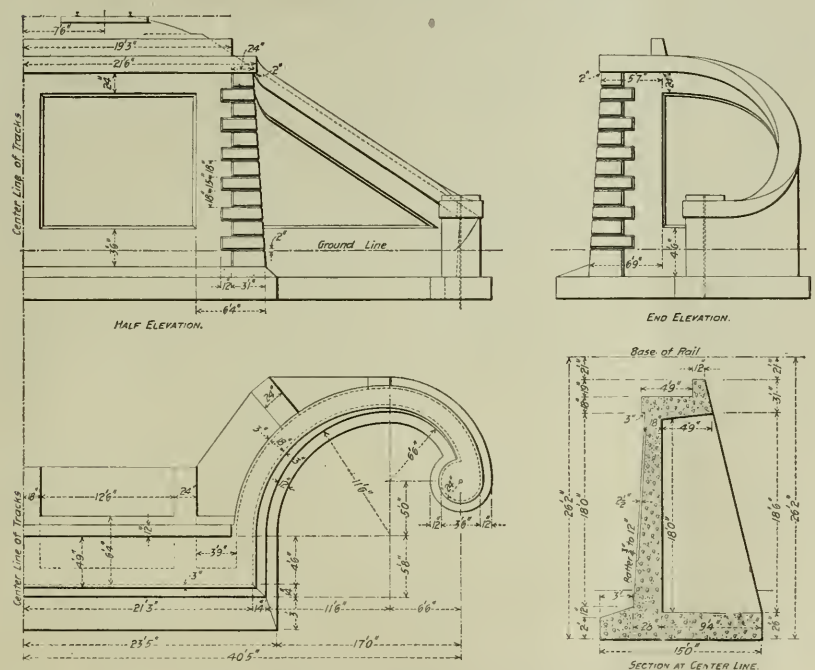
On account of the number of trains and the fact that the floor of the bridge was made of a reinforced concrete slab resting on I-beam floorbeams, it was decided to erect the bridge complete on one side of the existing structure. This was done on false work which consisted of a line of bents with a single cap under each end of the girders. The bents were erected between the old and new abutments and on the cap was laid a line of steel rails. The girders were unloaded from the cars by two wrecking cranes, one at each end and lowered on to the falsework. This was done on Sunday, when there were few trains to be delayed during the unloading. After all of the steel work had been unloaded it was jacked up and erected on the falsework by the railroad company's bridge gang. The concrete floor was then put in and allowed to set for two weeks, after which the ballast and ties were laid. The ornamental work was not put on until after the new girders were in place.

Because of the frequent service of the shuttle trains it was not possible to take out the old bridge and put the new one in on a week day, but as these trains did not run on Sunday it was decided to do the work on that day. The old structure was similar to the new bridge, being composed of three through plate girders, but having the tracks supported on floorbeams and stringers.

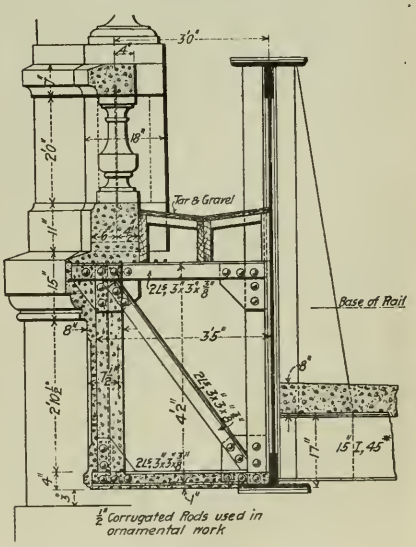
When all of the early inbound trains had crossed the bridge, the work of taking up the rails and ties on the inbound track was commenced at 9 a.m. The stringers and floorbeams under this track were then cut loose and by means of one wrecking crane at each end of the bridge, these parts carried back and deposited on the right-of-way. The outside girder was lifted up by the cranes and placed on two push cars standing on the adjacent track, and was pulled back out of the way. Then the new bridge, completely erected, was pulled over on the falsework, half way in place, so that the out-



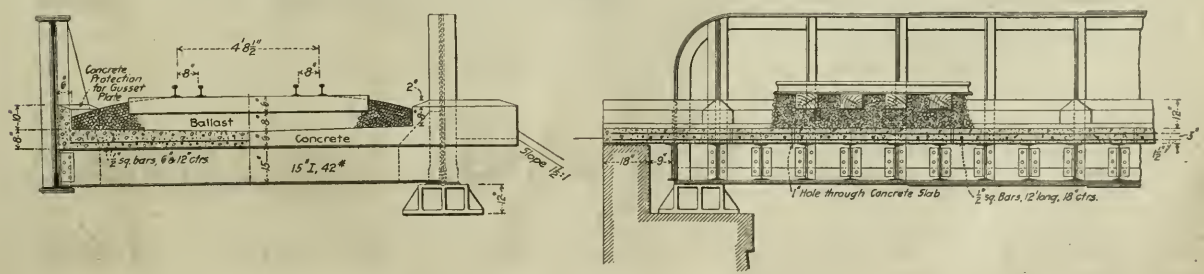

Section through Bridge and Elevation of Abutment.




Details of Concrete Abutments and Wing Walls.




Section through Girder and Balustrade.




Standard Solid Bridge Floor, Wabash Railroad.

bound track on the bridge was in line with the inbound track on the embankment. This was done by triple blocks and 1½-in. rope, attached to locomotives pulling back of the cranes. One triple block was fastened to a 12-in. x 12-in. vertical timber with one end buried in the ground and the other end resting against the coping of the abutment and projecting over the top about 2 ft., and the other block was attached to the girders. It was necessary to do the work in this way because the city authorities would allow no obstruction in the roadway, so that no falsework could be placed under the bridge. When the new girders were half-way in place the rails were laid down on the ballast and ties already in place and joined up with the inbound track on the embankment. As soon as the inbound track was connected up, the other half of the old bridge was cut apart and taken away by the wrecking cranes. The temporary connection of the new bridge was broken and the whole structure pulled into its permanent position. By six o'clock in the evening of the same day both tracks were connected over the new bridge and traffic resumed as usual. With this method of doing the work one track was always available, and the regular trains were handled without delay, there being crossovers immediately beyond each end of the bridge.

The total weight of the structure while being pulled into place was 230 tons; this included the weight of steel work, concrete floor, ballast and ties. As soon as the bridge was finally in place, work was commenced on the ornamental concrete sheathing.

## Awards for the Pennsylvania at St. Louis.

The Pennsylvania has been awarded the World's Fair grand prize for its locomotive testing plant, engineering models and tunnel construction on exhibition in the transportation building at St. Louis, and also the grand prize in the department of liberal arts for the model of the New York terminal station. The company has also been awarded gold medals for its Y. M. C. A., pension relief and savings fund exhibits in the department of social economy. A gold medal has also been awarded to each of the following collaborators in the preparation of the Pennsylvania's exhibits: J. J. Turner, Third Vice-President, Pennsylvania lines; Theo. N. Ely, Chief of Motive Power, Pennsylvania Railroad system; F. D. Casanave, Special Agent; A. W. Gibbs, General Superintendent Motive Power, Pennsylvania Railroad Company; E. D. Nelson, Engineer of Tests; A. S. Vogt, Mechanical Engineer; G. L. Wall, Director of Tests; J. E. Sague, Professor W. F. M. Goss, E. M. Herr, F. H. Clark, F. M. Whyte, H. H. Vaughn, H. V. Wille, C. H. Quereau, Willard A. Smith, J. A. Aspinall, Karl Steinbiss, members and associate members of the Advisory Committee: Charles M. Jacobs, McKim, Mead & White, Klee Brothers, Victor Mindeleff and Professor G. I. Alden.

The proposal to double-track the Trans-Siberian Railway in order to increase its carrying capacity for troops and munitions of war has been abandoned as impracticable at this time because of the inevitable interruption of traffic which would occur on the present single track line. Plans are being made, however, for increasing the capacity next summer by utilizing the rivers in eastern Siberia, increasing the number of boats on them and building a second line through the country between the streams. This can be done with but little interruption of traffic, but the cost is sure to be great. The time required, however, would be short, and time is the essential consideration.

## Superintendents of Bridges and Buildings.

The Association of Railway Superintendents of Bridges and Buildings held its fourteenth annual meeting in the Sherman House, Chicago, October 18, 19 and 20. It was called to order by President Montzheimer, Chief Engineer of the Elgin, Joliet & Eastern. After a prayer by Mr. J. H. Cummin, of the Long Island Railroad, Dr. Howard S. Taylor, representing the Mayor, delivered an address of welcome, which was responded to by Mr. Cummin. The President, in a brief address, reviewed the condition of the association during the past year. A booklet outlining the work and purpose of the association had been sent to the general managers of all railroads and had yielded good results in additions to the membership, which is now about 300.

The membership committee reported 86 applications for membership, a number of which came from Australia and New Zealand. All were admitted on vote of the association. The Treasurer reported a balance of $678 on hand.

According to custom, the subjects for last year's convention were brought up for further discussion. There were nine of these, and with the exception of the second, in regard to the gaining of ties on bridges to leave rail without camber, on which a few brief remarks were made, they were passed without discussion.

There were 12 subjects for committee report this year and two individual papers. The first report for discussion was on the best form of traveler to use in erecting steel railroad bridge spans up to 200 ft. The report, with the exception of a number of letters read to the convention by the chairman, is reproduced practically in full in another column.

Mr. R. H. Reid (L. S. & M. S.) said they use steam wrecking derrick cars of 40 to 60 tons capacity, which will handle all ordinary work. They can place girders up to 103 ft. in about a half hour. This was considered the cheapest and most economical method since the derricks belong to the motive power department and the B. & B. department is therefore at no expense on their account except when actually using them. The cost of the derrick, locomotive service and their crews is $2 per ton of metal erected. The total cost for all girder construction erected by these derricks never exceeds $5 per ton.

Mr. W. O. Eggleston (Erie) does not use chains for lifting heavy loads in bridge work, using stirrups with 1¾ or 2-in. rods instead.

Mr. Steffens (N. Y. C. & H. R.) explained methods employed on his road. In one case a number of 116-ft. span, 78-ton plate girders were put in on the West Shore by steam derricks. They replaced old Phœnix truss column spans, the latter being dismantled by a traveler of two or three bents. A unique method will be used on the Pennsylvania division, over the Susquehanna river, where five half-through spans will be replaced with deck girder construction. To eliminate the cost of falsework a trolley or traveler has been devised, the method of operation being described by the speaker. He was confident the cost would be small compared to falsework.

Asked about methods for steel trestles, one method described by Mr. Smith, of the committee, employs a cantilever traveler with a trolley boom, the trolley running forward to convey the members. A method used by the New York Central in a treacherous stream in Pennsylvania, Mr. Steffens said, involved the use of low falsework on each side for the traveler to straddle the structure.

There was no printed report on subject No. 2: "What has been the experience in the use of concrete under bridge bed plates and turntables in place of pedestal stones, and what is the best form and material for bed plates under various styles of iron bridges?" The subject was taken up for discussion by the convention and later a brief written report was received from the chairman of the committee, Mr. C. F. Loweth (C., M. & St. P.). This report testified to the good results that the writer had observed and experienced with concrete in two applications referred to. Some 100-ft. spans were mentioned, the seats for which had been in four years and no wear was observable. Turntable centers on which the load had been placed 18 hours after setting had been in service two years without any sign of deterioration. According to the writer's experience, concrete was in every way as suitable for bridge seats as stone, if not better, since it will permit the use of a higher unit pressure. It must be first class concrete, however.

Mr. W. F. Steffens (N. Y. C. & H. R.) said the unit pressure on the New York Central for masonry is 250 lbs. per sq. in.; for concrete it has been made 200 lbs. A very rich mixture is used, the proportions being 1:1:2. Mr. Alexander (Bangor & Aroostook) related an experience with concrete turntable walls and foundation that failed under the action of frost, the quality not being rich enough. The foundation was replaced with a heavier one, which was cross-laid with old rails bedded in the concrete, forming a grillage.

On the Lake Shore Mr. Reid said the proportions are 1 part of cement, 3 of gravel and 6 of crushed limestone. They get a very hard concrete, that will stand severe shocks, being much less brittle than limestone. Speaking of the hardness of concrete, Mr. Killam (Intercolonial) told of an instance where it took two men two days to put a hole 14 in. deep in a certain piece of concrete masonry on their road. He spoke of the detcrious effect of sea water on concrete in their harbor works, and other members testified to the same effect.

Mr. Steffens described a method they have for winter work, which consists in making the forms double, with a 6-in. space between, the latter being packed with manure. They have never had a case of frosted concrete. They heat their materials.

Questions having been asked about the cost of concrete for bridge seats, Mr. Bailey gave $7 a yard. Mr. Killam said an item so small cannot be accurately computed as there are variable factors affecting it. With them the figure is $6 to $7 a yard. They use White Bros. cement, an English brand.

The consensus of opinion brought out by the discussion was that concrete was a good material for bridge seats and turntables where properly mixed and applied.

The report on the next subject, "Best Method of Caring for Trestles While Being Filled," is printed in abstract in another column. The discussion did not develop much new matter in addition to what was presented in the report. Some members related interesting experiences in filling trestles across sink holes. A case on the Lake Shore was of a trestle a mile long through a marsh. When the filling began the trestle became badly distorted, so much so that after filling as rapidly as possible the stringers were removed and the track put on the bank. Settlement was provided for continually until gradually the fill was got into permanent shape. Mr. Aldrich (N. Y., N. H. & H.) told of a sink hole in which they resorted to the use of old car bodies to form a sort of pontoon or grillage for the fill. A temporary

track was built to carry the road around the point while the filling was being done, the temporary track being about 150 ft. away. The weight of the fill forced the mud up on both sides almost level with the track and it began to displace the temporary track. The fill was finally brought to a condition of permanency. Mr. Alexander filled a trestle on an 8-deg. curve, keeping the material wet down as filling progressed. He took out the stringers as soon as the filling was completed and found no trouble in keeping the track in surface. He thought it good practice to wet the work down whenever practicable as otherwise the fill will continue to settle for quite a while. Mr. Reid told of filling a trestle on the Lake Shore, 75 or 80 ft. high. Before beginning work it was braced in every way possible. The filling was done at the rate of 75 to 100 cars a day, men below spreading the material in order to progress uniformly. Yet despite all precautions as the filling rose the bracing was crowded off.

The next report considered was, "Steam Hammers vs. Drop Hammers for Pile Drivers," extracts from which are given elsewhere. Supplementing his statements in the minority report, Mr. Reid said that after the experience related with the steam hammer they substituted a 4,500-lb. drop hammer which did the work with entire satisfaction.

Mr. Carpenter (Southern) thought that for road work the steam hammer is not as suitable as the drop hammer. He related an instance from his own experience where he had to drive 60-ft. piles on the inside of a 5-deg. curve, 14 ft. from the center of the track, with 30-ft. piles on top of them for a temporary tank. He was able to do the work quite satisfactorily with a drop hammer, but did not think it would have been possible with a steam hammer. Mr. Reid has driven 2-in. pine sheet piling with a 3,200-lb. drop using a short light blow, without splitting or seriously injuring the piling. Most of the members appeared to have used the drop hammer and the testimony was therefore largely favorable to it for track work.

Mr. Penwell (L. E. & W.) told of a case where he was able to observe a steam and a drop hammer working in competition. A washout occurred on a piece of track in which his line and the Pennsylvania were jointly interested. Both set to work on the repairing, the Pennsylvania using a steam hammer on one end and his road a drop hammer on the other. The steam crew seemed to be able to set their piles quicker and drive straighter but after starting they could not drive as fast or as far. However, in his opinion, for ordinary bridge work the steam hammer is preferable.

Mr. Killam said his specifications state that driving shall stop when the pile only goes 1 in. under a 25-ft. fall of a 2,200-lb. ram. Mr. W. H. Finley (C. & N. W.) said that the action of the pile depends on the nature of the soil and therefore specifying the amount of penetration for the last blow is not a safe guide. He related an instance of some piles that moved 8 in. at the final blow, yet in 48 hrs. in trying to drive them enough deeper to put on an additional cap, they were moved only with the greatest difficulty. In another case they drove 800 piles in quicksand and each one had to be given 500 blows, the penetration being as great for the first as the last blow. One was withdrawn to see if it had not been shattered by the pounding, but was intact. In his opinion the steam hammer is preferable, giving quicker and better results and being more scientific.

Subject No. 9 was "Best Record Forms for Buildings, Water Tanks, Etc." The committee obtained a supply of the record blanks used on the Chicago & North Western, and distributed them among the members, asking opinions and criticisms. The report is made up of the replies of those members suggesting changes in the blanks. In addition to the Chicago & North Western blanks the report submits copies of blanks from the Michigan Central, Minneapolis & St. Louis, Colorado & Southern, Rock Island and Lake Erie & Western. The report is signed by B. J. Sweatt, Chairman; B. F. Pickering, A. Shane, I. O. Walker, I. F. White, William E. Harwig.

There was no discussion of the report.

At the beginning of the Wednesday morning session the report on "Best Freight and Roundhouse Doors and Fittings for Same" was taken up. The report was brief. It stated that the freight house door in common use is the wooden panel door, moving horizontally, hung by two wheels to a track on the wall. Brief mention of vertically-moved doors was made and their advantages stated. The wood-panel square-top door with as little glass as possible is recommended for roundhouses. There should be clearance at the bottom to avoid springing from crowding over snow and ice and heaved track in winter. An acceptable method of fastening is mentioned. The report is signed by John I. Banks, Chairman; J. McIntyre, R. K. Ross, E. M. Gilchrist, G. W. Walker.

Mr. J. P. Snow (Boston & Maine) sent a written discussion. Where the platform must be enclosed and the side of the house is therefore close to the track there is often difficulty in spotting the cars opposite the doors. The posts also usually interfere. They are using an arrangement based on the scheme described by Mr. A. S. Markley (C. & E. I.) before the Maintenance of Way Association last spring. The B. & M. terminal freight houses are built of wood, with wooden side posts set 6 to 8 ft. in from the side of the building. The roof trusses overhang these posts, carrying the side walls and doors. The doors are hung on two parallel tracks to be run by each other and also to be run apart to provide large openings. At water terminals where freight sheds must accommodate vessels, teams and cars, the door problem is complicated. On the water side the doors must be 16 to 20 ft. high and continuous. It is best to hang them outside of the posts, though there must be a fender platform outside, not over 2 ft. wide. Doors for admitting teams to the sheds must be large (14 ft. high x 16 ft. wide). An inexpensive and fairly convenient method of opening the door is to have it in halves and to hinge it strongly at the top. Then slide the lower half part by counterweights up inside the upper half and hitch by a crotch hitch to the lower corners of the latter and haul it up to a horizontal position. For sliding-door hangers the essential features are strength, simplicity and impossibility of getting off the track. Roundhouse doors should swing in and there should be provision for holding them open. Usually the doors and posts of roundhouses occupy, when standing open, about 18 in. of width, which is waste room. The Boston & Maine reduces this to 10 in., thereby saving about 5½ per cent. of the size of the building. The posts are made of Z-bars and the doors are hung by three hinges on angle-iron lugs.

Some members having indorsed patented makes of doors, Mr. A. Shane (T., St. L. & K. C.) said the objection to these doors was their high cost. He claimed he could make doors, which can be cheaply maintained, at 25 per cent. of the cost of patented doors.

Mr. H. Rettinghouse (C. & N. W.) said a committee on the Chicago & North Western had discussed the door question in an effort to learn if there was not something in the way of material and manner of construction that is superior to the present wooden nailed doors. They had in mind an iron door with a frame of angles and a body of sheet metal. They made inquiries of users of steel rolling doors regarding their action in cold weather. Some replies were favorable and others adverse, the latter stating that for roundhouse use the gases affected them. The cost of an iron door such as mentioned above would be $50 for black iron and $60 for galvanized. An estimate on a wooden door furnished them was slightly under $80. of which $38 was for material and the balance for labor.

Mr. A. S. Markley (C. & E. I.) said they had abandoned the round top roundhouse door as the upper hinge had to be placed so low that warping and distortion were assisted thereby. Mr. G. W. Andrews (B. & O.) said it was hard to build large doors without wind and almost impossible to fasten them with the ordinary bolt. He described a method he used of having a rod run up the inside of one door and a simple arrangement of lever and hooks for forcing the other door to place.

Mr. Killam said the Intercolonial had abandoned the round top door and the windows in the door. The latter are placed above the doors, which are square topped. They have no trouble keeping these doors tight.

On the Duluth, Missabe & Northern, Mr. W. A. McGonagle said that on account of trouble from snow and ice they stop their roundhouse doors about 10 in. from the ground and place below them a timber notched over the track, which is separate from the door. On the Lake Shore they use a somewhat similar scheme. A plank is hinged to the bottom of the door and when the door is to be opened the plank is folded upward.

The report on "Best Method for Preserving Timber and Piles in Structures" was next considered. The report states the advantages of timber preservation and describes the different methods. It quotes Dr. Herman von Schrenk's statement of conditions to which the ideal preservative should conform, which is found in Bulletin No. 14, U. S. Department of Agriculture. An appendix contains the specifications of the U. S. Government and of the Bell Telephone Company for creosoting southern yellow pine; the specifications of the Norfolk Creosoting Company for creosoting timber; and some statistical information. The report is signed by W. F. Steffens and C. C. Witt.

In presenting the report Mr. Steffens read some letters for the purpose of showing that of the great amount of timber track structures on railroads in this country, the number containing treated timber is extremely small. He stated that the structural aspect of this question has not been as largely dealt with as some others. Impregnation by crude petroleum is in the experimental stage and is not far advanced. He thought it inadvisable from the structural standpoint, because it increases the inflammability of the timber. Replying to a question of Mr Reid, regarding the strength of creosoted yellow pine sap wood which beforehand has little strength, he said that tests by the Bureau of Forestry had showed an increase of strength, though the results were not regarded as conclusive and are to be carried further. The discussion of the subject by members developed nothing new.

Subject No. 12 was "Best Method of Protecting Low Overhead Structures Over Tracks from Gases and Blasts of Locomotives." Extracts from the report are printed elsewhere.

Mr. Steffens stated that they had had an experience similar to that related by Mr. Aldrich in the report, where the cement and expanded metal protection had dropped off. He asked about the practice followed by the city of Columbus, Ohio, namely, that of using

⅞-in. wooden sheathing. Mr. Reid said this was used in Buffalo, and although it protects from the cinders and the blast action, he did not think it protected fully against gases and steam.

Mr. Steffens reported that they think they have at last found the ideal protection. It is a coating which is a neutral pitch, and is a patented process. Tests have shown it to be acid proof and proof against temperature changes. It had also withstood tests against brine and caustic soda.

"Best Forms of Construction of Engine Houses" was next discussed. The report opens with a presentation of the advantages and disadvantages of rectangular engine houses and quotes rather fully from the paper by Mr. George P. Nichols on this subject, read before the Western Railway Club last February. Some rectangular houses are being built by the Pere Marquette and the transfer tables are described as follows: "The transfer table is designed with several special features, the end in view being absolute reliability and rapidity of service. The table is equipped with two motors with series-parallel controllers, the same as in use upon modern street cars, and in addition to the motor equipment an auxiliary gasoline engine has been provided, complete with air starter, for use in case of accident to the power plant or at times when the power plant could be closed down to advantage. The transfer table has a capacity of 175 tons, and will operate with a speed ranging from 200 to 800 f.p.m. when run by the two 25-h.p. motors. When operated by the gasoline engine it operates at about one-half normal speed. Rolling wood shutters are used for all the track doors opening on the transfer table."

A circular letter was sent to members asking questions and requesting drawings. Among the latter is one from the Gulf, Colorado & Santa Fe showing plans for a house to be used in southern Texas. It is exceptionally high, being 18 ft. at the side next to the turntable, 31 ft. on the opposite side, and 38 ft. at apex of roof. It is provided with a continuous louvre placed at the apex of roof and extending clear around the house. This takes the place of smoke-jacks, none of these being used. The slope of the main roof is ⅜ in. in 12 in. and the extra height is obtained by two vertical raises of about 5 ft. each; windows are provided at each of these points. The outside wall is pierced with windows clear to the roof. This plan results in exceptionally good light and ventilation.

Some of the replies to the circular letter are given in an appendix to the report. The report is signed by A. W. Merrick, Chairman; L. H. Wheaton, R. L. Heffiin, C. W. Kelley, C. C. Mallard, A. B. Manning.

Mr. Andrews (B. & O.) thought that all roundhouses should be on concrete foundations, have vitrified brick floors, a pit for every stall and a drop pit for every 10 stalls. Their roundhouses have all piping overhead and are equipped with a blow-off system, which quickly pays for itself they find. The stalls in the newest houses on the B. & O. are 90 ft. and at the rear of the pits is a lorry track for conveying locomotive parts. Telescoping swinging smoke-jacks are used. Referring to the rectangular design, he thought engines could be got out of the circular house much easier and quicker and that the circular house should be more economical of operation. Mr. Schall (Lehigh Valley) said he had built a rectangular house in 1884 which had a yard on each side and it proved expensive to operate.

There was no printed report on "Best Methods of Filling Ice Houses and Conveying Ice to Refrigerator Cars." A brief written report was submitted in which the committee expressed the opinion that for filling houses of 1,000 tons or less, horse power combined with hand labor is the most economical for lifting or elevating the ice. Above this, power should be used, an endless chain conveyor being the suggested method, where the source of supply is nearby or where the ice is taken from cars. To ice refrigerator cars, elevated platforms and dumping through the roof seem to be the most suitable means. Where crushed ice is used, the best practice is to have hopper "buggies" and elevated platforms, the ice being discharged from the buggy into the car.

Some description of methods in use by different roads and packing companies was brought out in the discussion. Mr. Shane (T., St. L. & W.) said they expected to put up a 25,000-ton icing station, and he saw no reason why some arrangement could not be devised by which a train of cars could be iced as quickly as a few cars. An idea that had occurred to him was to have a long elevated platform with pockets, which could be filled with crushed ice upon notification, before the arrival of the train. A member suggested that the pockets would have to be movable to provide for cars of different lengths and designs.

The written report on "Best Methods of Filling Track Water-Tanks Automatically" was brief. The committee thought that the pumping should be either by steam or gasoline engines, though the former is preferable, as it furnishes steam for heating the tanks in cold weather, and also where there is a roadside tank, one pumper can serve both. The water should pass from the roadside tank to the track tank by gravity, and feed pipes should be spaced 300 ft. apart to insure uniform filling. The supply should be regulated by a float valve in an auxiliary tank at one side.

Mr. Reid said the Lake Shore does not use the automatic cut-off and supply valve. They employ a "maintainer" who attends to the filling and removes from the tank the foreign matter that falls into it, and which would interfere with the action of the scoop. The automatic valve is too slow where trains are frequent. Mr. Steffens (N. Y. C. & H. R.) said they have the automatic valve in use at Croton, one of their busiest points, and it gives entire satisfaction, permitting the tank to fill in two minutes.

Two individual papers were presented during the convention. One was on "Cleanliness of Station Grounds and Buildings" by Mr. J. H. Markley (T. P. & W.). He suggested methods by which with the exercise of some care and watchfulness, right-of-way, yards, station grounds, buildings, etc., may be kept much cleaner and more presentable looking than is usually the case.

The other paper was entitled "The Evolution of Railroad Bridge Building," by Mr. W. H. Finley, Principal Assistant Engineer of the Chicago & North Western.

The subjects for next year are: 1. Construction and maintenance of docks and wharves. 2. Relative value of concrete and timber piles. 3. Concrete building construction, including platforms. 4. Anchors for plows and derricks. 5. Methods of repairing roofs of various kinds. 6. Methods of watering stock in transit. 7. Protection of water tanks and water pipes.

For the first time in its history the association will have standing committees, the subjects being as follows: 1. Pile and framed trestle bridges. 2. Steel bridges. 3. Buildings. 4. Docks and wharves. 5. Water supply. 6. Fire protection. 7. Fences, crossings and cattle-guards. 8. Preservatives for wood and metal. 9. Coaling stations and cinder pits. 10. Records and accounts.

The officers for the ensuing year are: President, C. A. Lichty (C. & N. W.); First Vice-President, J. B. Sheldon (N. Y., N. H. & H.); Second Vice-President, J. H. Markley (T. P. & W.); Third Vice-President, R. H. Reid (L. S. & M. S.); Fourth Vice-President, R. C. Sattley (C. & N. W.); Secretary, S. F. Patterson (B. & M.), re-elected; Treasurer, C. P. Austin (B. & M.), re-elected; Executive Committee, W. O. Eggleston, A. E. Killam, H. Rettinghouse, J. S. Lemond, W. H. Finley, C. W. Richey.

Pittsburg was chosen as the next place of meeting.

## Exhibits at the Convention of the Association of Railway Superintendents of Bridges and Buildings.

Following is a list of the exhibits at the convention:

American Track Barrow, Lowell, Mass.—Sample of the "Dandy" car and "Pony" car.

American Valve & Meter Co., Cincinnati, Ohio.—Catalogues and circulars of Poage water column.

Barrett Manufacturing Co., Chicago.—Samples of "Black Diamond" roofing and water proofing. Photograph of train shed of Dearborn Station, Chicago, covered with 1,600 squares of Barrett's three-ply prepared roofing; in service 12 years.

J. A. & W. Bird & Co., Boston and Chicago.—Samples of Rex "Flintkote" roofing and Magnite cold water paint.

F. W. Bird & Son, East Walpole, Mass.—Samples of Paroid roofing, Hydrex waterproofing felt and Neponset waterproof papers.

Boston & Lockport Block Co., Boston, Mass.—Samples of "Metaline" bushed tackle blocks.

Philip Carey Manufacturing Co., Cincinnati, Ohio.—Samples of Carey's magnesia flexible cement roofing, roofing paints and steam pipe covering. Catalogues and pamphlets.

H. Channon Co., Chicago.—Samples and photographs of steel and wood tackle blocks.

Cortright Metal Roofing Co., Philadelphia, Pa.—Samples of Cortright metal slates and Victoria shingles.

Paul Dickinson, Chicago.—Model of roundhouse equipped with movable telescoping smoke jacks, and cast-iron ventilators and chimneys.

Jos. Dixon Crucible Co., Jersey City, N. J.—Pamphlets describing Dixon's silica-graphite paint for the protection of steel.

Fairbanks, Morse & Co., Chicago.—Sample of Barrett No. 30 track jack. Small model of No. 8 direct-acting stand pipe. Catalogues, pamphlets and drawings.

Gifford Bros., Hudson, N. Y.—Working models of ice-handling machinery.

Heath & Milligan Manufacturing Co., Chicago.—Piece of steel plate painted with the company's protective paint, taken from North Western elevated structure, Chicago, after 8 years' service.

Illinois Malleable Iron Co., Chicago.—Small model and blueprints of the Bruyn automatic swinging smoke-jack.

Industrial Works, Bay City, Mich.—Blueprints and photographs of pile drivers and wrecking cranes.

Link-Belt Machinery Co., Chicago.—Photograph of 500-ton coaling station for B. & O. S. W. Ry.

Mann-McCann Co., Chicago.—Sectional model showing the Ravelin system for electric wiring roundhouses, blacksmith shops, foundries, etc.

The Miller Anchor Co., Norwalk, Ohio.—Model of the Miller anchor for derricks and wrecking purposes, and auger for setting same.

Geo. P. Nichols & Bro., Chicago.—Photographs and drawings of transfer tables, turntables and drawbridge machinery.

Otto Gas Engine Works, Chicago.—Blueprints and photographs of Otto standpipes, Otto tank valves and fixtures, gasoline coaling stations, and sand blast car. Samples of tank valve and Otto track jack.

St. Louis Expanded Metal Fireproofing Co., St. Louis, Mo.—Copies of book entitled "Corrugated Steel Bars as Applied to Steel-Concrete Construction."

Standard Paint Co., New York and Chicago.—Samples of "Ruberoid" roofing, P. & B. and "Giant" insulating and building papers and P. & B. paint.

Stowell Manufacturing & Foundry Co., South Milwaukee, Wis.—Samples of Wilbern door hangers, "Matchless" and "Climax" hangers and "315" baggage car door hanger; warehouse door latch.

Trussed Concrete Steel Co., Detroit, Mich.—

Samples of "Trus-Con" bars and Kahn trussed bars.

Variety Manufacturing Co., Chicago.—Working model of Cross horizontal folding door and Cross freight elevator door.

## The Haberkorn Valve Mechanism for Locomotives.

The Haberkorn Engine Company, Fort Wayne, Ind., maker of stationary engines with a steam distribution for which Corliss economy is claimed at high speeds, has adapted its valve mechanism to locomotive use also. In the accompanying illustrations Fig. 1 shows a sectional plan of valves and cylinder and Fig. 2 the operating and controlling gear. Two piston valves are used, one of which (the upper in the view) is the cut-off valve and the other the main or distribution valve. They are driven from the usual arrangement of eccentrics through a stationary double link and radius rods. The reverse lever is connected to the radius rod of the main valve through the usual reach rod, tumbling shaft and hanger. The radius rod of the cut-off valve is attached to a second tumbling shaft which is bored to receive the main tumbling shaft and is supported by the latter. The second tumbling shaft is connected by a reach rod to a crank shaft to which is keyed a worm segment enclosed in a casing. This is in the cab convenient to the engineman and has a dial and pointer for indicating the cut-off. The center is the "full-stroke" position, the cut-offs decreasing as the pointer is moved forward or back of this point. The cut-off valve is given $^{1}/_{16}$ in. negative lap. The indicator should therefore be in the central position for starting trains and for switching, as by reason of the negative lap and minimum travel of the valve it performs no function at all in this position, its cut-off being delayed until after the main valve has cut off.

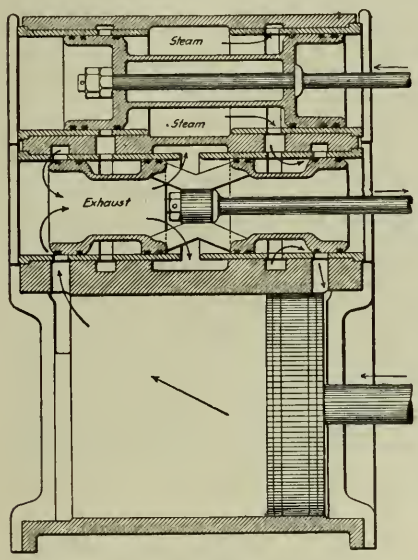



Fig. 1—Section through Valves and Cylinder.

The reverse-lever quadrant has but four notches—a full stroke, a running, a central and a back-up notch. The first gives a 90 per cent. cut-off, the second 75 per cent., and the back-up 80 per cent. In the running position, release occurs at about 90 per cent. of the stroke and exhaust closure, or compression, at about 80 per cent. This, of course, applies to the main valve only, without regard to the cut-off valve. It will be observed that the two valves receive their motion from opposite eccentrics. Should the gear be in forward motion with a short cut-off for instance, and it is desired to reverse the engine quickly, it would only be necessary to throw the reverse lever; for though the valves would then be moving in the same direction the travel of the cut-off valve and the influence of its negative lap are such that the main valve would control. A result obtained with the cut-off valve which is directly opposite to that given by the usual valve is that minimum slow travel produces a long cut-off and maximum fast travel a short cut-off.

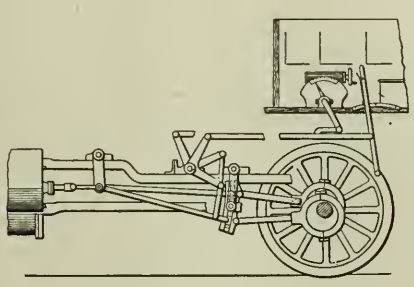
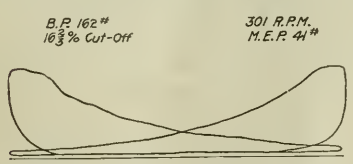


Fig. 2—Haberkorn Locomotive Valve Gear.

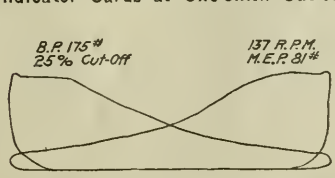
A Wabash locomotive with 18-in. x 24-in. cylinders and carrying 175 lbs. boiler pressure was equipped with this mechanism something over a year ago. It has 3½ per cent. clearance, and a 5-in. valve travel in full gear, which at 25 per cent. cut-off produces $^{5}/_{32}$ in. lead and $^{13}/_{16}$ in. port opening. The clearance given includes only that of the cylinder and the ports under the main valve. The steam space around the latter increases this clearance to 9 per cent., but this additional 5½ per cent. is in communication with the cylinder only during admission and expansion, affecting the curve of the latter favorably, and is cut off during release and compression. The volume to be filled during the latter event is therefore only 3½ per cent.

This locomotive has been tried in different kinds of service, and has been continuously in passenger service for 14 months. Two sets of indicator cards taken from this engine are shown, one of which was taken at 16⅔ per cent. cut-off, 301 r.p.m., position of reverse lever and worm gear being as shown in Fig. 2. The other was taken at 25 per cent. cut-off, 137 r.p.m., with ⅛ in. smaller nozzle than the first, which explains the higher back pressure. The load of the engine in both cases was five cars weighing 300 tons. Both cards show an excellent steam distribution with free admission, clearly-defined cut-off, a good expansion line, and late release and compression.

During the summer of 1903 this engine pulled daily, for three months, a train of six Pullman cars weighing 360 tons over a 105-mile division in 2 hrs. 13 mins., making five stops, on a consumption of 4,400 gals. of water and 4 tons of coal. Locomotives of the same type with ordinary valves used on the same run 6,600 gals. of water and 6 tons of coal. The Haberkorn locomotive, except at starting, was at no time run at greater than 25 per cent. cut-off, and often when running at speed this was reduced to 18 per cent., where road conditions permitted.




Indicator Cards at One-sixth Cut-off.




Indicator Cards at One-fourth Cut-off.

The directions to enginemen are to run with a full throttle and the shortest possible cut-off, which is easily and quickly regulated by the worm gear, even at high speeds. In view of the difficulty of shifting the reverse lever of ordinary gears at speeds above 30 m.p.h., especially on the large locomotives, this is a feature that is not only appreciated by the engineman, but is productive of the most economical operation of the engine by enabling the runner to readily and quickly change the cut-offs to meet the constantly varying conditions of the line. He does not have to touch his lever except to change to running position. The lever, however, may be shifted at any time with one hand.

The locomotive was equipped under the supervision of Mr. E. F. Needham, Master Mechanic at Fort Wayne. It has been in the shop for flue work and tire turning, but no repairs to the valve gear have been necessary. The valves for this 18-in. cylinder are each 8 in. in diameter and the parts of the gear are much lighter than those ordinarily used. Lost motion, which may be a seriously disturbing factor in the ordinary gear at short cut-offs, has no appreciable effect with this gear because of the large port openings.

## Train Accidents in the United States in September.[1]

unf, 2d, 1 a.m., Louisville & Nashville, Hubbard Springs, Va., a freight train was derailed by a landslide and the engine and nine cars were wrecked. The fireman was killed and two other trainmen were injured, one of them fatally.

rc, 3d, St. Louis & San Francisco, Rolla, Mo., freight train No. 37 ran into the rear of a preceding freight (No. 35), wrecking the engine and seven cars, most of which fell down a bank.

After the accident two passenger trains following these freights arrived and were set on a side track a short distance in the rear. The engine of the leading passenger train was run forward to pull back a part of freight train No. 37, and, on returning, backed violently into the baggage car of its own train, crushing one end of it; at the same time, the passenger train was pushed back into the engine of the second passenger train, doing considerable damage. This collision was due, it is said, to the misplacement of a switch. Fifteen passengers were injured.

bc, 6th, 4 a.m., Buffalo, Rochester & Pitts-

[1]Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defects of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

burg, Carman, Pa., butting collision of freight trains, making a bad wreck. One brakeman and one fireman were killed and three trainmen were injured. The conductor and engineman of the northbound train misread an order, calling "Carrier" "Carman."

†unx, 6th, Wabash road, Pendleton, Mo., a passenger train running at high speed was derailed and one passenger car and one dining car fell down a bank. Eight passengers were killed and 35 passengers and four trainmen were injured. The derailment occurred on a tangent, and careful investigation was made to discover its cause, but no evidence of defect was found, either in track or cars.

dn, 7th, 11 p.m., Pennsylvania road, Gallitzin, Pa., a freight train which became uncontrollable on the steep descending grade at that point was derailed and 20 cars fell down a bank. Two trainmen were killed and six injured.

†unf, 7th, Wheeling & Lake Erie, Chagrin Falls, Ohio, a mixed train consisting of an engine and nine cars, four of which were ahead of the engine, with a caboose in front, carrying one passenger, was derailed by running over a farmer's wagon at a crossing. The passenger and the conductor, who also was in the caboose, were killed, and two brakemen were injured. The man on the wagon was injured.

eq. 7th, 9 p.m., Chicago, Rock Island & Pacific, Tiskilwa, Ill., several cars in an eastbound freight train were derailed by the sudden stoppage of the train in consequence of the bursting of an air-brake hose, and a part of the wreck fell upon the westbound track.

†Westbound passenger train No. 11 came on immediately after and ran into the wreck, and the engine and several cars of the passenger train were badly damaged, the engineman not having time even to close the throttle. Two passengers and two employees were killed and 27 passengers and three employees were injured. None of the injuries were very serious.

bc, 8th, Norfolk & Western, Ardell, W. Va., butting collision of freight trains, wrecking both engines and 30 cars. A tramp was killed and one fireman was fatally injured. It is said that the collision was due to the mistake of an operator in delivering orders.

rc, 9th, Northern Pacific, Sand Point, Idaho, a freight train drawn by two engines ran into the rear of a preceding freight in the yard, wrecking both engines and several cars. A telegraph operator in the caboose of the leading train was fatally injured.

†unf, 9th, 1 a.m., Seaboard Air Line, Monroe, N. C., passenger train No. 41 was derailed just as it entered upon a trestle bridge 262 ft. long, and the whole train, except the engine and first two cars, fell into Catawba river or into the meadow adjoining the river. The engine crossed the bridge on the sleepers. The engineman, fireman and two passengers were killed and nine passengers and three trainmen were injured.

Every trainman being injured, no danger signal was sent back and in a few minutes an empty engine following ran into the chasm created by the wreck and fell on the passenger cars. The engineman of the empty engine was killed. The derailment of the passenger train was caused by malicious loosening of a rail.

bc, 10th, Buffalo, Rochester & Pittsburg, Mumford, N. Y., butting collision between northbound freight train No. 24 and a southbound train consisting of an engine and caboose. Three trainmen were killed and several others injured. It is said that the northbound train had disregarded a meeting order.

unf, 11th, 1 a.m., Central of Georgia, Ogeechee, Ga., a passenger train was derailed at a switch which had been maliciously misplaced and the engine was overturned. The fireman was killed and the engineman and two other trainmen were injured.

unx, 11th, 8 p.m., St. Louis, Iron Mountain & Southern, Arkadelphia, Ark., a dead engine in a freight train was derailed on a bridge and, knocking down the trusses, fell, with one span of the bridge and eight loaded cars, into Ouachita river.

unx, 11th, Vandalia Line, Collin, Ind., a work train broke through a trestle bridge, and four cars fell to the ravine below. The conductor and two brakemen were injured.

*rc, 12th, Atchison, Topeka & Santa Fe, St. John, Kan., rear collision of freight trains, wrecking engine and four cars. The wreck took fire and was mostly burnt up. One fireman and two brakemen were killed and the engineman was injured.

*rc, 12th, Wabash road, Paris, Mo., a freight train standing at a water tank was run into at the rear by a following freight, badly damaging engine and several cars. The wreck took fire and, with two spans of a bridge, was burnt up.

bc, 12th, Southern Pacific, Reno, Nev., butting collision of passenger trains, each drawn by two engines, wrecking all four engines and several baggage cars and passenger cars. A fireman and a coal passer were killed and 12 passengers were injured.

xc, 13th, Cincinnati, Hamilton & Dayton, Glendale, Ohio, a passenger train ran over a misplaced switch and into the head of a freight train standing on the side track, wrecking both engines and several cars. The passenger engineman was killed and the fireman fatally injured.

dn, 17th, Lake Shore & Michigan Southern, Chicago, Ill., a passenger train was derailed at a misplaced switch and the engine was overturned. The engineman and six passengers were injured.

xc, 18th, Long Island road, Long Island City, N. Y., collision of passenger trains, near the terminus, badly damaging one engine and several cars. Both firemen were killed. The collision is said to have been due to a misplaced switch.

bc, 19th, Baltimore & Ohio, Flushing, Ohio, butting collision of freight trains in a tunnel, wrecking both engines and several cars. Four trainmen were injured.

bc, 19th, Cincinnati, Hamilton & Dayton, Toledo, Ohio, butting collision of passenger trains; 30 persons injured.

dr, 19th, Union Pacific, Kansas Falls, Kan., passenger train No. 4 was derailed and all of the cars were ditched, one sleeping car being overturned; 11 passengers were injured. It is said that the track was undergoing repairs at the time and had been left insecure.

unf, 19th, Yazoo & Mississippi Valley, Mileston, Miss., a passenger train was derailed by running over a cow, and the engine was wrecked. The engineman was fatally injured.

unx, 21st, St. Louis, Iron Mountain & Southern, Sageeyah, Ind. T., a freight train was derailed and the engine was wrecked. The engineman was killed and the fireman injured.

unx, 21st. Norfolk & Western, Lockburn, Ohio, a passenger train was derailed and the engine was overturned. The engineman was killed and the fireman fatally scalded.

unf, 21st, Illinois Central, Barclay, Ill., a passenger train was derailed at a switch which had been tampered with, and several cars were ditched. The fireman was killed and the engineman and several passengers were injured.

bc, 21st, Buffalo & Susquehanna, East Nichols, N. Y., butting collision between a passenger train and a freight, overturning the passenger engine; engineman killed and two other trainmen injured.

xc, 23rd, 1 a.m., Missouri, Kansas & Texas, Lewis, Mo., a passenger train, running at high speed, ran over a misplaced switch and collided with a freight train standing on the side track, wrecking the engine and five freight cars. The engineman was killed and two passengers were injured. It is said that the switch was unlighted because the supply of oil had run out. The agent at the station had suddenly left and the duty of attending to the lights had devolved on the section boss.

o, 23rd, Baltimore & Ohio, North Branch, Md., a freight train was wrecked by the explosion of 850 lbs. of dynamite in a wagon which was being moved across the track in the face of the freight. In the explosion one trainman was killed.

†bc, 24th, Southern Railway, Hodges, Tenn., butting collision of passenger trains, resulting in the death of 59 passengers and trainmen and the injury of over 100 others, some of them fatally. The trains in collision were passenger train No. 15 westbound, from Bristol to Knoxville, and passenger train No. 12 eastbound from Chattanooga to Salisbury. The westbound traiu disregarded an order to wait at Newmarket for the eastbound. The engineman of the westbound is among the killed. A large majority of the persons killed were in the forward passenger cars of the eastbound train; these cars, being of lighter construction than the sleeping cars in the rear of the same train, were crushed by the latter.

†dr, 25th, 4 a.m., New York Central & Hudson River, Lock Berlin, N. Y., a westbound passenger train was derailed by a broken rail and three sleeping cars fell across the eastbound freight track. A freight train came along a moment afterward and ran into the wreck, demolishing the cars and injuring 25 passengers, one of them fatally.

†unf, 26th, Chicago, Burlington & Quincy, Elmwood, Ill., a passenger train was derailed by a washout and the baggage car and smoking car were wrecked. One passenger was killed and 15 were injured, three of them fatally.

*xc, 26th, Maine Central, Lewiston, Me., a passenger train ran over a misplaced switch and collided with a freight train standing on a side track, making a bad wreck, which took fire and was mostly burnt up. The parlor car was overturned. The engineman, fireman and mail agent were killed and two passengers and seven trainmen were injured, one of the latter fatally.

unf, 26th, Michigan Central, Linwood, Mich., a passenger train was derailed by running over a cow; engineman killed, two other trainmen injured.

dn, 27th, 2 a.m., St. Louis, Iron Mountain & Southern, Vulcan, Mo., passenger train No. 17 was derailed by running at high speed when entering a curve and several passenger cars were badly damaged; two of them fell down a bank into a stream of water; 34 passengers were injured.

unf, 27th, Chicago, Burlington & Quincy, Wheeler, Kan., a mixed train was struck by a tornado and both of the two passenger cars were thrown into the ditch; but they were not overturned and the passengers were not seriously injured. Several freight cars were wrecked.

bc, 28th, Western New York & Pennsylvania, Franklinville, N. Y., butting collision of freight trains, wrecking the engines and eight cars. One brakeman was killed. There was a dense fog at the time.

rc, 29th, Atlantic Coast Line, Charleston, S. C., an express train which was unexpectedly stopped was run into at the rear by a following local passenger train, damaging the rear car. It is said that the stoppage of the leading train was due to the accidental pulling of the bell cord by the porter of a sleeping car while making up a berth.

bc, 29th, New York, Ontario & Western, Preston Park, Pa., butting collision of freight trains due, it is said, to a misunderstanding of orders. The fireman was killed and three other trainmen were injured.

unx, 29th, New York, New Haven & Hartford, South Weymouth, Mass., a passenger train was derailed and the engine fell down a bank. The fireman was killed and the engineman and two other trainmen were injured, the engineman fatally.

dn, 29th, Norfolk & Southern, Elizabeth City, N. C., freight train No. 10 ran into an open draw, and the engine and one car fell to the bottom of the stream. It is said that the engineman was unable to stop the train because of a defect in the brakes.

### Locomotive Tests at St. Louis.

The locomotive testing plant of the Pennsylvania Railroad Company has been in operation since May 4 last, and the first official test was run on May 25. The accompanying table gives the general dimensions of the engines which have been subjected to tests up to date. The first engine tested was the Pennsylvania simple H6a standard consolidation freight locomotive. The second was the Lake Shore simple consolidation. The third was the Michigan Central two-cylinder cross compound consolidation, and the fourth was the four-cylinder tandem compound (2-10-2) freight locomotive of the Santa Fe. These first four engines are all used in freight service and the results of the tests should show the relative advantages of simple and compound cylinders for this class of service. The fifth engine tested was the de Glehn four-cylinder balanced compound owned by the Pennsylvania, and the sixth engine, the tests on which have just been completed, is the Santa Fe four-cylinder balanced compound built by the Baldwin Locomotive Works.

It is the intention, if time permits, to test several other engines before the close of the Fair, among which are the Cole four-cylinder balanced compound owned by the New York Central, the four-cylinder balanced compound built by the Hannover Machine Works of Germany, the Pennsylvania E2a standard high speed Atlantic type locomotive, the Michigan Central 4-6-2 simple passenger locomotive, and the New York Central simple Atlantic type locomotive.

Locomotives Tested at St. Louis.

| | Name of road. | Type of engine. | Cylinders. | Diam. of drivers, ins. | Total weight of engine, lbs. | Cylinder dimensions, ins. | Tubes. No. | Tubes. Diam., in. | Tubes. Length Ft. | Tubes. Length & in. | Grate area, sq.ft. | Heating surface, sq. ft. (outside). | Ratio heating surface to grate area. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. 1. | Penn. R. R. | 2-8-0 (H6a) | Simple | 56 | 194,200 | 22x28 | 373 | 2 | 13 | 8½ | 49.1 | 2,843.6 | 57.9 |
| No. 2. | L. S. & M. S. | 2-8-0 | Simple | 63 | 181,300 | 21x30 | 338 | 2 | 15 | 0 | 33.5 | 2,857.0 | 85.8 |
| No. 3. | Mich. Central | 2-8-0 | Two cyl. comp. | 63 | 189,000 | 23 & 33x32 | 363 | 2 | 15 | 7 | 49.4 | 3,181.0 | 64.4 |
| No. 4. | A., T. & S. F. | 2-10-2 | Tandem comp. | 57 | 285,740 | 19 & 32x32 | 393 | 2¼ | 20 | 0 | 58.5 | 4,817.3 | 82.4 |
| No. 5. | Penn. R. R. | 4-4-2 (de Glehn.) | Balanced comp. | 80⅝ | 162,000 | 14.1 & 23.7x25.2 | 139* | 2¾ | 14 | 5¼ | 33.4 | 2,656.0 (inside) | 79.5 |
| No. 6. | A., T. & S. F. | 4-4-2 | Balanced comp. | 73 | 187,000 | 15 & 25x26 | 273 | 2¼ | 18 | 1 | 49.4 | 3,029.0 | 61.3 |

*Serve tubes.

### Protecting Low Structures Over Tracks From Locomotive Gases and Blasts.

The report on this subject submitted to the meeting of the Superintendents of Bridges and Buildings at Chicago, October 19th, is made up of several letters, of which the following are extracts:

*New York, New Haven & Hartford.*—"We have a tunnel under a hotel where the hotel is supported by box girders, and the under sides of these girders were covered with expanded metal and two coats of cement plaster put on to this metal. We have had no trouble with the cement, but we have had trouble with the expanded metal rusting off and the whole thing falling down. When this was originally built this was put on with plenty of time for it to set up and get in good shape before any engine passed under it. The original coating has all fallen off, as I have said, on account of the expanded metal rusting off, and we had it put on again one year ago, and it has nearly all come off the second time. We have something like 70 regular trains which pass under this structure working steam. This structure is only about 250 ft. from where the trains stop at the station. They are long, heavy trains, and are working pretty hard. At the point where our cement plaster is located there is more or less moisture that gets into this from somewhere that seems to affect this expanded metal. I have about made up my mind that the best thing in a new structure is to provide metal enough to stand the wear of the blast, and put on paint that will take care of the gases by applying often enough so that the gases won't get at the iron. I have had better success with graphite paint for this kind of work than any other. There is no danger of the iron rusting out where you sand blast it off 70 times a day, as we do this. This structure is about 15 ft. above the top of the rails."—Grosvenor Aldrich.

*Boston & Maine.*—"I have no hesitation in saying concrete, in answer to the question as to the best material to be used for protection of any style of metal overhead bridge. The concrete to be made of Portland cement, and an aggregate not exceeding pea size. As to the best method of application: The concrete must be applied in some way so that it will be homogeneous and continuous throughout. Expanded metal under lower flanges is excellent to reinforce the concrete, but it must be embedded in the concrete at least one inch clear of the flange.

"Great care and very wet concrete must be used in conjunction in order to get a proper bond with the work above. If the under side of the flanges are packed first, and the edges of the expanded metal, or other bonding material, left exposed with the idea of being later packed in concrete arches or other filling, there will result a joint between the hardened concrete under the flange and the filling work that will admit engine gases which will rust off the reinforcing metal, and sooner or later the concrete below the flanges will drop off. This result has happened, and it gives a bad name to concrete protection, while the fault lies with the method of doing of the work rather than with the material or general method.

"Without doubt the best results would be obtained from a design of iron work that would admit a form of matched boards suspended by wires about two inches below the iron, and then to fill the whole with very soft, fairly rich, concrete. The outsides of girders or trusses should be covered as well as the inside.

"A great help to ordinary paint is a close sheathing of matched boards under the iron work, which presents a plane surface underneath. In this case the rush of air from the passage of the cars following an engine cleanly sweeps the gases from under the bridge so there is very little opportunity for the acids to get in their work. Where the floor is framed in the ordinary way, the smoke lingers a long time under the bridge until it cools enough to drop out of the pockets of the framework by gravity.

"The ordinary method of protection is by paint. This, for structures subject to engine gases, should not be made of metallic pigment of any kind. These gases where severe will cut the best lead paints as quickly as naked iron. Only inert pigments should be used. Carbon, graphite, or gums are not so affected."—J. P. Snow.

*Lake Shore & Michigan Southern.*—"I do not know of a thoroughly good protection against smoke, gases, and cinders which is practicable of application on overhead bridges. We are 'up against' that proposition hard on the Lake Shore, and have used paint in liberal quantities and at frequent intervals to endeavor to preserve our structures, but not with entire satisfaction up to the present, though we hope by more liberal and frequent use of first class paint to improve the conditions."—R. H. Reid.

*St. Louis Southwestern.*—"I consider the best method of protecting low overhead structures from smoke and gases and from blasts from locomotives is to keep the structures well protected with a good quality of paint. There are quite a number of paints specially made for protecting against locomotive smoke and gases that I believe would stand the test. I do not think it is practicable to cover them on the under side, as I would consider it a dangerous practice. The covering might become loose, and, by sagging, cause an accident to men on top of freight cars while trains are passing under, or it might fall on the train and do damage."—J. S. Berry.

*South Terminal, Boston.*—"In the train shed at the Boston Terminal, it is found that the cold condensed gases from locomotives do most damage, in some cases completely destroying 14-ounce copper in less than two years. Hot locomotive gases seem to have very little effect on the metal work where the latter is not exposed directly to the blast."—E. J. Beugler.

Mr. H. K. Higgins, Principal Assistant Engineer of the New York, New Haven & Hartford, writes as follows: "Only a small proportion of such surfaces will be subjected to blast action, usually not to exceed about 30 in. in width directly over the centers of tracks. The subject should therefore be considered under two heads: *A*, metal exposed to gas only; *B*, metal exposed to gas and blast action.

"*A.* Metal exposed to gas only, hot or cold, wet or dry, can be positively protected by coating it with any inert, incorrodible substance. Ordinary paint does not fill the bill. A coating of hot asphalt applied to heated iron has in some cases proved entirely effective. Care must be taken that the asphalt is so manufactured, or rather refined, that it will contain little volatile matter, and of such origin and quality that it will not grow brittle and crack. It is easy to fail in either direction. Asphalt cut or dissolved in fluids, such, for example, as carbon disulphide, and applied cold, drying by evaporation, leaves a porous coating, and is consequently of little value unless burned or baked on. Possibly some other substance could be found which would improve the mixture.

"Linseed oil, which forms the base of all ordinary paints, even when pure, is destructively affected by sulphurous acid. So, also, are most, if not all, varnishes. In many cases, however, especially of old structures, nothing but paint can be used, and it becomes necessary to make the best of a bad matter and use the best paint possible. Some experiments made eight years ago indicate the value of a paint made by adding powdered graphite to an ordinary red lead paint mixed as thick as brushes will work. The eight years' test shows that with not too

severe conditions such paint, two coats, will last eight, and possibly ten, or more years. The philosophy of it is that the red lead and oil form a cement which holds the graphite in place. The surface consists of graphite, which resists the action of acid and water as well as gas direct.

"Of course any paint must be applied to a clean surface. This is difficult to obtain, but a *sine qua non* for success. The deservedly much-lauded sand blast will do the trick, but it must be used with discretion. The sand will cut iron or steel surprisingly fast. Iron, when kept properly painted, should have little need of sand blast cleaning.

"*B.* The sand blast action of a locomotive exhaust adds a very serious complication. On lines of heavy traffic it will cut through a 1-in. pine board in three months. About 30 trains a day starting from a station stop will cut through 1½ in. of Portland concrete in about four years. Concrete reapplied will not last nearly so long.

"In a comparatively recent bridge near Boston the bottom flanges of I-beams were covered with a $^1/_{16}$ in. sheet of lead. This lasted some six months under very unfavorable conditions. Possibly a plate of say ¼ in. would be better, as it would tend to cushion the blast action. The writer would like to see this tried.

"Another promising possibility is a cloth —not felt or paper but woven fabric—composed largely of asbestos or similar fibrous incombustible material soaked in raw asphalt; that is, asphalt of decidedly sticky, pitchy nature. This should cushion the blast, protect the iron, be easily applied, and not too expensive. Either lead or asphalted cloth could profitably be limited to a width of say 30 in. directly over track center, as only there is the sand blast effect seriously destructive."

## Railroad Shop Tools.

(*Continued.*)

### RADIAL DRILLS.

The universal radial drill shown in the accompanying illustration, Fig. 1, is made by the Niles-Bement-Pond Company, New York. It is made in several different sizes, the one shown being the 7-ft. size which will drill to the center of a 14-ft. circle. The maximum distance between the spindle and the face plate is 79½ in. and the traverse of the spindle is 22 in. A 5-h.p. motor running at a constant speed of 900 r.p.m. drives the spindle through a positive mechanical speed-changing controller. This controller consists of an oil-tight box containing an adjustable revolving cage in which are mounted five sets of gears. By moving the controller handle to any one of the five index points on the outside of the box, the adjustable cage is moved into a corresponding position and one pair of gears engage with the motor pinion and a central pinion mounted on the shaft leading to the machine, thus giving the desired speed. All of the gears in the cage which are not in actual use, remain idle because of the eccentric mounting of the cage inside the box. The device is arranged so that the working gears run in oil.

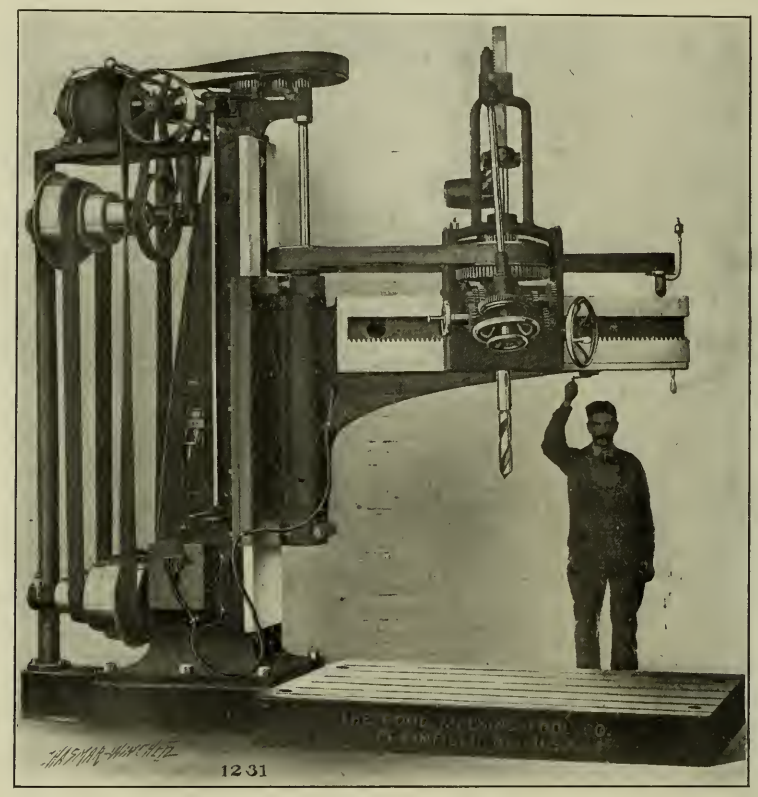



Fig. 2—Niles-Bement-Pond Plain Radial Drill.

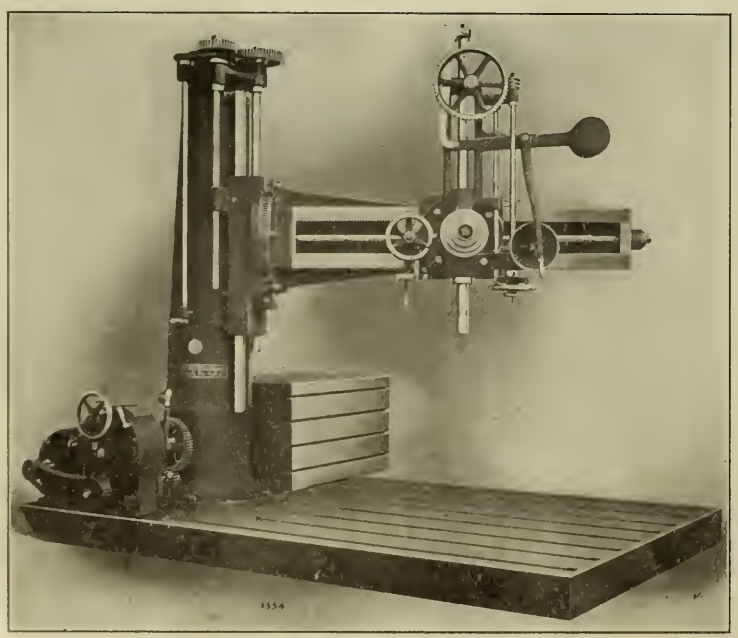


Fig. 1—Niles-Bement-Pond Universal Radial Drill.

Where a universal drill is not required, the 6-ft. plain radial drill, Fig. 2, made by the same company, is an efficient and useful tool. This machine has a wide floor plate, 9 in. deep, to which the upright column is bolted. The column has a broad flat wearing surface for the saddle which can be raised or lowered by power. The swinging arm is mounted on the saddle and has a vertical adjustment of 48 in. It is not necessary to clamp the saddle to the upright when drilling and for this reason the time lost by loosening and tightening the binder bolts is saved. The spindle, which is counterbalanced, has an adjustment of 18 in., and the maximum distance between its lower end and the floor plate is 89 in. The smallest radius of the spindle is 16 in. and the greatest radius is 72 in. From the face of the upright to the center of the drill, the minimum distance is 25 in. A rack and pinion movement is provided for raising and lowering the spindle and for the traverse of the saddle on the swinging arm. These are so arranged that the operator can control both movements and swing the arm at the same time. Six changes of spindle feed are obtained by means of an automatic friction feed device. The belt for driving the spindle runs over a pulley keyed to the upper end of the spindle and the back gears are arranged the same as on a lathe. When required for heavy drilling they can be thrown

in and out readily. A compact arrangement of motor drive is shown in the illustration of this machine.

The 5-ft. radial drill made by the Hamilton Machine Tool Company, Hamilton, Ohio, and shown in Fig. 3, has a base 60 in. x 115 in. in which T-slots for clamping are formed as shown. The column is of box section and is mounted on a heavy stump which extends up inside to the full height of the column. At the bottom of the stump is a circular anti-friction bearing so that the column can be easily rotated through a complete circle. A sleeve clamp is provided for clamping it in any position. The arm is also made with a box section and slides on flat bearing surfaces formed on the column. It can be clamped at any desired height and is provided with gibs to take up wear. The arm is raised and lowered by power, the operating lever being located on the column and held in place by a locking pin so that it cannot be shifted by accident. A coarse-pitch screw is used for raising the arm and it turns in a bronze nut. Ball-bearings are provided at the top and bottom of this screw to save power. The drilling head can be moved along the arm either by a power screw or by a rack and pinion turned by a hand wheel. By means of a fixed lever it can be clamped to the arm at any point in its traverse. The spindle is made of crucible-steel and is counterbalanced; quick advance and return feeds are provided which can be operated by power or by hand. Threaded jam nuts are placed on the spindle above the sleeve to prevent it from being forced away from the work when heavy undercutting or facing is being done and ball-bearings are also provided for taking up the end thrust of the spindle.

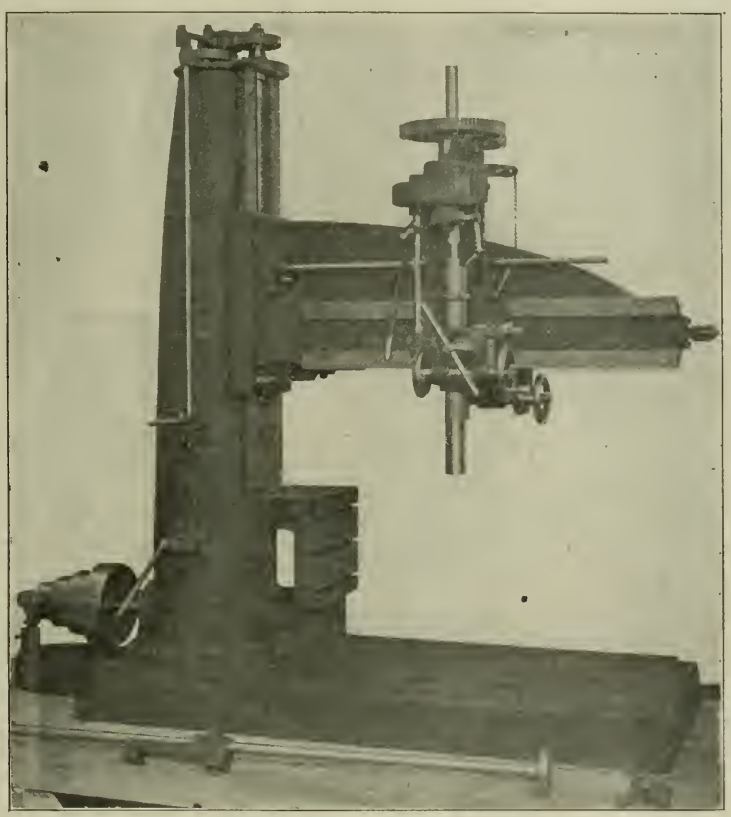


Fig. 3—The Hamilton Radial Drill.

The positive geared power feed used on this machine is shown in Fig. 4. It is enclosed in a cast-iron box and the changes of feed are produced by the two sets of gears driven directly from the spindle and operated by means of the two small levers shown underneath. The sliding shaft A, contains a movable key B, the corners of which are beveled so as to readily pass the adjacent gears when changing from one to another. By moving the shaft A, the key B can be engaged in any of the feed gears C, each of which is provided with four key-ways. The spring pin D is placed so as to constantly exert a pressure on the key sufficient to force it into the key-way whenever the two are opposite each other. The feed gears C are seperated by hardened steel collars so that the key must be entirely clear from one gear before it can engage another. Shaft A is hardened and ground and ample facilities are provided for oiling all of the working parts. The lower feed gears E, are friction driven, the object being to allow the gears to slip in case of a severe strain and thereby preventing damage to the gears to any other part of the machine. Six changes of feed ranging from .005 in. to .062 in. per revolution are provided by this mechanism for each of the spindle speeds. The feed worm is operated through a friction drive and can be quickly engaged or disengaged. The worm wheel is made of phosphor-bronze while the worm is of steel, and both are kept constantly immersed in oil.

An automatic stop is provided on the machine, which can be set for any desired depth by referring to the graduations marked on the spindle sleeve. The back gears are placed at the rear of the arm next to the column and are driven by a positive friction clutch

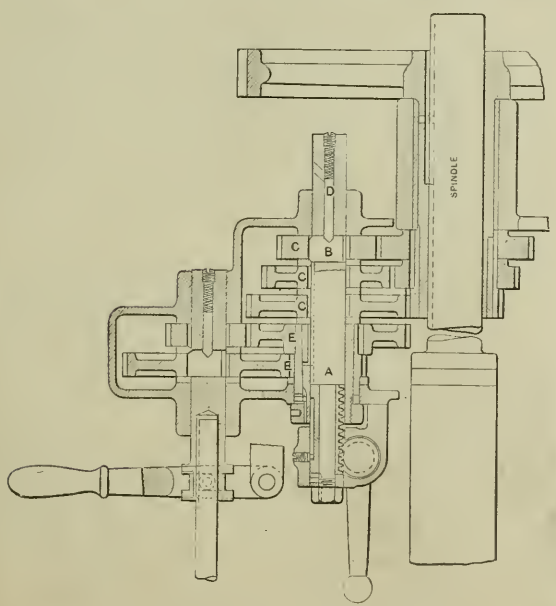



Fig. 4—Positive Geared Power Feed.

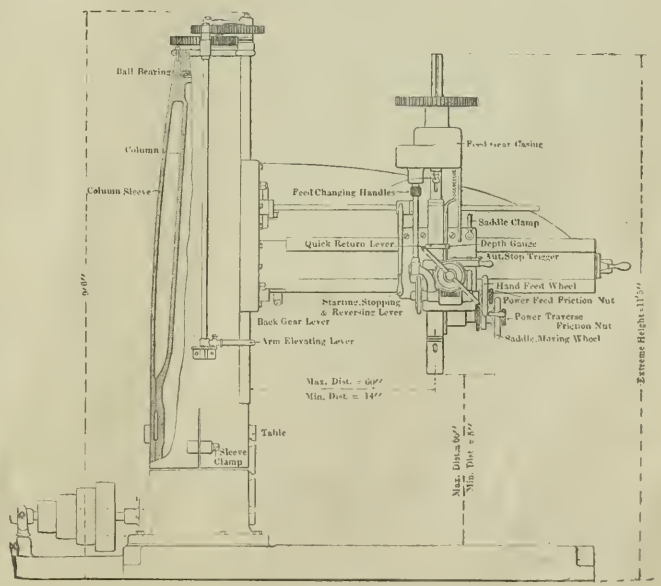



Fig. 5—The Hamilton Radial Drill.

which can be regulated to release at a given strain. The location of the operating levers is shown in the accompanying drawing, Fig. 5. The tapping device is arranged for both right and left-hand tapping. The upper lever is used for starting, stopping and reversing the spindle and the back-gear lever is used for producing slow back-gear speeds or fast belt speeds as desired. Thus, when tapping with back-gears engaged, after the tap has reached the required depth it is backed out at slow speed by shifting the upper or reversing lever, when, if desired, the back-gear lever may be thrown over, increasing the spindle speed and accelerating the return of the tap.

The machine is equipped with a plain box table, 22 in. x 22 in., which is provided with T-slots as shown. The principal dimensions of the machine are as follows:

| | |
|---|---|
| Extreme height of drill | 9 ft. 6 in. |
| Drills to center of a circle of | 120 in. |
| Greatest distance from spindle to base | 66 in. |
| Greatest distance from spindle to plain table | 42 in. |
| Least distance from center of spindle to face of column | 14 in. |
| Diameter of spindle, least section | 2 7/16 in. |
| Spindle bored to fit Morse taper | No. 5 |
| Traverse of spindle | 18 in. |
| Vertical traverse of arm | 40 in. |
| Horizontal traverse of head | 46 in. |

*(To be continued.)*

## Accident Bulletin No. 12.*

The Interstate Commerce Commission has issued Accident Bulletin No. 12 for the three months ending June 30, 1904. The number of persons killed in train accidents was 167 and of injured 2,378. Accidents of other kinds bring the total casualties up to 12,095 (677 killed and 11,418 injured). These accidents are classified in the following table:

*Table No. 1.—Casualties to Persons.*

| | Pass'rs Killed. | Pass'rs Inj'd. | Employees Killed. | Employees Inj'd. |
|---|---|---|---|---|
| Collisions | 10 | 761 | 68 | 538 |
| Derailments | 12 | 343 | 55 | 385 |
| Miscellaneous train accidents | 1 | 30 | 21 | 321 |
| Total train accidents | 23 | 1,134 | 144 | 1,244 |
| Coupling & uncoupling | .. | ... | 60 | 746 |
| While doing other work about trains or while attending switches | .. | ... | 31 | 2,459 |
| Coming in contact with over head bridges, structures at side of track, etc. | 2 | 11 | 16 | 271 |
| Falling from cars or engines or while getting on or off | 29 | 331 | 133 | 2,019 |
| Other causes | 3 | 386 | 236 | 2,826 |
| Total (other than train accidents) | 34 | 728 | 476 | 8,312 |
| Total, all classes | 57 | 1,862 | 620 | 9,556 |

In train accidents, the total number of killed, both of passengers and of employees, is less than in the corresponding quarter of the preceding year; and the same is true of employees both in train accidents and in other classes. The reduction in the passenger death list is gratifying, but the yearly tables, given below, show, unfortunately, a large increase which completely neutralizes the decrease for the quarter.

Of the total in the table below 176 collisions and 144 derailments affected passenger trains.

*Table No. 2.—Collisions and Derailments.*

| | No. | Damage.* | Persons Killed. | Persons Injured. |
|---|---|---|---|---|
| Collisions: | | | | |
| Rear | 235 | $196,322 | 14 | 276 |
| Butting | 136 | 321,588 | 39 | 552 |
| Train separating | 212 | 97,815 | 9 | 102 |
| Miscellaneous | 597 | 256,712 | 16 | 369 |
| Total | 1,180 | $872,437 | 78 | 1,299 |
| Derailments: | | | | |
| Defects of roadway | 234 | $161,114 | 5 | 208 |
| Defects of equipm't | 585 | 561,221 | 11 | 146 |
| Negligence | 58 | 47,249 | 7 | 42 |
| Obstruction: | | | | |
| Unforeseen | 71 | 111,966 | 15 | 94 |
| Malicious | 62 | 13,613 | 12 | 67 |
| Miscellaneous | 228 | 257,652 | 17 | 171 |
| Total | 1,238 | $1,142,815 | 67 | 728 |
| Total, col. and d. | 2,418 | $2,015,252 | 145 | 2,027 |

*To road and equipment.

Following is the usual list of Class A train accidents—all in which the damage is reported at $10,000 or over, notable cases in which passengers are killed, and those doing damage less than $10,000 and down to $2,000, wherever the circumstances or the cause may be of particular interest.

The accident most fatal to passengers in this record was a derailment (No. 7 in the foregoing table). The cause, however, was one which constantly recurs in the collision record—forgetfulnes on the part of an engineman. In this case the man at fault was killed. The circumstances show the weakness and insufficiency of the requirement—ostensibly a safeguard—that the conductor of a train, equally with the engineman (so far as possible), shall guard against disaster. This requirement is found in all rule books. Theoretically, the conductor, in this case, having in his possession a copy of the slow-order, could have had his mind on the matter, approaching the sidetrack, and his hand on the emergency brake valve with which every car is equipped, and thus could have stopped the train in spite of the engineman's failure to act. But, practically, this safe-

*Following is a list of the accidents which occurred in the year covered by this bulletin, with the number of persons killed and injured in each:

| | | Killed. | Injured. |
|---|---|---|---|
| 1. | July, '03, Rockfish, Va. | 22 | 25 |
| 2. | Aug., '03, Durand, Mich. | 22 | 15 |
| 3. | Oct., '03, Lambertville, N. J. | 17 | 35 |
| 4. | " Indianapolis, Ind. | 16 | 25 |
| 5. | Nov., '03, Kentwood, La. | 32 | 38 |
| 6. | " Tremont, Ill. | 16 | 20 |
| 7. | Dec., '03, Godfrey, Kan. | 7 | 21 |
| 8. | " Laurel Run, Pa. | 65 | 4 |
| 9. | " East Paris, Mich. | 18 | 57 |
| 10. | Jan., '04, Willard, Kan. | 18 | 37 |
| | | 233 | 277 |

No. 1 was a butting collision between a passenger and a freight; 2, rear collision of circus trains; 3, rear collision of work trains; 4, collision between passenger train and yard train; 5, rear collision of passenger trains; 6, butting collision, freight train and work train; 7, derailment of passenger train due to failure to give stop signal; 8, derailment of passenger train by accidental obstruction; 9, butting collision, passenger trains; 10, butting collision, passenger and freight

CAUSES OF TWENTY-SEVEN PROMINENT TRAIN ACCIDENTS (CLASS A).

[NOTE.—R. stands for rear collision; B., butting collision; M., miscellaneous collisions; D., derailment; P., passenger train; F., freight and miscellaneous trains.]

COLLISIONS.

| No. | Class. | Kind of train. | Killed. | Injured. | Damage to engines, cars and roadway. | Reference to record. | Causes. |
|---|---|---|---|---|---|---|---|
| 1 | B. | F. and F. | 1 | 2 | $1,150 | 32 | Collision between freight and work trains; work train pushing car ahead of engine; despatcher, 27 years' experience, overlooked eastbound extra when giving orders to westbound. |
| 2 | B. | P. and P. | 0 | 51 | 1,750 | 25 | Southbound train waiting on sidetrack as northbound train approached; a train porter, of three months' experience, became unaccountably confused and threw switch for sidetrack. Injuries slight. |
| 3 | B. | F. and F. | 0 | 0 | 2,175 | 58 | Conductor and engineman of extra train overlooked the fact that the time of regular train had been changed by new time-table issued that day. |
| 4 | R. | F. and F. | 0 | 1 | 2,200 | 23 | Block-signal operator (experienced) gave clear signal when block section was not clear. |
| 5 | R. | P. and P. | 3 | 21 | 2,700 | 1 | Engineman (experienced) ran past three automatic stop block signals; signals were 6,410 feet, 3,830 feet, and 1,330 feet back from point of collision; flagman also back 1,000 feet. |
| 6 | B. | P. and P. | 0 | 10 | 2,754 | 48 | Conductor of train No. 1 examined register and failed to note that train No. 2 had not arrived. |
| 7 | B. | F. and F. | 3 | 3 | 3,025 | 57 | Operator failed to deliver meeting order. |
| 8 | B. | P. and F. | 2 | 24 | 4,100 | 4 | Conductor and engineman, who had been on their trip only 15 minutes, overlooked meeting order. |
| 9 | B. | P. and F. | 0 | 17 | 6,430 | 52 | Engineman and fireman of empty engine overlooked meeting order. |
| 10 | B. | P. and P. | 0 | 27 | 8,691 | 53 | Conductor and engineman (experienced) forgot meeting order. Injuries of passengers slight. |
| 11 | M. | P. and F. | 0 | 3 | 9,500 | 11 | Cars of freight train left standing on main track while switching was being done on side tracks; engineman of freight in service only 2 weeks. |
| 12 | B. | F. and F. | 0 | 3 | 13,000 | 29 | Mistake of despatcher; sent conflicting orders when he could and should have used the "duplicate form," sending the orders to the two trains in the same words. |
| 13 | B. | F. and F. | 1 | 3 | 13,400 | 9 | Eastbound train had order to run 6 hours 20 minutes late; ran 6 hours 5 minutes late. |
| 14 | B. | F. and F. | 1 | 5 | 15,000 | 8 | Operator (experienced) reported that a train had not passed, when in fact it had, thereby leading to the delivery to another train of an order which caused collision. |
| 15 | B. | F. and F. | 1 | 1 | 15,000 | 59 | Engineman (who was killed) started from station, at beginning of trip, without order from conductor and without going to despatcher's office for orders as required by rule. Conductor, being in the office at the time, was left behind. |
| 16 | B. | F. and F. | 0 | 2 | 20,000 | 49 | Block signalman admitted westbound train to block section occupied by an eastbound train. |
| 17 | B. | P. and F. | 2 | 25 | 20,000 | 6 | Freight, waiting on a sidetrack, ordered to meet 3 trains, was started out after 2 trains had passed; conductor, engineman and flagman, while waiting, had slept, and on waking assumed that 3 trains had passed. |
| 18 | B. | P. and F. | 1 | 8 | 21,575 | 28 | Conductor and engineman of freight overlooked meeting point. (See further note in text below.) |
| | | Total | 15 | 206 | $162,450 | .. | |

DERAILMENTS.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | D. | F. | 0 | 2 | $5,603 | 19 | Brake-beam dropped and damaged air pipe; air-brakes became inoperative, and train ran away on steep grade. Men in charge had not complied with the rule requiring them to stop and inspect cars before descending grade, and also neglected to use hand brakes, in lieu of retaining valves, to partly control speed. |
| 2 | D. | F. | 0 | 0 | 8,500 | 39 | Air brakes on one car, unknown to trainmen, remained applied, and heated a wheel, causing it to break. |
| 3 | D. | F. | 0 | 0 | 10,000 | 18 | Broken wheel flange. |
| 4 | D. | F. | 0 | 2 | 10,165 | 14 | Defective spindle in switch, allowing switch to become unfastened. |
| 5 | D. | F. | 0 | 0 | 11,127 | 15 | Broken wheel. |
| 6 | D. | F. | 0 | 0 | 15,000 | 36 | Thirty-four cars derailed, of which 23 were wrecked. Believed due to drawbar pulled out; speed of train, 45 miles an hour. |
| 7 | D. | P. | 7 | 23 | 25,797 | 20 | Engineman (who was killed) overlooked order to reduce speed on entering sidetrack at small station where main track was obstructed. Engineman, of 30 years' experience, on duty 4 hours. |
| 8 | D. | P. | 1 | 6 | 30,000 | 67 | Occurred 10 p. m.; washout at iron pipe culvert, caused by unusually severe local storm. |
| 9 | D. | F. | 0 | 1 | 39,000 | 64 | Derailment, caused by broken wheel flange; occurred on bridge; derailed cars knocked down 2 spans of bridge. |
| | | Total | 8 | 34 | $155,192 | | |
| | | Total col. and der. | 23 | 240 | $317,642 | | |

guard fails in a large percentage of the emergencies which it is designed to provide for. The inadequacy of the requirement that the fireman shall be an assistant lookout man is also illustrated in this case. To be of sufficient value as a lookout to be relied upon firemen must not only be intelligent and experienced, but also must be trained in lookout duties.

In the collision record, the salient feature is the fact that three cases occurred on block-signaled lines. Two of these (Nos. 4 and 16) fortunately were unattended by fatalities; but the third, No. 5, killed three passengers. This case is somewhat similar to a notable one recorded in Bulletin No. 7 (January, 1903) where over 100 persons were killed or injured (23 deaths). In both cases the automatic block-signal equipment of the road was complete and in good order.

While, as in these cases, the block system, as used and administered on the best-managed railroads, does not provide against extreme recklessness or all kinds of gross negligence, and to that extent falls short of perfection, the roads not block signaled continue to fill the records with costly and fatal collisions, which the block system would undoubtedly have prevented. Nos. 1 and 12 in the present record were due to errors by despatchers—errors in work, the very essence of which is or should be constant watchfulness against errors. No. 8 records the forgetfulness of a conductor and an engineman whose minds had had only 15 minutes in which to lapse from their supposedly normal state of vigilance. No. 17 shows concurrent recklessness on the part of three men, or inexplicable dulness.

In No. 18 the engineman of the freight (who was killed) started out from a station on the time of a passenger train then due from the opposite direction. Either he forgot about the passenger train or assumed that a switching engine which had passed was the passenger train. The conductor of the freight, sitting in the caboose, heard the switching engine pass, but took no pains to identify it; the engineman having started the train immediately afterwards, the conductor then assumed that the switching engine was the passenger train.

The rest of the collisions in the table are no less worthy of attention, for they show costly blunders, which would be startling if they had not become so common.

YEARLY TABLES.

For the year ending June 30, 1904, the total number of casualties was 55,130 (3,787 killed and 51,343 injured). These totals are not comparable with those given in the Commission's Annual Statistical Reports, for the reason that the monthly reports deal only with accidents to passengers and employees while actually on duty. The monthly reports take no account of accidents to "other persons."

In Table B comparisons may be made of the totals of the principal classes of casualties. The large increase of 64½ per cent. in the number of fatal accidents to passengers (in train accidents) is but the record of a condition which has already been made familiar by the quarterly bulletins and by the daily newspapers month by month. This exhibit of the dangers of railroad travel is one which the most conservative must agree should be termed alarming, and each succeeding bulletin adds materially to the mass of evidence going to enforce the observations and recommendations which were made in the last annual report of the Commission.

TABLE A.—CASUALTIES TO PERSONS, YEAR ENDING JUNE 30, 1904.

| | Passengers | | Trainmen. | | Train-men in yards. | | Yard trainmen. | | Other employees. | | Total employees. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. |
| Collisions | 166 | 3,383 | 267 | 2,077 | 51 | 738 | 41 | 295 | 105 | 590 | 464 | 3,700 |
| Derailments | 103 | 1,422 | 229 | 1,078 | 20 | 196 | 20 | 201 | 16 | 264 | 285 | 1,739 |
| Miscellaneous train accidents (excluding the above), including locomotive-boiler explosions | 1 | 140 | 62 | 980 | 15 | 325 | 14 | 165 | 4 | 81 | 95 | 1,551 |
| Total train accidents | 270 | 4,945 | 558 | 4,135 | 86 | 1,259 | 75 | 661 | 125 | 935 | 844 | 6,990 |
| Coupling and uncoupling | .. | ... | 69 | 926 | 89 | 895 | 111 | 1,538 | 9 | 82 | 278 | 3,441 |
| While doing other work about trains or while attending switches | .. | ... | 51 | 4,788 | 48 | 2,279 | 40 | 1,815 | 69 | 1,779 | 208 | 10,661 |
| Coming in contact with overhead bridges, structures at side of track, etc. | 5 | 33 | 79 | 620 | 13 | 260 | 13 | 286 | 11 | 44 | 116 | 1,210 |
| Falling from cars or engines, or while getting on or off | 115 | 1,517 | 291 | 3,434 | 131 | 2,365 | 163 | 2,541 | 115 | 1,031 | 700 | 9,371 |
| Other causes | 30 | 1,582 | 133 | 559 | 120 | 412 | 86 | 398 | 882 | 10,224 | 1,221 | 11,093 |
| Total (other than train accidents) | 150 | 3,132 | 623 | 10,327 | 401 | 6,211 | 413 | 6,578 | 1,086 | 13,160 | 2,523 | 36,276 |
| Total, all classes | 420 | 8,077 | 1,181 | 14,462 | 487 | 7,470 | 488 | 7,239 | 1,211 | 14,095 | 3,367 | 43,266 |

TABLE B.—CASUALTIES FOR THREE YEARS.

| | 1904 | | 1903 | | 1902 | |
|---|---|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. | Killed. | Injured. |
| Passengers: In train accidents | 270 | 4,945 | 164 | 4,424 | 167 | 3,586 |
| Other causes | 150 | 3,132 | 157 | 2,549 | 136 | 2,503 |
| Total | 420 | 8,077 | 321 | 6,973 | 303 | 6,089 |
| Employees: In train accidents | 844 | 6,990 | 895 | 6,440 | 697 | 5,046 |
| In coupling accidents | 278 | 3,441 | 253 | 2,788 | 143 | 2,113 |
| Overhead obstructions, etc | 116 | 1,210 | 93 | 992 | 104 | 1,070 |
| Falling from cars, etc | 709 | 9,371 | 678 | 8,025 | 537 | 6,867 |
| Other causes | 1,429 | 22,254 | 1,314 | 20,759 | 1,035 | 18,615 |
| Total | 3,367 | 43,266 | 3,233 | 39,004 | 2,516 | 33,711 |
| Total passengers and employees | 3,787 | 51,343 | 3,554 | 45,977 | 2,819 | 39,800 |

TABLE C.—COLLISIONS AND DERAILMENTS.

| | 1904. | | | | 1903 | | 1902 | |
|---|---|---|---|---|---|---|---|---|
| | No. | Loss. | Killed. | Injured. | No. | Loss. | No. | Loss. |
| Collisions | 6,436 | $5,190,918 | 630 | 7,083 | 6,167 | $5,615,746 | 5,042 | $4,285,683 |
| Derailments: | | | | | | | | |
| Due to defect of roadway, etc. | 866 | $612,538 | 33 | 716 | 821 | $636,718 | 547 | $443,706 |
| Due to defect of equipment | 2,297 | 1,953,392 | 60 | 630 | 1,841 | 1,502,325 | 1,609 | 1,295,299 |
| Due to negligence of trainmen, signalmen, etc. | 333 | 302,592 | 41 | 355 | 297 | 230,907 | 255 | 136,241 |
| Due to unforeseen obstructions, etc. | 336 | 402,417 | 132 | 416 | 277 | 317,456 | 239 | 546,478 |
| Due to malicious obstruction of track, etc. | 110 | 102,717 | 19 | 196 | 71 | 157,290 | 57 | 63,246 |
| Due to miscellaneous causes | 913 | 818,503 | 103 | 848 | 1,169 | 1,136,535 | 926 | 874,753 |
| Total | 4,855 | $4,192,159 | 388 | 3,161 | 4,476 | $3,981,231 | 3,633 | $3,359,728 |
| Total collisions and derailments | 11,291 | $9,383,077 | 1,018 | 10,244 | 10,643 | $9,596,977 | 8,675 | $7,645,406 |

## Concrete and Concrete-Steel.*

It was about 1893 that the first important application of reinforced concrete, of which Monier appears to have had the first conception, was made in France. Since that time this new style of construction has been extensively used and its adoption seems destined to become still more general.

MATERIALS USED.

*Cement.*—Portland cement and other slow-setting cements are generally used in reinforced constructions. Lime is also used in the parts where the resistance or strength may be less, and quick-setting cements are used in the construction of pipes.

*Proportions of Sand and Gravel.*—Although silicious sands and gravels are preferable, those of calcareous nature may be used when the former are not available. The mixing is done in proportions varying as the sizes of the particles, and in order to reduce the voids to a minimum. In buildings, the usual practice is to add 300 kg. of cement to a total volume of 1.2 cu. m. of sand and gravel mixed, and it is assumed that, after losses at the mixing pans and after ramming, there is 1 cu. m. of concrete measured in place. In submarine works, the proportion of cement is increased to 500 or 550 kg. per cu. m., measured in place.

*Water Used in Mixing Concrete.*—Contractors, as a rule, use a concrete which is just moist enough to flow between the reinforcing members and coat them with cement, but, at the same time, is able to stand ramming. Some have advised the use of very wet concrete in moulds and forms perforated with holes through which the excess water can be drained; but several experiments have shown that the concrete thus made is greatly inferior as to its resistance and coefficient of elasticity.

*Metal.*—The cheapest quality of steel, having a strength of 40 to 45 kg. and an elongation of 20 to 26 per cent., is generally used.

ARRANGEMENT OF PRINCIPAL MEMBERS.

*Members in Tension.*—Until recently, the reinforced concrete was subject to tension in deflected members only. Lately, M. Vizentini used it in lattice girders, and the writer has used it in the construction of the chords and web members of the bow-string truss bridge tested to destruction at Ivry, Paris, in November, 1903. In both cases, the aim has been to give to the metal bars the same length as the members they reinforced, and in doing so, it was possible to obtain members which did not present sections of smaller resistance, such as are found in riveted members.

*Members in Compression.*—In France the practice is to reinforce compressed members with longitudinal bars or rods, connected at certain intervals by perforated diaphragms or by wires. In all calculations, the transverse ties are neglected, and the resistance of the metal is supposed to be added to the resistance of the concrete.

The upper chords of the Ivry bridge were designed differently. Helicoidal spiral rods were bedded in concrete near the surface, and against the inner face of these coils reinforcing longitudinal rods were placed. Several experiments and the Ivry test have proved that the spiral rods or hoops give to the core of concrete gripped within them a greater crushing strength—2.4 times greater—than the strength of longitudinal reinforcing members of the same weight.

Moreover, hooped concrete becomes about 20 times more ductile than concrete rein-

*Abstract of a paper by A. Considère, presented before the International Engineering Congress, St. Louis, October, 1904. Translated from the French by P. A. Seurot.

forced longitudinally, and, therefore, gives more surely and more completely the proper resistance of which it is capable, notwithstanding settlements of the abutments or the effects of expansion.

SLABS AND BEAMS SUBJECT TO FLEXURE.

Designers have endeavored to invent special arrangements, the description of which would be too long; only their essential differences will be mentioned herein.

*Longitudinal Reinforcements.* — Leaving out of consideration reinforcements latticed in some more or less rational way and skeletons built up of standard shapes and riveted members, the use of which has only a secondary importance in France, it may be said that, generally, the longitudinal reinforcements consist of round rods with smooth surfaces, and that the adhesion of the concrete is assumed to be sufficient to prevent slipping. Experiments have shown that such is generally the case under two conditions: good workmanship, and a relatively low ratio between the diameter of the rods and the span of the beams. It must not be concluded from this that bars with rough surfaces or with corrugations will not be useful, nor that the method of tying the longitudinal rods by transverse stirrups, as is done in foreign countries, could not be utilized.

Some designers have only reinforced along their whole length the lower fibers of members subjected to flexure, without trying to insure the resistance to tension of the upper fibers, above the supports, where bending moments of opposite direction to those existing at the middle of the span are developed. With this faulty disposition, serious breaks, not admissible in good construction, occur above the supports.

There are two rational types:

1.—In continuous beams the lower reinforcing members are generally carried throughout the entire length of the beams, and, in addition to these, upper reinforcing members are placed above the intermediate supports, the duty of which is to resist the negative bending moments.

The upper reinforcing members are extended throughout the entire length of the beams when the concrete has not strength enough to resist all the strains, or simply when it is found convenient to do so in order to fix the transverse ties.

2.—In the second type, recommended and used by M. Hennebique, only one-half of the lower bars extend horizontally for the entire length of the beams. The other half is found only at the center of the beams, along about one-third of their length and rise, at both ends, at such an angle as to reinforce properly the upper fibers above the supports. Besides the advantage of reinforcing the concrete, wherever it is subject to tension, without the help of additional rods, the bars so bent effectively resist all shearing stresses near the supports, where they are the greatest. On the other hand, this arrangement tends to lessen the compressive strength of the beams on the supports, which in certain cases may be detrimental. It is well also to note that the bars so bent are subject to tensile stresses along their entire length, and that, therefore, they tend to pull their extremities with all this concentrated effort, whereas straight bars are held by the adhesion distributed upon their whole length, and exert no pull, or very little, at their extremities.

To these few remarks, which refer alike to all deflected pieces, it is well to add a few words in reference to arches or floors.

Arches or floors carrying loads are generally reinforced only in a direction perpendicular to the direction of the beams. On the contrary, floors, such as street or bridge floors, which must carry heavy concentrated loads, are reinforced in two directions, perpendicular to each other. They are often divided into squares or slabs supported by two series of beams forming a grillage.

*Transverse Reinforcements.*—These reinforcements, the duty of which is to resist all shearing stresses, can be divided into three types:

1.—Vertical reinforcements, composed of flat or round iron wound in the shape of stirrups around the lower reinforcing bars.

2.—Bars alternately inclined at 45 deg. in two directions, as the diagonal members of a bridge truss.

3.—Bars inclined at 45 deg. but in one direction only ascending from the center toward the supports, that is, in the direction where the shear produces tension.

Theoretically, the last type is the most rational, but it is little used owing to the difficulty of keeping these inclined members in position during the concreting, when, after all, it is necessary to fasten their upper ends to horizontal metal bars generally doing no work whatever.

The second type adds to this trouble another, and that is the introduction of useless reinforcing members in the direction of the compression, which is easily resisted by the concrete. Vertical stirrups are used in France almost exclusively.

CALCULATION OF THE BENDING MOMENTS AND SHEARS.

In all armored or reinforced construction, this calculation is particularly difficult, owing to the fact that the component parts have become dependent upon one another, losing their identity in the whole. This solidarity of the component parts manifests itself in three distinct ways.

*Longitudinal Continuity.*—Floors, beams and girders are nearly always continuous over the supports. If they had everywhere an equal resistance to flexure, the stresses could be determined by the usual formulas for calculations of strength of materials; in other words, if $a$ were the common length of the spans and $p$ the uniformly distributed load per meter, the bending moment would be $^1/_{12}\ pa^2$ on supports and $^1/_{24}\ pa^2$ at the middle of the spans. But, in most constructions, the load bears only upon certain spans, and therefore the moment at a support may be much lower than $^1/_{12}\ pa^2$, whatever be the construction of the pieces, and the moment at the center of the spans may be much higher than $^1/_{24}\ pa^2$, so that the safety would be endangered in certain cases if the stresses were calculated by the above formulas. This is the reason why French designers assume that the safe minimum of the moment on the supports is only $^1/_{40}\ pa^2$, so that the resistance at the center must be based upon a bending moment of $^1/_{10}\ pa^2$. It is known that the moment would be $^1/_8\ pa^2$, if the fact that the beam is built in or fixed at both ends were neglected.

*Distribution of Concentrated Loads Between Parallel Members.*—This distribution depends evidently upon the relative values of the floors, slabs, or arches, of the beams and of the girders, and no general rule can be given. However, it is interesting to note that in the experiments made by the Commission for the study of reinforced concrete appointed by the Minister of Public Works in France, it has been discovered under various circumstances that the fatigue of beams or girders supporting concentrated loads was less than half what it should have been, were it not for the solidarity of similar and parallel members.

*Width of Arches or Floors Strained by Concentrated Loads.*—The Commission made no experiments in this instance. It is evident that the area of a floor containing two series of reinforcements perpendicular to each other, and strained—that is, under the influence of a load—depends upon the thickness of the concrete and the size of the reinforcements. For floors under roadways, having a thickness of 12 to 16 cm., it is generally admitted that concentrated loads can be uniformly distributed on a width of 1 m.

*Participation of the Arches and Floors in the Deflections of the Beams.*—The experiments of the French Commission were not made upon a sufficiently large number of constructions to permit final figures to be obtained; but, nevertheless, their results, give, perhaps, the most desirable and profitable data for the calculations. Very narrow floors or arches may be considered as being intimately united to and forming parts of the beams. The coefficient of participation is still 0.90 when the ratio of the spacing of the beams to their span is equal to 0.40, so that the width of the floor thoroughly conforming to the deformations of the beam is $0.90 \times 0.40 = 0.36$ of the span of the beams. If the spacing of beams increases beyond this limit, the effective work done by the floor does not increase much, and the equivalent width of floor does not seem to go beyond 0.40 of the span of the beams.

CALCULATIONS OF THE SIZES AND DEFORMATIONS OF REINFORCED BEAMS.

*Formulas More Generally Used.*—In calculating dimensions, M. Hennebique uses an empirical rule, which deserves a great deal of attention, owing to the very large number of constructions in which it has been successfully used. But some engineers who do not believe in using methods at variance with incontestable scientific principles, do not accept it because it is based upon the hypothesis of the inequality of the two opposite components of the couples of flexure. In practice, the result of the empirical formula mentioned above is to give, for tension and for parts subject to tensile stresses, values from 5 to 20 per cent. lower than those found with the other formulas.

It appears that M. Coignet was the first to publish in France a theoretical study of the strength of armored concrete, in which he applied to the calculations of bending stresses the hypothesis of the conservation of plane sections, which serves as the basis of the science and study of the strength of materials. He has neglected the tension in the concrete because it does not appear in fissures.

M. Christophe has taken up the same hypothesis in his important treatise, "Le Béton Armé et ses Applications" (Armored Concrete and Its Applications). He has corrected an error pertinent to the position of the resultant of pressures, and has taken 10 as the ratio of the coefficient of elasticity of metal and concrete. He very ably deduced from these hypotheses, formulas which apply to the various problems the designer has to solve.

*Results Obtained and Consequences.*—The writer thought advisable to study the properties of armored concrete, and, first of all, the effects of setting in relation to the volume; that is, its contraction, the internal stresses developed, and the production of fissures or cracks.

Afterward, he found that armored concrete when intact, or the concrete of blocks or portions separated by fissures, can withstand greater elongations than those which break ordinary unarmored concrete, and that, in these supplementary deformations, the coefficient of elasticity of the concrete is practically nothing.

He proved that the hypothesis of conservation of plane sections, although wrong in itself, gave results accurate enough to calculate all bending moments, except in the immediate vicinity of heavy concentrated loads.

In order to draw from these facts conclusions referring to the calculation of armored constructions, it is enough to recall the well-known fact that the coefficient of elasticity of concrete under compression decreases very much before rupture happens, especially in deflected beams where there is, before rupture, a decided shortening. This must be borne in mind in all calculations of resisting moments and breaking loads, and, consequently, of safe working loads proportional to this resistance or strength.

From this the following conclusions can be drawn:

*Longitudinal Reinforcements and Concrete.*—For preliminary calculations or deductions following the deformations, it is necessary to take into account the tensile stresses of the reinforced concrete, and the nullification of its coefficient of elasticity beyond the elastic limit.

For calculating the sizes, there is an added factor of safety in neglecting not only the uncertain help given by the tensile strength of the concrete to the resistance or strength of the reinforcing members, but also the fact that the neutral axis has been lowered, as a certain consequence of the tensions developed even in fissured concrete. One is thus compelled to adopt M. Christophe's formulas by giving to the ratio of the coefficients of elasticity a value equal to 15 or even 20, instead of 10, in order to take into account the diminution of the coefficient of elasticity of concrete compressed before rupture.

*Transverse Reinforcements.*—Some designers assume that the transverse or inclined reinforcements ought to resist alone the sum of all shearing stresses. Others think that for floors, slabs, or flat arches, almost invariably poorly reinforced, and resisting, in consequence, only low shearing strains, concrete and the longitudinal reinforcements are sufficient to take care of these strains without the additional help of stirrups. On the contrary, all designers seem to be of one accord in reinforcing transversely all beams, because the concrete filling does not always adhere to the floor girders.

## Railway Signal Association.

The annual meeting of this association was reported in the *Railroad Gazette* of October 21, with the exception of the discussion of the standard specifications for manual interlocking machines and material, as proposed by the committee on that subject. The subject was found to develop so much discussion of details that the meeting got no farther than through the "General requirements." At the end of that chapter the report was laid on the table, with a view to continuing the discussion at subsequent meetings. Mr. Christofferson, the chairman, reported that he had been unable to get the members of the committee together for adequate discussion of the subject and that therefore the conclusions reported had been reached by correspondence. This naturally left many paragraphs in less finished form than would be desirable, and numerous points which could readily be settled in a committee meeting were brought up for discussion in the general meeting, so that the association practically spent two or three hours in "committee of the whole." The principal points discussed were the following:

The clause referring to free transportation of material was made to read *necessary* men, tools and material, some members having found that they had transported long distances for a contractor material used on another road. The proposition having been made that clauses which are liable to frequent change should be omitted from standard specifications, Mr. Ten Eyck suggested that the proper rule was to make the specifications as full as possible and have each clause so worded that the changes most frequently desired could be made simply by erasing words. Paragraph No. 4 was amended so as to read, "the purchaser will do all necessary *draining*, grading and blasting, and also provide all necessary permits for building tower." The association voted down a proposition to amend this paragraph so as to require the purchaser to furnish insulating rail joints and rail braces. Paragraph No. 8 was revised to read, "all threads must be United States standard unless variations therefrom are permitted by the purchaser. . . .".

It was voted that the fiscal year of the association shall hereafter end on September 30. President Mock appointed a committee to inquire into the efficiency of long burning lamps, and to report on the most suitable illuminating oils, of which Mr. C. C. Rosenberg (L. V.) is chairman. Mr. P. G. Ten Eyck (N. Y. C.) takes the place of Mr. Balliet as chairman of the Committee on Line Wires, Mr. Balliet having been chosen Secretary of the Association.

## Steam Hammers vs. Drop Hammers for Pile Drivers.

Two reports, a majority and a minority report, were submitted on this subject to the Association of Railway Superintendents of Bridges and Buildings at the Chicago meeting. The majority report was, in part, as follows: The superiority of the steam hammer for some classes of work, such as foundation work under buildings, piers, etc., is apparent; while for road work, those who are using steam hammers would not exchange them for drop hammers under any circumstances. In the city of Chicago where, perhaps, more piles are driven for foundation work than anywhere else in the United States, steam hammers are used almost exclusively. The Illinois Central has steam hammers in use for foundation work and also uses them in driving falsework from the ground. They are said to have given most excellent service. The C. & E. I., the Santa Fe, and the Fort Worth & Denver all use steam hammers successfully in road work.

The committee believes the steam hammer is the best type of hammer for all kinds of pile driving, and when used with a bonnet makes pile driving a comparatively easy job. Piles can be driven without injury to the pile in almost any kind of earth with a steam hammer, where it would be rent from head to point by a drop hammer. The pile is held much more firmly under the steam hammer, and is guided home in much better fashion than can be accomplished with the drop hammer; besides there is not the injurious strain upon car and machinery that is felt from the drop hammer.

The cost of maintenance is much less for the steam than for the drop hammer, and the cost of driving piles is also much less. The first cost of the steam hammer is, of course, much greater, but it is a good investment notwithstanding.

The report is signed by O. J. Travis, Chairman; N. H. LaFountain, F. J. Leavitt, G. O. Lilly, H. Rettinghouse.

The minority report is by Mr. R. H. Reid, of the Lake Shore. He says: "I think for very hard driving, such as hard clay and hard pan, and in some cases for very soft driving, that the heavy drop hammer is the best, as it has enough energy in its blow to break the hold of the pile in the earth and force it down, where many times a steam hammer will not do this. I have seen a steam hammer bang away on the tops of piles until they were completely worn off and got so hot that they even took fire, but still would not go down. I think, also, that a drop hammer is more convenient to handle than a steam hammer, in a road driver, as the steam hammers are so very heavy that the driver needs lots of counter-weight to balance it when it is swung. Also, they are so long that very long leaders must be used in order to get piles under them, and with a heavy hammer at the top of the long leaders the machine is very likely to tip over on the track with much elevation or a track which is very much out of surface, as the tracks frequently are where work is being done. If I could only have one hammer for general railroad pile driving I would prefer a drop hammer to a steam hammer, as I think the work in general can be done cheaper, everything considered, with a drop hammer than with a steam hammer. I understand, of course, that a steam hammer is very desirable in some kinds of work, but for a single hammer I would prefer a drop hammer.

"In regard to using a bonnet with a steam hammer, this same piece of head gear can be used fully as well with a drop hammer, and will take up proportionately less of the energy of the blow of a drop hammer than of a steam hammer."

The following communication from Mr. A. S. Markley, of the Chicago & Eastern Illinois, was appended to the report.

During the past year the Chicago & Eastern Illinois bought a new pile driver from the Industrial Works, Bay City, Mich., with steam hammer. The hammer and frame complete weighs 5,170 lbs. The hammer alone weighs 2,840 lbs.; drop of hammer, 28 in. In a recent test made with this hammer it developed the following: Sixty-six blows for 1 ft. penetration with steam hammer, time 1 minute; 83 blows for 1 ft. penetration with steam hammer, time 1½ minute.

After making the above test the drop hammer weighing 2,900 lbs. was placed in the leads with a drop of 32 ft. with the following results: Twelve blows 1 ft. penetration with drop hammer, time 2 minutes; 10 blows 1 ft. penetration with drop hammer, time 2 minutes; 10 blows 1 ft. penetration with drop hammer, time 3½ minutes; 12 blows 1 ft. penetration with drop hammer, time 2½ minutes.

We then removed the drop hammer and replaced the steam hammer, with result given below: Two hundred and three blows 1 ft. penetration with steam hammer, time 3 minutes; 341 blows 9 ft. penetration with steam hammer, time 5 minutes.

These tests were all made on the same pile and at the same time just as quickly as the change in the hammers could be made.

With our experience in the past nine months with steam hammers there are several reasons why they are much better than the drop hammer. The effect is equal if not better than the drop hammer and requires no toggling; when the pile is once placed in the leads the hammer resting on it holds it in line, while with the drop hammer a great deal of toggling is necessary.

With the hammer we have a pile can be driven 7 ft. below the base of rail. With this arrangement, by using a little care, piles can be driven to their proper depth without being sawed off to put on the cap for temporary work. This we have done in a number of cases with good results and considerable time saved. In several cases where the piles after being driven the tops of which were of uneven surface, after the cap had been placed on them, the steam hammer was set on the cap, and pile driven so that the cap had a uniform bearing on all of them. With the steam hammer driving the top of piles below the rail, which cannot be done

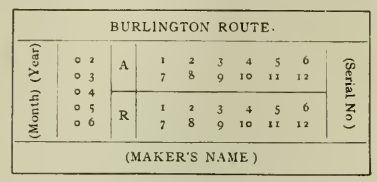
with any certainty with the drop hammer, there is from 2 to 3 ft. of pile saved on every pile driven, which in the course of a year means considerable saving, not only in the length of piles but in the hammer lines, piles, rings, and time.

In the test just referred to it required a great many more blows with the steam hammer to drive the pile 1 ft. than with the drop hammer, with the latter falling the full length of the leads, 27 ft. The piles were driven just as firm and penetration just as deep with the steam hammer as it could be done with the drop hammer. I believe everything is favorable to the former, with the additional advantage that the steam hammer does not damage the pile on the end and does not require it to be banded, which saves considerable money in this direction. It makes no difference where the head of the pile is in the leads with the steam hammer. It is just as effective one place as another. The longer the piles in the leads the less the drop of the hammer and less effect the hammer has on the pile. With our experience with the steam hammer we can drive four piles with it to where we can drive two with the drop hammer.

## Specifications for Air-Brake Hose.*

The former M. C. B. standard specifications for air-brake hose, which were superseded by new specifications at the last convention of the association, called for a three or four ply hose to be made of a good grade of rubber and canvas, canvas layers to be strongly frictioned or cemented together and the inside rubber tube to have a high degree of stretch. The Burlington, not being satisfied with these specifications, drew up a different set, which called for a lower grade of rubber for the inner tube and friction layers between the canvas. This was done because experience on that road and elsewhere had shown that by far the largest proportion of hose was rendered unfit for service because of external mechanical causes and not through failures that might be attributed to the quality of materials used. The function of air-brake hose is to retain air under pressure without leakage, and to do this successfully the inner tube must be made of a fairly good grade of rubber without serious imperfections of continuity, the canvas layers must hold together reasonably well and there must be a sufficient number of layers to resist severe external mechanical usage, such as chafing, bruising, etc. Of course, other things being equal, a high grade of rubber is an advantage from a mechanical standpoint, but in practical the only real effect is to increase the cost of hose from 25 to 40 per cent.

In order to get more definite and positive information on which to base the new specifications, the Burlington made some laboratory and service tests of several brands of air-brake hose to determine, if possible,




Label for Air Hose, C., B. & Q.

the relationship between ordinary laboratory tests and service performance. For this purpose twelve lengths, each 122 in. long, of six different brands of air-brake hose were obtained, and one length of each brand was retained to make laboratory tests to represent the original condition of the material. The other lengths were applied to suburban passenger cars, each length having a brass tag fastened to it, showing its individual number and the following marking: "Test Hose No. ———. Return to Laboratory, Aurora, Ill."

Samples were called in at intervals of six months and subjected to the regular laboratory tests. The laboratory tests were the usual ones, consisting of determination of the friction of canvas layers, stretch of inside rubber tube, permanent set taken by rubber, bursting pressure and observations concerning the condition of the hose. The friction of the hose was determined by taking a section of hose 1 in. wide, placing it on a roller 1¼ in. in diameter and attaching a 25-lb. weight to a loosened end of the canvas. The friction was determined by the time it took for the weight to unwind a length of 12 in. The stretch of rubber was determined by measuring the length to which 1 in. of the inside tube, 1 in. wide, would stretch before breaking. This differs from the present method of making and expressing results of stretch in that at present a length of 2 in. is used, and the stretch is expressed in per cent. The permanent set was determined by first stretching the rubber to nearly its maximum length, releasing, and then placing gage marks 1 in. apart on it. The rubber was stretched to nearly its maximum length for ten minutes, released ten minutes, and the increase of length then measured. The bursting pressure was determined by means of water pressure, using a hand pump. The bursting pressure, friction and stretch are shown in Fig. 1. It will be noted that the original samples of the brands tested, range in friction from 1 second to 40 minutes, in stretch from 2½ in. to 7 in. and in bursting pressure from 650 to 825 lbs. per sq. in.

The most striking point shown by the plotted results is that, although some samples of hose have high initial friction, this friction dropped away quickly, and seems to bear no relation whatever to the bursting pressure which the hose maintains or to the stretch of the rubber. These results seem to indicate that just as good service may be expected from a hose having low friction and low stretch of rubber if the hose is substantially made, as can be expected from a hose giving high results in these two particulars.

From the results of these tests, covering almost three years, the Burlington drew up the following specifications for air-brake and signal hose, which are known as 15B, and are dated October 31, 1903. Hose is now being bought in accordance with them:

1. Air-brake and signal hose must be four-ply and the inner tube not less than 3/32 in. thick. Each length must be 22 inches (variations of ¾ in. being allowed) and capped with rubber, vulcanized on each end. The wrapping must be frictioned on both sides and must have a distinct layer of rubber between each ply.

2. The inside diameter of air-brake hose must be not less than 1¼ in. nor more than 1 5/16 in., and shall have enlarged ends as follows: For a space of 3 in. from the ends the internal diameter shall be not less than 1⅜ in. or more than 1 7/16 in. The inside diameter of signal hose must be not less than 1 in. or more than 1 1/16 in. and shall have enlarged ends as follows: For a space of 3 in. from the ends the internal diameter shall be not less than 1 5/32 in. nor more than 1 7/32 in.

3. Each standard length of hose must bear label like the one shown below. In the left-hand space must appear the month and year of manufacture, in the right-hand space the serial number and in the bottom space the manufacturer's name. The figures enclosed are for use in marking the date of application and removal. The figures must be not less than 3/16 in. in height and stand in relief not less than 1/32 in., so as to be readily removed by cutting without endangering the cover tube.

4. Air-brake and signal hose will be ordered in lots of 200 or multiples thereof. Each lot of 200 must bear a manufacturer's serial number, commencing with 1 on the first of the year and continuing consecutively until the end of the year. For each lot of 200 hose ordered 201 must be furnished. On receipt of shipment one piece from each lot will be submitted to the following tests:

5. *Bursting Test.*—A section 3 in. long will be cut from one end of the test hose and the remaining 19 in. will be mounted on standard nipples and must stand an hydraulic pressure of 150 lbs. per sq. in., under which pressure it must not expand more than 3/16 in. in diameter, and subsequently must stand 500 lbs. hydraulic pressure per sq. in. for ten minutes without bursting.

6. *Stretching Test.*—A section of the inner tube,

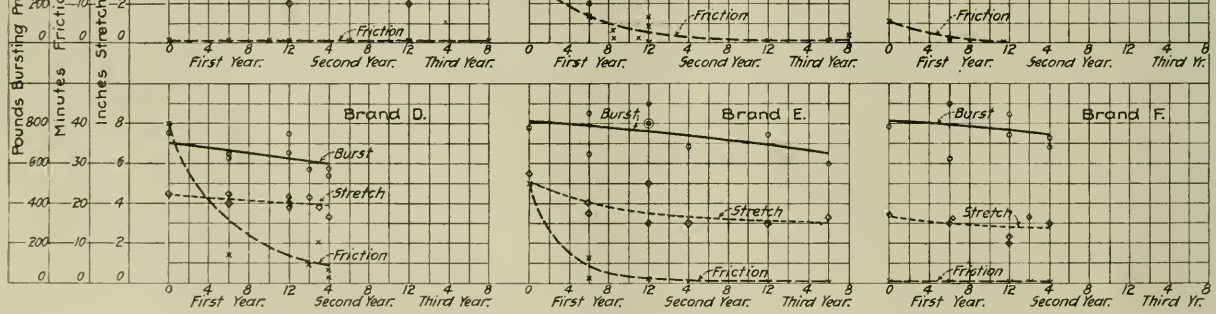



Fig. 1—Friction, Stretching and Bursting Tests of Air Brake Hose.

*Abstract of a paper read before the American Society for Testing Materials at Atlantic City, N. J., June, 1904, by M. H. Wickhorst, Engineer of Tests, C., B. & Q., Aurora, Ill.

1 in. wide will be stretched 300 per cent. and then immediately released. Marks 2 in. apart will then be placed on it, the rubber stretched 300 per cent., or so the marks are 8 in. apart, held for ten minutes, then released for ten minutes and elongation noted. The rubber must stretch 300 per cent. for ten minutes without breaking, and must not take a permanent elongation of more than ¼ in.

7. Material failing these requirements will be rejected and disposed of as manufacturers may direct at their expense.

It will be noted that the Burlington specification differs materially from the former M. C. B. specifications in the following particulars:

*First*—It requires no test for friction of canvas.

*Second*—Instead of calling for stretch of 400 per cent., it calls for only 300 per cent.

*Third*—The bursting pressure is about the same.

In order to fully meet the M. C. B. requirements, a much higher grade of rubber is required in the inner tube and between the canvas layers than is necessary for the service to which the hose is put, resulting in an increase of cost to the railroad company of from 25 to 40 per cent., with apparently but little if any increased service from the hose.

The Burlington has been buying hose to its own specification since January 1, 1903, and in order to have some fairly definite information as to the performance of specification hose, a record was started of all such hose removed from service. All hose removed from the C., B. & Q. R. R. division of the Burlington System is shipped to the store at Aurora, Ill. When received here it is looked over by a laboratory inspector and record made of each length of hose on a card form 3 in. x 5 in., as shown below:

*Air Hose Failures.*

Maker. Class, Most Serv.,
In serv., Date Made, Out serv., Serial No. Rec'd at Lab.
A. B. or Sig.,
Descriptive of failure,

Instructions for making out this record and tabulation of the results are as follows:

BURLINGTON ROUTE LABORATORY, AURORA, ILL.

*Air Hose Failures.—Methods of Keeping Records and Tabulating Statistics.*

1. For each sample of failed air-hose received at the laboratory or Aurora Store fill out a printed card 3 by 5 in. provided for the purpose.

2. Hose failures should be classified as follows:

*Due to External Causes. Due to Quality of Hose:*

A—Torn apart.
B—Chafed.
C—Cut.
D—Bruised at nipple end.
E—Bruised at coupling end.
F—Kinked.
G—Unclassified.
H—Defective inner tube.
I—Defective outer covering.
J—Defective wrapping.
K—Unclassified.

3. The cards should be classified in the file as follows:

*First.*—By periods of time, *e. g.*, one year.
*Second*—By maker.
*Third*—By class of failure.
Fourth—By months' service, using periods of two months. For example, a hose giving three months' service should be classified as four months' service.

4. At the end of each year or such period as may be desired the statistics should be tabulated on a tracing made for the purpose.

This record has been kept since October, 1903, and the results so far developed are shown below:

TIME IN SERVICE.

| | Class of Failure. | 2 m. | 4 m. | 6 m. | 8 m. | 10 m. | 1 y. | 1 y. 2 m. | Total. | Per Cent. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External Causes. | A. Torn apart | 9 | 11 | 12 | 6 | 4 | .. | .. | 42 | 8.35 | Total, 464, Per cent., 92.25 |
| | B. Chafed | 6 | 20 | 17 | 11 | 7 | 7 | 2 | 70 | 13.9 | |
| | C. Cut | 1 | 4 | 3 | 3 | 1 | .. | .. | 12 | 2.38 | |
| | D. Bruised at nipple end | 29 | 64 | 46 | 24 | 15 | 3 | 1 | 182 | 36.2 | |
| | E. Bruised at coupling end | 6 | 15 | 12 | 5 | 6 | 2 | .. | 46 | 9.13 | |
| | F. Kinked | 1 | 8 | 31 | 21 | 15 | 3 | .. | 79 | 15.7 | |
| | G. Unclassified | 8 | 10 | 5 | 4 | 4 | 2 | .. | 33 | 6.55 | |
| Quality of Hose. | H. Inner tube | .. | .. | .. | .. | .. | .. | .. | .. | .. | Total 39, per ct., 7.75 |
| | I. Outer cover | .. | 3 | 9 | 14 | 6 | 2 | .. | 34 | 6.75 | |
| | J. Wrapping | .. | .. | 1 | 1 | .. | .. | .. | 2 | .39 | |
| | K. Unclassified | 1 | .. | .. | .. | 2 | .. | .. | 3 | .59 | |
| | Total | 61 | 135 | 136 | 89 | 60 | 19 | 3 | 503 | 99.9 | |

This record has not been kept long enough to draw conclusive evidence from, but it seems to show fairly clearly that the great bulk of hose is removed on account of being rendered unfit for service by external mechanical causes, apparently largely due to abuse by trainmen. For instance, failures due to Class A, "Torn Apart," are undoubtedly largely cases where the brakeman has failed to uncouple the hose. Failures due to Class D, "Bruised at Nipple End," show 36.2 per cent. These apparently are cases where the brakeman finds the angle cock hard to turn and uses his heel or a piece of iron and accidentally hits the hose at the nipple end, bruising and weakening it at this point. Where hose fails due to material giving out, it is almost always due to unwrapping of the outer covers. This apparently would argue for high friction, but it will be noted that the percentage of failures from this cause is not great, and as shown above, even where hose has high initial friction, this quality is short-lived.

In order to determine how long a sample of hose retains its friction when kept without being put into service, samples were retained in the laboratory as shipments were inspected, making determinations of friction, stretch of rubber and set of rubber at intervals of three months. The results of the determination of friction are shown below:

25 Pounds Unwinds 12 in. in

| Sample. | Original. | 3 Months. | 6 Months. | 9 Months. | 12 Months. |
|---|---|---|---|---|---|
| 1 | 40 hrs. | 3 hrs. 15 min. | 17 min. | 4 min. | 11 min. |
| 2 | 4 hrs. | 4 hrs. | 17 hrs. | 11 hrs. | 3 hrs. 30 min. |
| 3 | 15 hrs. 45 min. | 20 min. | 10 min. | 7 min. | 7 min. |
| 4 | 2 hrs. | 25 hrs. | 35 min. | 15 min. | 40 min. |
| 5 | 7 hrs. 30 min. | 3 min. | 2 min. | 2 min. | |
| 6 | 6 hrs. 35 min. | 1 hr. 20 min. | 40 min. | 12 min. | |
| 7 | 11 hrs. | 1 hr. | 40 min. | | |
| 8 | 13 hrs. | 4 hrs. | 40 min. | | |
| 9 | 3 hrs. | 51 min. | 26 min. | | |
| 10 | 45 hrs. | 10 hrs. | 7 hrs. 30 min. | | |

From this it will be noted that all the samples show a loss of friction after three months; most of them losing almost all friction in six months, although in some cases the friction is retained somewhat longer.

In this connection it will probably be of interest to include some figures as to the amount of hose used per car per year, compiled by G. G. Yeomans, Purchasing Agent of the Burlington. Figures were first obtained from the purchasing agents of a number of roads on which climatic conditions were about the same as the Burlington and of the number of feet of hose bought exclusively for repairs covering a period of two years. He also obtained independently from the mechanical departments, the average number of all classes of air-brake equipment covering passenger cars, locomotives, freight cars, etc. From this he has figured the number of feet of hose used per car per annum for repairs. These roads were using different qualities of hose, and the results are shown below:

| Road. | Price of Hose. | Feet Per Car Per Year |
|---|---|---|
| Burlington | Medium | 1.47 |
| No. 1 | Medium | 1.51 |
| No. 2 | High priced | 1.30 |
| No. 3 | Cheapest | 3.35 |
| No. 4 | Part cheap, part medium. | 1.85 |
| No. 5 | Cheap | 2.14 |

From the table it would seem that, while hose cheap in price is dear in net results, on the other hand, hose high in price is likewise not the most economical.

## Travelers for Erecting Steel Bridge Spans Up to 200 Feet.

The best form of traveler to be used in erecting steel railroad bridges of spans up to 200 ft. furnished one of the most interesting subjects for discussion at the recent meeting of Superintendents of Bridges and Buildings in Chicago. The committee having the subject in charge reported as follows:

After considering in a general way the methods followed by different railroad companies and contractors in the erection of bridges of less than 200 ft. span, it was decided that, in order to cover the field fully, inquiries must definitely include derrick cars and similar equipment, as well as the type usually called travelers. The replies received to inquiries sent out represent railroads having a total of about 90,000 miles of main line. Those companies which are definitely committed to the erection of steel bridges with their own men and equipment comprise lines covering about 55,000 miles. Those companies which have contractors do their erecting, comprise lines having a total mileage of about 30,000 miles. More than 60 per cent., therefore, of the mileage represented by the replies received is committed to the policy of erecting its own bridges. In many cases the companies which do their own erecting limit this practice to girder bridges and in some cases to the short girders. This limitation, however, does not apply to a large percentage of the total mileage. It is found that out of the 90,000 miles represented by replies received, something over 35,000 miles apply to systems which erect all their own steel bridges.

The use of derrick cars is quite generally advocated in the replies received, but the extent to which they are used varies according to circumstances. The Chicago & North Western, the Illinois Central and the Chicago, Burlington & Quincy, representing a total of approximately 15,000 miles of line, have practically adopted the derrick car as the best equipment for erecting all classes of steel railroad bridges under 200 ft. span. This means not only girder bridges, but through truss bridges as well.

The drawings and photographs which the committee has accumulated indicate that there is very little choice between one overhead traveler and another. They also indicate that, so far, at least, as essential elements are concerned, there is very little difference between one derrick car and another. It would, therefore, appear that any discussion of the subject must be primarily a discussion of the comparative merits of derrick cars and through travelers. The following is a summary of the points which have been given consideration by the committee:

(1) Adaptability. Years of experience have shown the overhead traveler to be perfectly adapted to the erection of through and deck bridges. Its general type is well-known and simple. It is generally conceded, how-

ever, that the derrick car is better fitted for erecting girder bridges.

(2) Interference with Traffic.—It is claimed by the advocates of the overhead traveler that this type of rig interferes less with traffic and is, therefore, preferable for use on lines where trains are frequent. A derrick car, in order to meet the requirements placed upon it, must be self-propelling and if the turnout has been constructed in close proximity with the bridge, the interruption of traffic should not be much, if any, greater than that occasioned by erection with an overhead traveler. A self-propelling derrick car will, in many cases, take the place of a work train and result in less interference to traffic for that reason.

(3) Cost of Preliminary Preparations.—The additional cost in case of an overhead traveler is represented by the extra width of falsework to provide a runway for the traveler, and by the cost of erecting and taking down the rig. The extra cost in case of derrick car consists of the provision of spur track at the site for the use of the car.

(4) Economy in Operation.—No reliable information regarding costs was obtained by the committee. Its opinion is that in the erection of girder bridges and trestles a derrick car is by far the cheapest form of rig to be used; and for the erection of truss bridges a derrick car is, to say the least, no more expensive in operation than an overhead traveler.

(5) Permanent Investment.—As a permanent investment the overhead traveler is much less than the derrick car, but the derrick car can be used in so many other ways when it is not engaged in the erection of bridges that it is found by those who have used it to be a most valuable tool to have in the department.

The report is signed by G. W. Smith, Chairman; Moses Burpee, George J. Bishop, A. O. Cunningham, J. C. Hain, I. F. Stern.

## General Passenger Agents.

The forty-ninth annual meeting of the American Association of General Passenger and Ticket Agents was held at Fort Monroe, Va., October 19 and 20. The election of officers resulted in the choice of Mr. F. E. Boothby (Maine Central) as President for the ensuing year; A. J. Smith (L. S. & M. S.), Vice-President, and Messrs. T. W. Lee, W. L. Ross and Charles Cleland, members of the executive committee. Mr. A. J. Smith, the veteran Secretary, declined re-election, and C. M. Burt (Central of New Jersey), of New York City, was elected to succeed him.

Among the communications from other associations was one from the Traveling Passenger Agents, by Mr. G. G. Noble, South Eastern Passenger Agent of the Lehigh Valley, Philadelphia. This report tells us that—

The power to make friends and to form an acquaintanceship immediately is most indispensable to the successful traveling passenger agent. Personal friendship is the principal stock in trade he has to-day. In the days of the old quarter-sheet and old-fashioned colonist movements, when the traveling passenger agent performed nearly all of his transactions through the local ticket agent, I am told that it was not deemed essential for him to be on intimate terms with the passenger. This is not the case to-day. The traveling passenger agent must be personally acquainted, not only with every local ticket agent and every passenger representative of foreign lines in his district, but he must have a host of friends in every city, town and village in his territory. He should be on intimate terms with the business and professional men and be well acquainted with the newspaper fraternity throughout his territory. A general passenger agent of one of our largest roads made a statement not long ago that it was advisable to change traveling passenger agents from one territory to another to prevent them from becoming "rusty." But if a traveling passenger agent becomes rusty in one territory he will soon get that way in another.

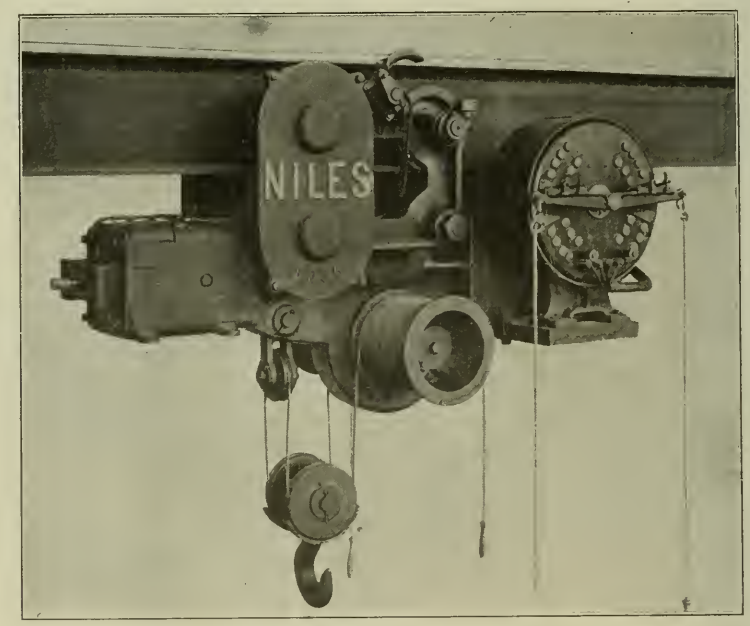
When the meeting took up the resolution to abolish or restrict the business of Sunday excursions, a large number of telegrams and letters were produced from religious organizations in all parts of the country. Secretary Smith said that the better element of the entire country was protesting against the desecration of the Sabbath and demanding that employees be given a regular rest day. The charges of Sabbath desecration appear to be based to a considerable extent on the experience of some country towns which have been flooded with undesirable and lawless crowds from large cities, brought out on one-day excursions. A representative of the Michigan Central said that his road had for years refrained from running Sunday excursions, but had been obliged to enter the field under pressure of competition. The business produces about $150,000 a year, but the company is ready to discontinue it whenever the other lines will join in the movement. The General Passenger Agent of the Maine Central opposed the resolution on the ground that Sunday recreation is demanded. Mr. Hardwick, of the Southern, made a plea for Sunday observance. He said that his road had discontinued Sunday excursions; this on moral grounds and also because of the feeling that they did not pay. "I have still the old-fashioned idea of the Sabbath day," said Mr. Hardwick. He held that the running of Sunday excursions was purely a local line matter, and largely one of particular locality. He said that as a general proposition the Southern did not encourage Sunday excursions, and furthermore, these were prohibited to some extent in certain States in which the company's lines run; that personally and officially he did not believe in encouraging Sunday work, or overtime at the office, at night, or on holidays; that the men were all the better for having these periods of rest and recreation for their own enjoyment. At the same time a certain amount of Sunday work, including some Sunday excursion traffic, he believed required by the public; it is in itself helpful to the public; but these were matters which could not be legislated upon in any general or blanket-like rule, and the matter therefore could only be dealt with by each line for itself.

No decisive action was taken, the question being referred to the several local traffic associations.

## A New Electric Traveling Hoist.

The Niles electric traveling hoist shown in the accompanying illustration is made by the Niles-Bement-Pond Company, New York, in sizes ranging from three-quarters of a ton to six ton capacity. It can be used either as a hoist or a small capacity crane. When used as a hoist it is run on an I-beam track and when used as a crane it is mounted on a traveling bridge and is arranged to run between the two I-beams or channels of the bridge. The controllers for raising and lowering the hook and operating the traversing mechanism can be placed either on the hoist, on the bridge and operated by cords from the floor, or in an operator's cage attached to the bridge.

When used on an I-beam, the controllers are attached to the hoist and are operated by cords from the floor. This hoist will run on straight and curved tracks, and it is usually provided with a separate motor for traversing, but if desired, hand traverse can be furnished, or all the traversing mechanism may be omitted and the trolley moved along the track by pushing on the load. The increased service of the electric traverse, however, much more than compensates for the slight additional cost.




A New Electric Traveling Hoist.

The hoist is self-contained in a heavy cast-iron frame to which the motors are attached end on, and the power is transmitted directly from the armature shaft to the drum shaft through a train of worm wheel gears.

The traversing mechanism is also driven through a train of worm and worm wheel gears similar to the hoisting mechanism, except that when the trolley is arranged to run on a single I-beam, a double set of transmission gears is used to connect the worm gear shaft to the truck wheel shafts. All the mechanism is enclosed in an oil and dust proof casing and is noiseless in operation.

In addition to the braking effect obtained by the use of the worm and worm wheel, an electric brake is attached to the hoist motor.

RAILROAD GAZETTE

## THE ONTARIO & WESTERN TRANSFER.

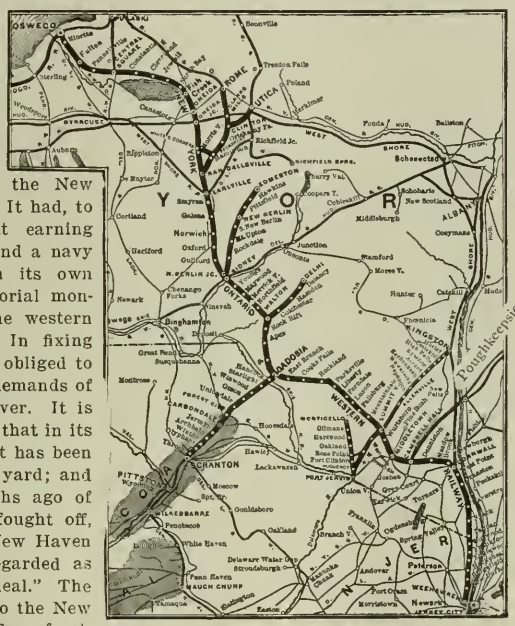
The fact forecast has become the fact accomplished; and by purchase of about 1,000 shares above a majority of the stock the New York, New Haven & Hartford has secured control of the New York, Ontario & Western. The purchase price was $45 a share, and, in fixed charges, the New Haven people figure out that the control will cost them about $460,000 a year, or about $960,000 a year if the minority stock is financed into their strong box at $40; and they assert, with plausibility, that the earnings of the Ontario will cover this expenditure, not counting increased receipts from traffic which the New Haven will bring to it. The fiscal transaction, however, mainly concerns the shareholders of the two roads and may be left there. But there are other aspects in which the transfer becomes a matter of importance to the public, and it may even be said to take a conspicuous place in the railroad history of the country.

Up to last week Wednesday, the New Haven had been a local railroad. It had, to be sure, large mileage and great earning power, a great Boston terminal, and a navy of Sound steamers; and within its own bounds an almost complete territorial monopoly. But in its relation to the western through business it was weak. In fixing through freight rates it has been obliged to submit to what it deemed unfair demands of the lines west of the Hudson River. It is hardly a strained metaphor to say that in its relation to the great trunk lines it has been a kind of colossal terminal freight yard; and a threatened paring a few months ago of coal percentages, with difficulty fought off, and which would have cost the New Haven some $300,000 a year, may be regarded as the starting point of the present "deal." The resistance of the coal companies to the New Haven's Lehigh & Hudson River plan of getting to the coal fields was another incentive.

It is primarily under the spur and stress of such a situation that the New Haven has taken its radical step. It will now have a voice in fixing coal rates; and, as it connects with the Erie at Campbell Hall, 30 miles from the Hudson River, and with the New York Central at Oneida, 122 miles west of Albany, it may have more influence in fixing rates to and from Chicago.

By this invasion of the coal fields it becomes an owner of a considerable coal field, a large coal yard for New England factories, and enters, as a factor, into the coal combination, so-called; and it proposes to become its own fuel carrier. That the coal-road and trunk-line presidents resisted this incursion, to the best of their ability may well be believed; and it would be interesting to know at their reported meeting with Mr. Mellen last week Tuesday what words were spoken and what compromises offered and rejected. But, whatever the proceedings, it is certain that Mr. Mellen, with the Ontario & Western option in his pocket, held the handle of the whip.

We mentioned last week several of the advantages to be derived from this new possession, and they have since been confirmed in the semi-official announcement of the transfer. To complete the record it may be added that the Ontario & Western, with its 500 miles of road and good equipment, has also, under its old hard and fast contract running for about 175 years, and antedating the New York Central control of the West Shore, large terminal privileges at Weehawken, opposite New York, which it reaches over 52 miles of the West Shore. This contract, subject to one or two technical differences, is strikingly analogous to that under which the New Haven uses the Grand Central Station in New York city; and contract rights of the Ontario & Western over the Rome, Watertown & Ogdensburg Division of the New York Central for 150 miles between Oswego and Niagara Falls are not to be overlooked. The contract we understand is terminable, but it would hardly be policy for the New York Central to cancel it, with loss




New York, Ontario & Western.

of the business and the risk of extension of a new rival over a level country to meet the Grand Trunk and the Wabash at Buffalo and Niagara Falls.

On the negative side should be cited the risk that the New Haven incurs of a hostile combination of the great companies should it prove to be a disturber of the peace; its new coal supply is not of the highest quality; and of course it is not going to save much on the cost of its fuel unless it uses anthracite much more freely than it does now; and no large railroad is going to use much anthracite in its freight engines unless compelled to do so, for the increase in the cost of coal would outweigh any possible decrease in freight charges. Another adverse item is the cost of changing from bad to good the railroad which connects New Haven with Campbell Hall; for with the proposed double-tracking much costly leveling and straightening must be done.

It must be assumed, however, that Mr. Mellen has counted the cost; and that he intends, if possible, to make the Poughkeepsie Bridge line, with the Ontario & Western as an annex, his chief freight line to the west, involving right away the complete double-tracking of the Highland Division and of the Berkshire Division to New Haven. He has never looked with favor on the New York harbor route for freight, involving the use of the New York division, already taxed with a great passenger traffic; and his experience with strikes in New York city has probably not weakened this opinion. How that transfer of freight to his northern route will affect his relations with the trunk lines—especially the Pennsylvania, not long ago supplying 50 per cent. of his through business (now reduced to about 40 per cent. by the Poughkeepsie Bridge) and the same company planning the costly Brooklyn loop to the New Haven's Harlem terminal—must be left to conjecture.

What further Kuroki flank movements in railroad strategy Mr. Mellen contemplates we do not know, but to those who are familiar with the New Haven's past history this latest stroke certainly comes as a surprise. Even if the new stroke is reckoned purely defensive, one marvels at the necromancy which he must have used to bind to his chariot wheels his old fogy board of directors in his swift and dusty progress. Indeed, we must be careful about using the term old-fogy; evidently Mr. Mellen has a united board behind him.

## LOCOMOTIVE VALVE GEARS.

The Stephenson link-motion has been the standard valve gear on American locomotives since the beginning of railroading in this country, the chief reason for this being that it combines simplicity and reasonable efficiency. Simplicity has been the keynote of all progress in locomotive design in the United States rather than extreme economy either of fuel or of water. Because of this fact, the deficiencies of the Stephenson gear, with its irregularity of steam distribution under various conditions and its excessive weight of moving parts are complacently put up with, and, of course, freely admitted; nevertheless it is used to the practical exclusion of every other kind.

Small port openings when running at high-speeds with short cut-off, excessive wire-drawing of the steam during admission, restricted release and consequent high back-pressure, and early exhaust with excessive compression, are inherent faults of the Stephenson link-motion and slide valve gears. Various other forms of valve gears have been devised to overcome the deficiencies of the link motion gear and to give a good steam distribution under all conditions. Most of them, while giving better steam distribution, perhaps, have been so complicated and the cost of maintenance has been so high that they have never had any practical application in service. It is not likely, however, that the link-motion slide-valve gear steam distribution can be excelled by any mechanism equally simple, and if improvement is desired something more complicated will have to be accepted. After all, there is not a large margin for improvement, all factors considered, and it is safe to say that any gear which shows any appreciable increase in cost of maintenance over the form of gear now in general use can expect little consid-

eration, since the advantages it may have in economy of fuel and water would be offset by increased running repairs and greater time out of service. On the other hand, the maintenance cost charged to gears used in present practice does not by any means represent the minimum obtainable, since the imperfect steam distribution is not only a large factor in causing wear of the gear itself, but causes wear and tear to many other parts of the locomotive as well. Therefore efforts of designers of substitutes should be directed toward the attainment of the dual object of improved steam distribution and decreased maintenance. Only under these conditions would a more complicated mechanism find favor.

Last week a description of a new valve mechanism designed to accomplish this dual object was given in these columns, and another is presented elsewhere in this issue. Each has been tested for a considerable period in various kinds of service on the road, most of the time in fast passenger service. Although the mechanisms differ radically in design, the records of both locomotives show each to be what the shop man calls "a good roundhouse engine"; that is, running repairs are light, the engine rarely needing attention beyond the necessary terminal work at the end of each run. As to the other essential feature—the steam distribution—the indicator cards tell all that is to be told.

## Operation of the New York Subway.*

The Subway in New York City is now in actual operation and those who have watched its progress toward completion with many hopes and possibly some misgivings can form some definite conclusions about its capacity, its sanitary conditions and the success of the project in providing real rapid transit. Beginning Thursday evening, October 27, at seven o'clock, five hours after it had been formally opened, the Subway from City Hall to Broadway and 145th street was thrown open for general use. The curious public swarmed into the stations and crowded the trains to the utmost until late at night and the new road had a severe test. In the first five hours up to midnight, 111,881 tickets were sold. Many persons rode continuously on the trains up and down. The receipts for the first day, amounting to $5,594, were given by the Interborough Company to the public hospitals of the city.

On Friday, 24 hours, 319,000 tickets were sold; on Saturday about 350,000, and on Sunday 309,875. Sunday's crowds of sightseers were bunched between noon and seven o'clock in the evening, and for most of that time the trains and platforms were packed and jammed. On Monday, the number of passengers carried dropped to about 240,000 for the 24 hours, and this is probably a fair estimate of the number of people who can be expected to use the new line regularly for the present, now that the novelty has worn off.

The four elevated lines in Manhattan, parallel to the Subway, carry about 500,000 passengers a day, and the Subway will relieve the congestion on them to the extent of probably 100,000 passengers a day. The two east side lines will not be much relieved until the east branch of the Subway is opened. The Third Avenue line is relieved of some of the local traffic below Forty-second street. The most relief will be experienced on the local trains of the two west side lines south of One Hundred and Tenth street. Above that street the Subway and the elevated road diverge and only a small part of the persons living between the two lines who have used the express trains on the elevated road will get to their offices any quicker by the Subway trains.

The relief on the surface street car lines was apparent at once. It is reasonable to assume that, of the 240,000 passengers carried in the Subway, at least 125,000 came from the surface cars, and the same conditions hold in this case as in considering the effect on the elevated lines. On the east side lines particularly, the surface cars have been relieved of the uncomfortable crowding below Forty-second street. Above Forty-second street on the west side the conditions on the surface lines were not so bad and the change has not been so apparent.

As yet there has been no change in the tentative time-table which was put into operation on the opening day. This table, which was printed in these columns last week, provides for about half the maximum number of trains for which the road was designed, and the first few days' experience has shown that during the rush hours the number of trains now run is inadequate, though quite sufficient during other hours of the day. The express trains, stopping at three stations between City Hall and Ninety-sixth street, and, with the local trains to carry passengers to local stations north of Ninety-sixth street, accommodate practically the entire population of the upper west side and a large part of the suburban passengers who come in to the Grand Central Station. These people have been quick to take advantage of the new service and as a consequence most of the expresses are uncomfortably crowded. Beyond Ninety-sixth street, where all trains run local, only a handful of passengers are carried in the local trains, and there is plenty of room in the express trains. During the rush hours the local trains as well as the expresses are crowded below Forty-second street (Grand Central Station), but above there they carry chiefly passengers arriving at express stations on expresses who are destined to some local station beyond. Running a few additional local trains during the rush hours and running the maximum possible number of expresses, at least between 7.30 a.m. and 9.30 a.m. and from 4.30 p.m. to 6.30 p.m., would probably take care of the normal traffic for the present without uncomfortable crowding of the cars and platforms. Not all of the cars ordered have yet been delivered and only about 45 trains are in use, so that more frequent trains are hardly possible unless some of the local runs are shortened and the cars thus released used in express service.

The ventilation in the tunnel seems thus far to be good and only a few complaints have been made on that score. In hot weather the atmosphere in the cars will undoubtedly be close and perhaps stuffy; but there is no likelihood of such serious trouble as has been encountered in the ventilation of the London tubes. The stations are clean, light and attractive in every way except for the omnipresent advertisements, which may be profitable but which are certainly unsightly and out of harmony with the handsome walls. At some of the stations, notably at the Brooklyn Bridge express terminal, the arrangement of ticket-sellers' booths is not all that could be desired and long lines of passengers are kept waiting their turn at the windows, extending during the worst crush even out on to the street above. In other respects the entrances and exits to the stations are well placed and of ample width to handle large crowds safely.

Of the most interest to the general public, however, aside from curiosity about the cars and stations is the running time of the trains. So far, at least, this has not been altogether what was expected. During the slack hours both local and express trains have made some good records, but in the rush hours the schedules announced have not been accomplished. There have been several failures of motors under the cars, resulting in delays of from 20 minutes to 35 minutes; and the unexpected crowds to be handled at stations have caused numerous minor delays which, while not blockading the line have disarranged the time-table badly. The running time from One Hundred and Forty-fifth street to Brooklyn Bridge for the express trains was announced to be 25½ minutes. During the rush hours with no delays of importance other than those at stations to take on and let off passengers, the actual time is between 35 and 40 minutes, about five to ten minutes slower than the express trains on the Ninth Avenue elevated. For the local trains, the running time between these two stations is actually from 50 to 55 minutes during slack hours, or a little slower than the Sixth Avenue elevated local trains. The chief delays occur above Ninety-sixth street, where all trains are for the present run on the local tracks running as locals to One Hundred and Forty-fifth street, which is for the present the northern terminus. The switching arrangements at this terminal are not adequate and some delays in starting trains have occurred there. When the single express track is put in service from One Hundred and Forty-fifth to Ninety-sixth street most of the delay at the upper end will be avoided. Between City Hall, Fourteenth street and Grand Central Station the running time of the express trains is fairly well maintained, and even during the hours of heaviest traffic the time from start to stop is four minutes to Fourteenth street and seven to eight minutes to Grand Central Station. This is less than half the time of the local trains on the elevated road, and is perhaps the most striking object lesson in "rapid transit" in the whole of the Subway operations; for many of the passengers save not only in the time spent in the cars but also from three to eight minutes in their foot journeys at either or both ends, thus making the whole saving as against the former time as much as 60 or 70 per cent.

Many of the minor delays which have occurred and which will continue to occur for some time yet are always to be expected in opening such a great establishment. Most of the employees are new men who have had but little training in their duties and none at all in handling such large crowds. They have not yet acquired the knack of making passengers "step lively," and the passengers themselves have not learned how to crowd into the new cars with enclosed platforms with the least resistance and the greatest speed. The motormen, quite properly, are a little cautious about running up to signals and do not seem to take advantage

*This Subway, or underground railroad, begins at City Hall Park, 1 mile from the southern end of Manhattan Island, and runs north under Elm street, Fourth avenue and Park avenue to Forty-second street and the Grand Central Station. It turns west on Forty-second street to Broadway and then north under Broadway to the north end of the Island at Kingsbridge. The north end of the line for about a mile runs on an elevated structure. At One Hundred and Fourth street an east side branch turns off from the main line and runs east under Central Park to Lenox avenue, thence north to the Harlem river and One Hundred and Forty-fifth street and under the river into the Borough of the Bronx. It will terminate at Bronx Park. A description of the engineering features of the tunnel was printed in the *Railroad Gazette*, September 4, 1903. Other articles on the history, traffic features, cars, signals, etc., were printed Sept. 16, Sept. 30 and Oct. 7 of this year.

of the full accelerating power of the motors in starting out from stations. At the interlocking plants the operators are not yet expert enough in their duties to handle the trains with minimum loss of time. There have been some delays due to signals failing to clear because of the fluctuations of the power signal currents, but aside from that, the whole installation of signals has been working with great success. The accidents to motors and control apparatus, hot boxes and similar breakdowns are bound to occur with equipment which has not been thoroughly broken in and no one can be blamed for such failures.

It is announced that on November 10, the east side branch from Ninety-sixth street and Broadway to One Hundred and Thirty-fifth street and Lenox avenue will be opened. The delay has been caused by a desire to get the main line running smoothly.

The Subway needs a little time to "find itself," of course. The general public is not so ready to accept reasonable excuses as it is to make complaints. There is no need for either complaints or excuses.

## Gross Earnings for September.

Railroad gross earnings for September as a whole show good increases. The gains are larger than the month before and are general throughout all sections of the country. The only railroads reporting losses are those in the anthracite region. For the month, 91 railroads report an increase in gross receipts of $2,589,768 over September of last year. This is compared with an increase on 97 roads in August of $1,551,206. Of 60 of the more important railroads reporting earnings for September, 37 show increases and 23 decreases; but the losses, with only a few exceptions, are small. In the Middle and Middle West, the larger traffic resulting from the Louisiana Purchase Exposition, has aided materially in increasing the receipts of the east and west trunk lines, and of some others. This traffic did not begin to be heavy until September. In the South and Southwest, the railroads have had a heavy movement of cotton. The movement in this commodity began much earlier this year than last and the receipts at southern ports during September were over 1,000,000 bales, as against half that number in September, 1903.

Earnings, when divided geographically, show that conditions have been most favorable among the Southern railroads. In this group, 11 roads report an increase of $1,063,668 for the month, only one road showing a decrease. Other returns may be summarized as follows: Middle and Middle West group (13 railroads), increase, $549,009; Southwestern group (10 railroads), increase, $530,137; Northwestern and North Pacific group (12 railroads), increase, $468,265; Trunk line group (seven railroads), increase, $292,899; Anthracite group (five railroads), decrease, $397,828.

Among the separate railroads showing good increases in gross, the Wabash heads the list with a gain of $369,914. Other increases are reported as follows: Southern, $351,999; Missouri, Kansas & Texas, $300,542; Canadian Pacific, $283,875; Illinois Central, $224,872; Chicago & North Western, 223,293; Atlantic Coast Line, $196,249, and New York Central & Hudson River, $194,389. The heaviest loss in receipts was made by the Great Northern, which showed a decrease of $311,350. This was probably the result of the smaller movement of wheat in the Northwest as compared with the season of 1903. Other decreases in earnings reported were: The Reading Company, $253,437; Lehigh Valley, $201,784; Erie, $200,822; Grand Trunk, $91,373, and the Denver & Rio Grande, $88,100.

The Long Island Railroad is preparing to electrify its main line and branches within a radius of 15 miles from its terminus at Long Island City; and by using the power house which will ultimately serve for the line beneath the East River to Manhattan, and which is now partly finished, the company expects to get some of the work ready for next summer's business. At the present writing the Rockaway Beach division has been equipped with third rail, and the main line as far out as the Belmont race track. The Manhattan Beach and Flushing divisions will be equipped later. It is expected to have the two lines first mentioned in operation before next summer. Power will be obtained from the new power house as above mentioned, which will be completed long before the tunnel is finished. A press despatch from Pittsburg says that orders have already been given for the electrical equipment for 122 cars.

## Wabash.

The gross receipts of this road for the year ending June 30 last were $23,023,627, which includes $14,064,657 from freight and $7,045,525 from passenger traffic. The freight receipts increased $737,178 over the preceding year, and this has been accomplished in spite of a decrease of over 22 millions in the ton mileage, the losses being offset by an increase in short haul and better paying freight, bringing the average rate per ton mile up to 6.4 mills as against 6 mills in 1903, an increase of 6⅔ per cent. The passenger receipts were $910,024 greater than in 1903. Since 1897 the gross receipts of the Wabash have doubled, the increase in passenger receipts being 150 per cent. A part of this is due, of course, to the larger mileage, the length of road operated in 1897 having been only 1,362 miles as compared with 2,517 miles this year.

In net earnings the Wabash, like nearly every other road, is unable longer to keep up the handsome increases of recent years. The increase in the cost of fuel is given as 30 per cent. and unusually severe storms in the spring of 1904 are given as another cause; and the total net ($5,340,118) is only $14,951 greater than in the year before. The President states that the established policy of expending large sums for improving the physical condition of the property has been kept up. A large amount of work was done improving the main line for the World's Fair traffic and completing the reduction of grades between St. Louis and Chicago (on which work has now been in progress for four years). This latter work has now resulted in obtaining a ruling grade between these points of only 21 ft. per mile instead of 50 to 60 ft. per mile as formerly.

The report gives considerable space to the line to Pittsburg, which has been in course of construction for the last two years and which was opened for business since the end of the fiscal year. The Wabash-Pittsburg Terminal Company is owned by the Wabash, ten millions of common stock of the parent company having been issued in exchange for the stock of the Terminal company; and the Terminal company owns a majority of the stock of the Wheeling & Lake Erie. The Wabash and the Wheeling & Lake Erie have agreed to use, if necessary, 25 per cent. of their gross receipts from traffic received from the new line to meet any deficit in the interest on the bonds of the Terminal company.

The principal statistics in the annual report follow:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 2,517 | 2,486 |
| Gross earnings | $23,023,627 | $21,140,829 |
| Freight earnings | 14,064,657 | 13,327,479 |
| Passenger earnings | 7,045,525 | 6,135,501 |
| Total tons carried | 11,712,011 | 11,525,269 |
| Tons carried 1 mile | *2,400,618 | *2,413,162 |
| Average train load, tons | 286 | 302 |
| Ton-mile revenue, cts. | .646 | .606 |
| Operating expenses | $17,683,509 | $15,815,662 |
| Maintenance of way | 3,681,608 | 3,700,962 |
| Maintenance of equipm't | 3,473,002 | 3,114,664 |
| Conducting transportat'n | 9,978,629 | 8,511,278 |
| General expenses | 550,270 | 488,759 |
| Net earnings | 5,340,118 | 5,325,167 |
| Additions to property | 1,050,746 | 817,289 |
| Interest on bonds | 3,092,423 | 3,034,513 |
| Surplus | 119,291 | 406,150 |

*000 omitted.

## Rock Island.

The Rock Island is an intricate affair. The annual report this year supplies a lack much felt in the last report, by giving at the outset the names and relations of the companies bearing the general designation "Rock Island." The original property was the Chicago, Rock Island & Pacific Railway Company. This was one of the four large systems west and north of Chicago. The other three were the Burlington, the Milwaukee and the Northwestern. The present controlling interests in Rock Island own $69,574,750 of a total of $75,000,000 of the stock of the old Chicago, Rock Island & Pacific Railway. They formed the Chicago, Rock Island & Pacific Railroad Company, of which they held the entire capital stock of $145,000,000. To this company was also turned over the St. Louis & San Francisco system subsequently acquired. The original Rock Island Railway and affiliated lines are known as the Rock Island System, while the St. Louis & San Francisco is known as the Frisco system. The Rock Island Railroad Company, to which these two systems are made over, is itself owned by the holding company known as the Rock Island Company. This is a New Jersey corporation. Its preferred stock alone has voting power. This preferred stock amounts to $54,000,000. The aggregate investment involved, as measured by the stock (at par) and the debt capitalization is $438,000,000, and $27,500,000 of preferred stock is sufficient to control this nearly half billion of book values. The mileage of the two systems now is:

| | |
|---|---|
| Rock Island system | 7,258.92 |
| Frisco system | 5,107.74 |
| | 12,366.64 |

The capitalization per mile of this mileage is:

| | |
|---|---|
| Stock | $10,325 |
| Debt | 25,107 |
| | $35,432 |

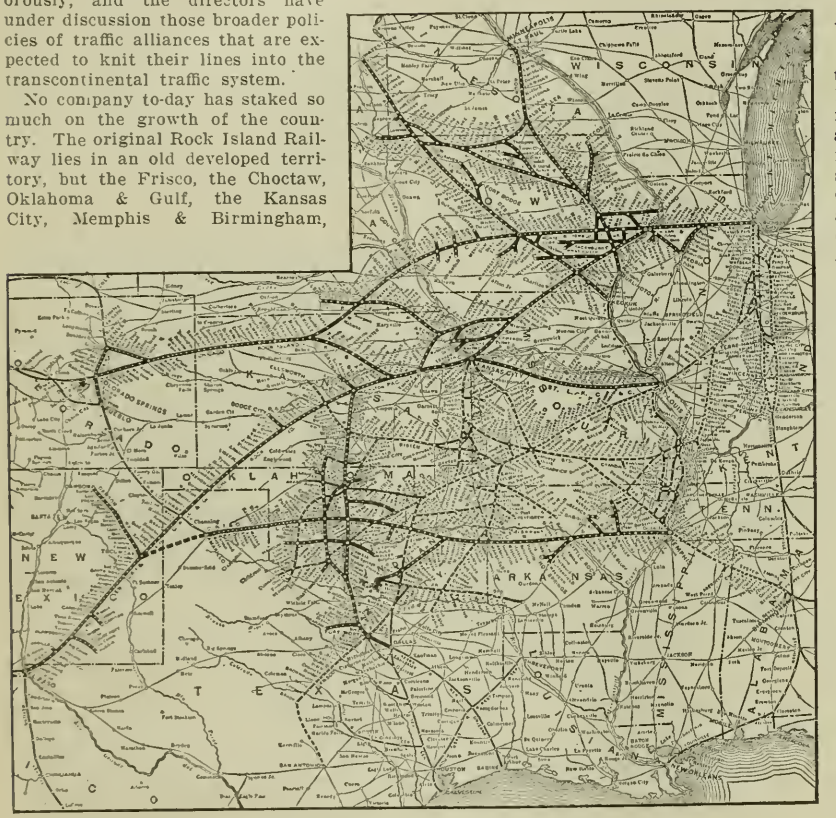
The gross earnings per mile for 1904 were $6,615.

The combined systems occupy the middle west, stretching north to St. Paul and South Dakota, west from Chicago, St. Louis, Omaha and Kansas City to Denver, southwest through Texas to the Mexican border, south to Fort Worth and Dallas; by connection to the Gulf at Houston, and by joint operation down the Mississippi Valley to New Orleans. By the Chicago & Eastern Illinois the company reaches the bituminous coal fields of Illinois and Indiana. By the Kansas City, Memphis & Birmingham it reaches into the northern Alabama coal and ore fields and by its trackage rights over the Mobile & Ohio via Tupelo it makes a direct outlet from this territory to the Gulf on the south. It is the imposing system of the great middle west.

In a peculiar sense Rock Island is an unfinished property. It is welded together out of so many diverse parts and the combination is so new that it will be some time

before the unities and system characteristics will be fully evolved. Its advent has greatly upset old traffic groupings in its territory. Physically its parts are as diverse as its traffic entities are different. Its rails are of all sizes from 40 lb. to 100 lb. The construction of branches and feeders is going on vigorously, and the directors have under discussion those broader policies of traffic alliances that are expected to knit their lines into the transcontinental traffic system.

No company to-day has staked so much on the growth of the country. The original Rock Island Railway lies in an old developed territory, but the Frisco, the Choctaw, Oklahoma & Gulf, the Kansas City, Memphis & Birmingham,




Rock Island and Frisco Systems.

and the Oklahoma and far southwest extensions rest their largest prosperity on a development of the country yet to come. In the welding of such a system the results to follow from the combination formed are highly speculative. The past year has been one to put the new system to severe test. The year has not been one of severe depression, but it has been one of hesitation. Failure of crops in some quarters, rate disorders in others, with strikes in the far west and exorbitantly high fuel and general increase in wages have made the year a severe one. The consolidated income account below shows how narrow has been the margin:

| | |
|---|---|
| All income | $5,629,408 |
| Expenses, taxes and interest charges.. | 3,552,037 |
| Available for dividends | $2,077,371 |
| 4 per cent. on preferred stock | 1,947,608 |
| | $129,763 |

The company was this year sustained by the dividends of the old Chicago, Rock Island & Pacific Railway alone. The Frisco system yielded nothing except an undivided equity of about $1,000,000.

The stock of the Rock Island Railway Company was this year raised from $75,000,000 to $96,000,000, and the preferred stock from $52,500,000 to $54,000,000, while the funded debt has been increased $17,180,940. All of these increases were for increasing the holdings in the Rock Island Railway Company and the Frisco.

The railway company authorized a new mortgage for $163,000,000. Of this $82,025,000 was reserved for refunding purposes, $15,000,000 is to reimburse the company for capital expenditures, and $66,000,000 is for future development purposes under proper safeguards.

During the year $6,256,000 was spent on the Rock Island Railway. This went into new shops and equipment and general betterments. Both systems added heavily to their equipment. The Frisco system had better increases for the year than the Rock Island system, as is shown below.

| *Rock Island System.* | 1904. | 1903. | Increase. |
|---|---|---|---|
| Av. miles op.... | 7,205 | 6,978 | 227 |
| Earnings: | | | |
| Freight ..... | $31,167,006 | $30,917,281 | $249,725 |
| Passenger ... | 11,697,033 | 11,490,543 | 206,489 |
| Mail and exp. | 1,926,638 | 1,845,776 | 80,861 |
| Miscellaneous. | 178,814 | 123,018 | 55,795 |
| Total ..... | $44,969,491 | $44,376,619 | $592,871 |
| Operating expenses: | | | |
| Maint. of way | $6,848,127 | $6,822,550 | $25,576 |
| Maint.of equip | 5,119,993 | 4,176,320 | 943,673 |
| Cond. Transp. | 18,345,418 | 15,811,356 | 2,534,062 |
| Gen'l expenses | 1,461,353 | 1,248,936 | 212,417 |
| Total ..... | $31,774,893 | $28,059,164 | $3,715,728 |
| Net. .... | $13,194,598 | $16,317,455 | *3,122,857 |
| Taxes ..... | $1,437,577 | $1,319,300 | $118,277 |
| Int. and rentals. | 7,062,655 | 7,096,730 | *34,075 |
| Total ..... | $8,500,233 | $8,416,030 | $84,202 |
| Balance . | $4,694,364 | $7,901,424 | *3,207,059 |
| Other income .. | 1,333,833 | 1,671,487 | *337,653 |
| Available for div | $6,028,198 | $9,572,911 | *3,544,713 |
| Dividends ..... | 5,985,060 | 4,680,766 | 1,304,293 |
| Surplus .... | $43,138 | $4,892,145 | *4,849,006 |

*Decrease.

| *Frisco System.* | 1904. | 1903. | Increase. |
|---|---|---|---|
| Av. miles op.... | 4,986 | 4,419 | 567 |
| Earnings: | | | |
| Freight ..... | $25,981,912 | $23,753,101 | $2,228,811 |
| Passenger ... | 7,206,113 | 6,063,204 | 1,142,909 |
| Mail and exp. | 1,573,957 | 1,324,213 | 240,743 |
| Miscellaneous. | 798,791 | 872,839 | *74,048 |
| Total ..... | $35,560,774 | $32,013,358 | $3,547,415 |
| Expenses: | | | |
| Maint. of way. | $3,795,273 | $4,099,874 | *$304,600 |
| Maint. of equip | 4,606,242 | 3,473,797 | 1,132,445 |
| Cond. Transp. | 13,649,855 | 11,593,309 | 2,056,546 |
| Gen'l expenses | 1,146,313 | 1,021,583 | 124,729 |
| Total ..... | $23,197,685 | $20,188,564 | $3,009,120 |
| Net ..... | $12,363,088 | $11,824,793 | $538,294 |
| Charges ..... | 10,514,353 | 9,361,468 | 1,152,885 |
| Balance ... | $1,848,735 | $2,463,325 | *$614,590 |
| Other income .. | 415,236 | 508,969 | *93,733 |
| Available for div | $2,263,971 | $2,972,295 | *$708,323 |
| Dividends ..... | 1,003,590 | 1,075,519 | *71,929 |
| Balance.... | $1,260,381 | $1,896,775 | *$636,393 |
| Spl appropriatns | 478,654 | 920,646 | *441,991 |
| Balance.... | $781,726 | $976,129 | *$194,402 |

*Decrease.

Both systems suffered in their transportation expenses, but Rock Island especially. Its coal bill increased over $1,000,000, or nearly 30 per cent. Its accident and damage expenses were $1,400,000, an increase of nearly half a million. All labor expense shows an increase but the increase of $250,000 in station service is especially noticeable, as this department of the service is too frequently passed over in the raising of wages. A very notable item to operating men is the decrease of $256,000 in car hire.

The operating department raised the train load on the Rock Island System from 189 to 225 tons per train. Altogether the company has had a hard year. It is to be congratulated that results were no worse. It was a severe test for a new system and save under very exceptional circumstances the company seems to have proved its ability to hold its ground. Fortunately the cash position of the company is so strong that one or two bad years do not constitute a serious menace.

## NEW PUBLICATIONS.

*University of Illinois Bulletin*, No. 1 of volume 2, is the first of a series to be published by the University Engineering Experiment Station, which was established last December. In contains the paper on "Tests of Reinforced Concrete Beams" by Professor Arthur N. Talbot, read before the American Society for Testing Materials, June, 1904.

## TRADE CATALOGUES.

*Smooth-On Manufacturing Co.*, Jersey City, N. J., has issued a new book describing its products. These include "smooth-on" castings, an iron cement for repairing blemishes, blow-holes or defects in iron castings; smooth-on compound No. 1, an iron cement, which withstands fire and is quick-hardening, for repairing leaks or making connections in steam or hydraulic work; smooth-on compound No. 2, same uses as No. 1, but slow hardening; smooth-on elastic cement, a metallic elastic cement for inside seams of marine and stationary boilers; smooth-on joints, a silicated iron cement for connecting bell-and-spigot cast-iron pipe in place of caulking lead, or in combination with it; smooth-on cement packing, a combination of smooth-on iron cement and rubber; smooth-on scale, of which the company makes several preparations for the prevention and removal of scale in steam boilers.

*Chicago Car Heating Company*, Chicago, has prepared a neat circular treating of its new vapor system of car heating, which was described and illustrated in the *Railroad Gazette* of June 24 last. The circular illustrates the system and details the apparatus by engravings from wash and black-and-white drawings. There is also interesting information about car heating, and descriptions of other specialties of the company.

*The O. F. Jordan Company*, Chicago, has a four page circular in two colors relative to its railroad labor-saving devices, which include the Jordan pneumatic or steam power earth and ballast spreader, high bank

builder and snow remover, and Warner's adjustable unloader. There are several half-tones from photographs showing the former machine and the work it will do. There are also a large number of testimonials together with a description of the device and a list of the different things that can be done with it. The unloader is also illustrated and a brief statement given of the service it will perform.

*Allis-Chalmers Company*, Milwaukee, Wis., issues an illustrated booklet entitled "Hydraulic Turbines and Governors." The Escher Wyss turbines used at Niagara Falls power plant, and for which the Allis-Chalmers Co. have the rights for making and selling in North America, are illustrated and described. A detailed description of the "Francis" type turbine and of the "High Pressure Impulse" type turbine is also given. Detailed descriptions and line drawings of the hydraulic governor as well as the results of tests obtained on turbines controlled by it are shown.

*The Trussed Concrete Steel Co.*, Detroit, Mich., has issued a book entitled "Facts Concerning the Kahn Trussed Bar." It contains numerous illustrations of tests and work already completed or under way by this company; also some letters of commendation from engineers and architects relative to the Kahn system of reinforced concrete. It shows the Kahn trussed bar to be represented in all the leading cities of this country and to have been incorporated in important government, municipal, railroad and private work.

*The Railway Appliances Company*, Chicago, in catalogue No. 116, describes the Oldsmobile railroad inspection car, for which it is sole agent. The catalogue, which is an eight-page pamphlet, presents the Model No. 2 Tonneau Car, larger than that shown in previous catalogues and designed to carry six persons. The catalogue has a letter from W. S. Kinnear, Chief Engineer of the Michigan Central, on performance of the car.

# CONTRIBUTIONS

## Incomes on Private Cars.

Chicago, Oct. 22, 1904.

To the Editor of the Railroad Gazette:

I have read with much interest your editorial on the private-car abuse and the hearing at Chicago last week; and have also seen a great deal of comment on the refrigerator car business in the daily papers; but one or two of the most significant things brought out at that hearing appear to have escaped the attention of the reporter, and I think your readers will be glad to have their attention called to them. The assertion by Mr. Midgley that the packers probably made as much profit out of the mileage receipts on their refrigerators as from the products carried in the cars appears to have been quite fully corroborated. Mr. F. A. Spink, Manager of the National Car Line, testified that his company had leased 50 refrigerator cars from the Swift Refrigerator Co., at a rental of $20 per car per month. Now, taking the average value of such cars at $800 each, this gives a gross return of 30 per cent. per annum.

But the most startling figures on this point, were brought to light in the examination of Mr. J. S. Leeds, Manager of the Santa Fe Refrigerator Despatch Co. He testified that the cars operated by his company were leased from the Atchison, Topeka & Santa Fe Railroad, the lease providing that no mileage should be paid for use of the cars on the owner's lines. The Refrigerator Company assumes the entire cost of repairs and management, and in addition the payment of 5 per cent. per annum on the capital invested. He stated that an average of about 65 per cent. of the cars were used free on the Santa Fe system, and the mileage earned on other roads by the remaining 35 per cent. of the cars, had been found amply sufficient to pay 5 per cent. per annum to the owners, and to cover all outlay for repairs and management. If, therefore, such results can be secured on 35 per cent. of the mileage of these cars in ordinary traffic, subject to the usual delays incident to movement in slow freight trains, with about the average miles per car per day produced by cars owned by railroads, what must be the profits on packers' cars, which—owing to the grip of the owners on railroads—have to be run at the speed of express trains, often averaging 180 and 200 miles per car per day, and every mile—loaded and empty—paid for?

This kind of a searchlight, when turned on this subject, discloses evidence which must convince the government and railroad managers that serious abuses exist; and it is up to these officials to devise means by which the evils complained of may be removed. If the railroads cannot agree to act together on this matter—and everybody admits that they do not know how to go to work individually—they should at least be willing to support every such effort as this to turn the X-rays on an iniquitous business.

S. R. H.

## The Manibill.

The manibill, as used on the Central of Georgia, is already well known to most of the readers of the *Railroad Gazette*. It was described in the issue of March 15, 1901, and at other times. This word was coined as a name for the blanks for waybills, freight bills, delivery receipts, notices of arrival, and other forms, when made of uniform size and so worded as to permit the whole of these documents—one of each—to be written at one writing by the use of carbon paper. The idea has been extended still farther by the addition of tissue sheets for copies to be retained either at the sending or receiving office.

The manibill has now been in constant use on the Central of Georgia for the past four years, and Mr. W. D. Beymer, auditor of the road, in answer to an inquiry, says that it takes only 1,160 manibills to cover the number of consignments formerly billed on 1,000 waybills; a statement which indicates that the proportion of waybills bearing only one entry was on that road very large. And the cost of paper is not increased at all for the quantity used is less. The manibill is 7 in. x 8½ in., therefore 1,160 manibills measure 69,020 sq. in. for the waybill portion. If the waybill of the former customary size (say one-half size 8½ x 11 and one-half 4¼ x 14) had been used it would take 89,250 sq. in. of paper, or 20,230 sq. in. more. No "Freight Received Book" is kept. Mr. Beymer says that notwithstanding an increase of 50 per cent. in freight receipts since the adoption of the manibill, there has been no increase in the number of revising clerks in the freight accounting office.

No more store room is required for records, though these are kept for seven years. It is found that about 15 per cent. of the manibills have to be corrected in weight or extensions at destination, but the clerk does not write a new freight bill except where the correction causes an increase in the amount of the bill. For a shipment where the weight is subject to correction, the billing agent omits the weight and charges from the freight bill portion.

It was expected that on the adoption of the single consignment manibill, the increase in work on the abstract, statistical and assorting desks in the accounting department, would be in exact ratio to the increase in number of bills, but it has been found that the work under the two methods of billing has been nearly equalized by the greater facility with which typewritten bills of smaller size are handled.

It was the practice under the waybill system to require of destination agents two records or reports of waybills received.

1. An abstract or report to the Freight Auditor.

2. A register of freight-bills to the agency cashier, and, in former years—

3. A record of waybills received as is now required by some lines.

Since the adoption of the single consignment manibill, the abstract to the Freight Auditor, the register to the agency cashier and the record of waybills received, are made by carbon process at one writing, saving greatly in labor. Under ordinary methods, the abstract and the register are separate and distinct, necessitating not only duplicate writing, but balancing of register against abstract or vice versa, both of which are avoided by the use of the combined abstract, register and record. The increases in work of the accounting department, if any, from the use of the single consignment manibill, will fall principally upon junior clerks who assort the billing and check it against abstracts, while the benefits from the use of the typewriter and more careful work of agents because of the use of a copy of the manibill as a freight-bill to the consignee, has fallen upon the higher salaried revising and statistical clerks.

Mr. Beymer says that where the number of consignments per waybill averages more than 1¼, and for heavy movements between large towns and cities, blanket manibills should be used. There are many advantages to agents in the single consignment form and because of the small average number of consignments per waybill under the old system, the single consignment form only is used on the Central of Georgia, although the Ocean Steamship Company, which is owned by that road, used a manibill of three consignments for several years prior to the adaptation of the idea by the railroad. The principle of the manibill can also be used for freight destined to another road to be settled for at a junction, or in interline freight accounts. In the latter event the name of the destination line is printed on the freight bill or is omitted therefrom and is inserted by the agent at destination with rubber stamp.

On the Central of Georgia a special form of manibill is made for the use of conductors of local freight trains; this has a blank for a receipt to be given by the conductor to shipper at a station where there is no agent. This is said to have proved much more satisfactory than the former plan of having such shipments billed by the agent at the next station.

A proposition has recently been made to include the bill of lading in all manibills; that is to say, to get the shipper to make out not only the shipping order but also the waybill, freight bill, etc. We do not understand that this proposition is approved by the Central of Georgia or by anyone who has had experience with the manibill. It seems probable that the percentage of corrections that would have to be made would be very large.

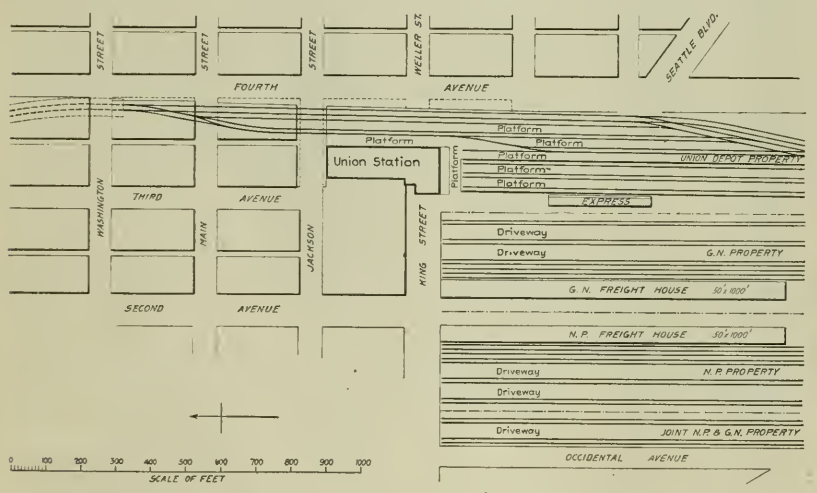
## Great Northern Terminal Improvements at Seattle.

The city of Seattle, Wash., lies between Puget Sound on the west and Lake Washington on the east. The coast line along the sound is deeply indented by Elliot Bay and between Elliot Bay and Lake Washington is a high ridge about 2½ miles wide at the narrowest point and broadening out to greater width at the north and south ends. The business district of the city is on this ridge sloping down to Elliot Bay, which forms the city's fine harbor. The Sound waterfront is fringed with a narrow strip of tide lands at the northern end and this spreads out into a tide flat of considerable area along the southeast shore of the bay.

The Great Northern enters Seattle from the north, coming down along Puget Sound from Everett. At Interbay, a suburb of the city about four miles out from the business center, it is joined by a branch line of the Northern Pacific coming into Seattle from the northwest, and at this point there are extensive freight terminals. The Great Northern continues south until it strikes the tide lands on the north shore of Elliot Bay and then turns east, following the shore line on a pile trestle over the tide lands, until it reaches the terminal station on the water front at the foot of Columbia street. The Northern Pacific enters Seattle from the south and enters the same station which it uses jointly with the Great Northern. Both roads have freight depots and delivery tracks for city freight on ground reclaimed from the tide flats at the foot of King street, east of the passenger station.

Seattle has grown rapidly and steadily in the last few years and is now one of the four important shipping centers on the Pacific coast. Besides serving the city itself, which has a population of about 120,000, the Great Northern and the Northern Pacific handle all of the export and import business to and from the Far East, which has also increased tremendously, and the existing terminals for both freight and passenger business are old and entirely inadequate for present needs. The railroad lines and the docks both being along the busy water front has created a congestion that interferes so seriously with main line traffic as to make some change imperative in order to afford relief. The vicinity of the present terminals is the only suitable place in the city and to carry out the plans for improvements, a large amount of additional land was acquired east of the old terminals on which to build new freight and passenger stations and the necessary yards and tracks to serve them. Because of the peculiar conformation of the land on which the city is built, the only way to approach the terminal from the north other than over the present line along the water front, was to build a tunnel under the high ground of the business district. This was decided upon since it was imperative to do away with the congestion along the docks.

Work on this tunnel was begun in May, 1903. It will be 5,104 ft. long and is expected to be completed this month. The north portal of the tunnel is between Virginia and Stewart streets, and from this point it runs southeast until it reaches Fourth avenue, under which it turns on a 4-deg. curve. For the remainder of its length it follows under Fourth avenue, turning south at Jefferson street on another 4-deg. curve. The south portal is about two blocks beyond this curve, between Washington and Main streets, and within less than two blocks of the new passenger station. The object in swinging so far to the east was to get under Fourth avenue, where the only rights required for prosecuting the work could be granted in a franchise obtained from the city; and also to get sufficient cover for the tunnel, the descent from Fourth to Third avenues being so abrupt as to make a line under the Third avenue impracticable. The maximum cover over the tunnel is 125 ft.



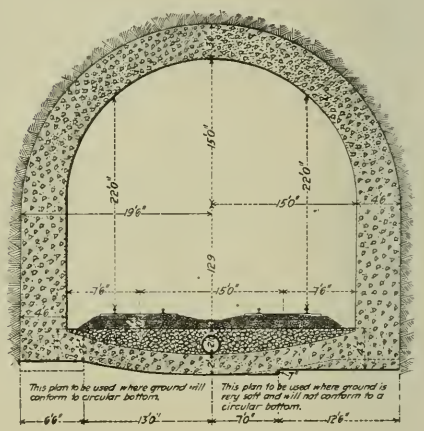

Plan of Great Northern Terminal Improvements at Seattle.

A section of the tunnel is shown in one of the illustrations. Its greatest width is 30 ft., giving 15 ft. between centers of track. The roof is semi-circular, on a 15-ft. radius, and the vertical clearance from the outer rails is 22 ft. The lining is concrete, 4 ft. 6 in. thick at the sides and 3 ft. 6 in. thick at the crown. An invert 2 ft. deep, of two different forms, as shown by the drawing, depending on the nature of the soil, has been used for the greater portion of the length of the tunnel. The filling is coarse broken stone up to sub-grade, above which is stone ballast 10 in. deep under the ties.

Many difficulties have been encountered in driving the tunnel. The material is principally clay, of varying consistencies, and containing numerous hard and soft pockets and strata of sand and gravel, some of which carry a considerable amount of water. This water has been the cause of most of the trouble. The peculiar nature of the material and the ground formation is such that wherever water is encountered there is a tendency of the strata above the tunnel, along the hillside, to settle in an oblique direction, and constant watchfulness and care had to be exercised to avoid damage to any of the buildings above.

The method of driving the tunnel for most of the distance has been by bottom advance drifts at both corners, with a drift at the crown following a little behind. A second drift is then cut above each corner drift, the two extending high enough to permit the concrete of the walls to be put in up to a little above the springing line of the arch. The semi-circle is then completed by winging out from the top drift, and timber arching is placed outside of the concrete line. The core thus left is removed by Thew electric shovels, except where a threatened settlement, as explained above, makes bracing necessary, when it is removed by hand shovels. One of the most complete applications of electricity to tunnel driving that has ever been made, has been used on this work. The power, which is direct current, is obtained from the Snoqualmie Falls Power Company. Mining locomotives, Thew electric shovels, belt conveyors, electric hoists, concrete mixers, ventilating fans, etc., are all driven by electric motors.

A part of material removed from the tunnel has been used to fill in the trestle along the tide lands, and a part to fill in the site of the new passenger and freight terminals and yards. This tract is located on the northeastern edge of the broad tide flat lying southeast and south of Elliott Bay, already referred to. It was reclaimed by filling to a depth of 15 ft., which will bring the tracks 7 ft. above high tide.

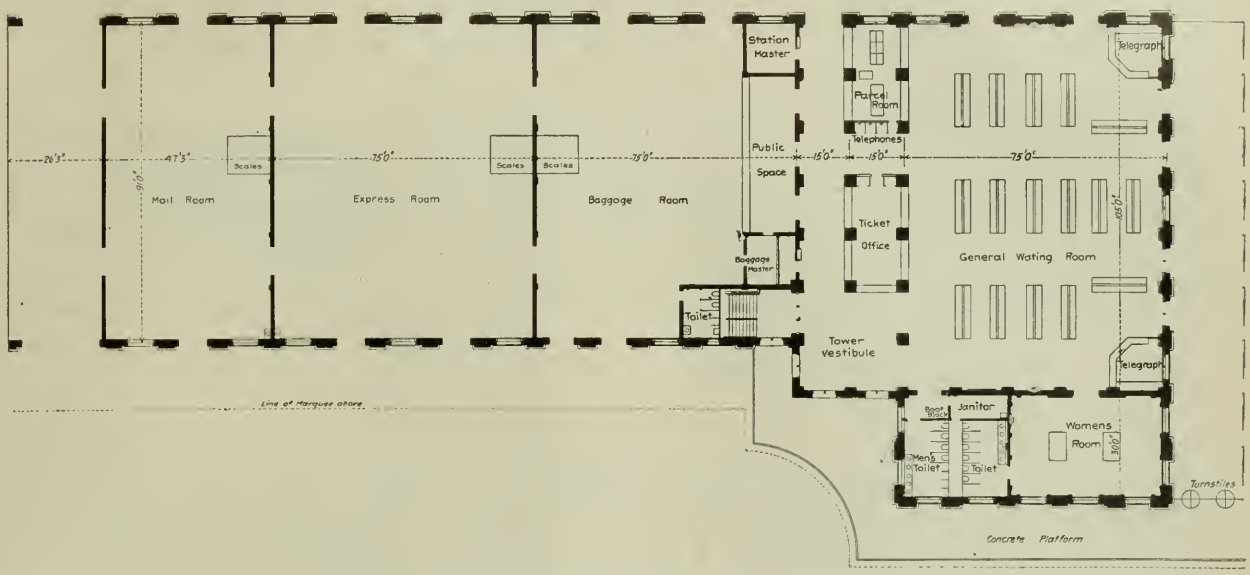



Section of Seattle Tunnel.

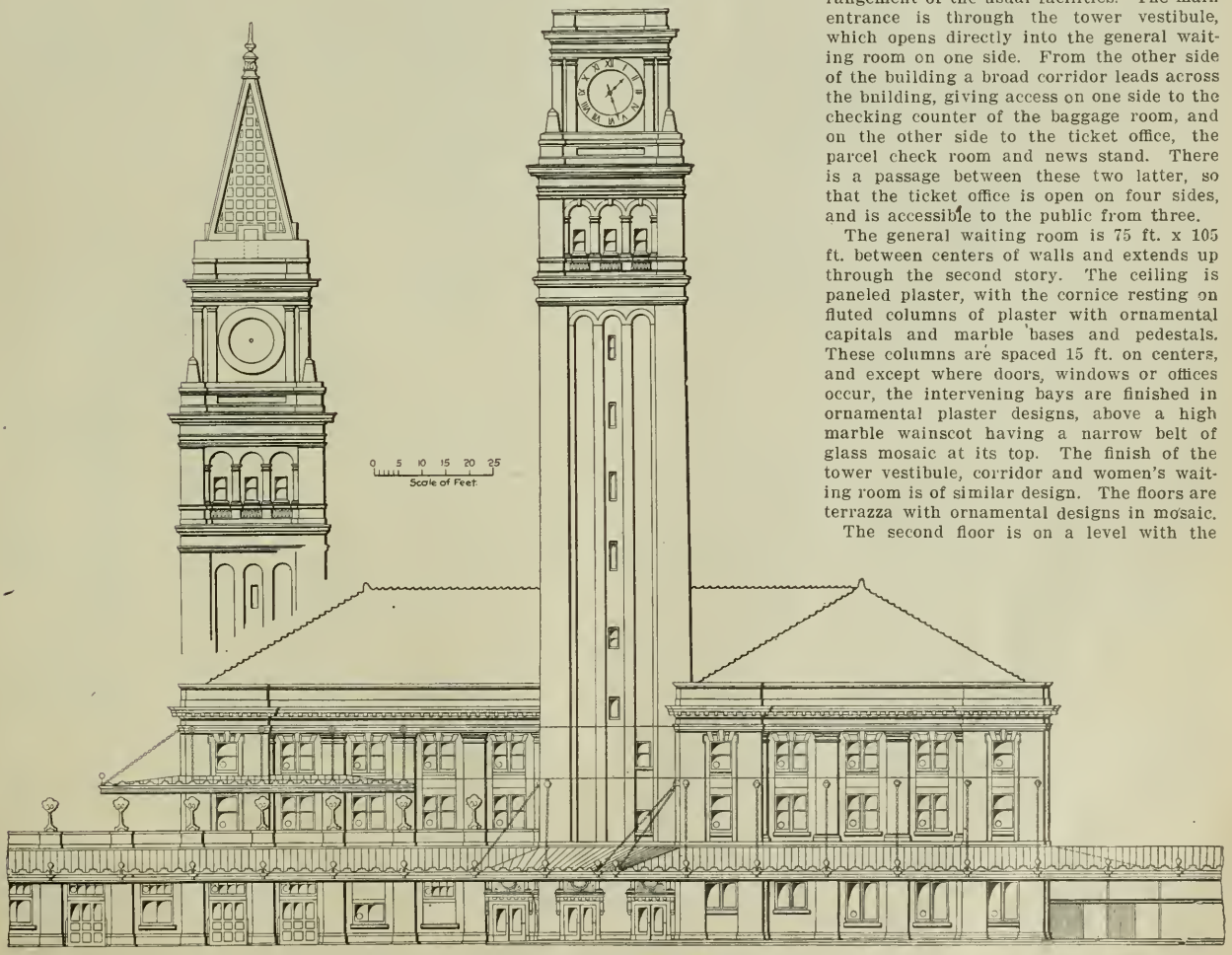
The new passenger station will be the joint property of the Northern Pacific and Great Northern, and will be on the west side of the main tracks, south of Jackson street, on the site of the old freight depots. It will extend back from Jackson street 330 ft. and will face west, its greatest east-and-west dimension being 155 ft. and the least, 95 ft. The first 184 ft. from the north end is devoted to mail, express and baggage rooms, and is one story high. Jackson street is to be carried over the tracks on a viaduct on a level with the top of this wing of the station, the roof of which will form an approach or driveway from the viaduct to the headhouse, with concrete walks on each side.

The headhouse is a three-story structure with a tower 245 ft. high on its west front. The foundations of the entire building are concrete on a grillage of I-beams for the walls and tower, and of corrugated bars for the piers, the whole resting on piling. The first story is granite, and the remainder is red pressed brick. The roof is tile with glass tile skylights and copper valleys and gutters.

The first floor plan shows a convenient ar-




First Floor Plan of New Passenger Station at Seattle for the Great Northern and Northern Pacific.




Elevation of West Front of Great Northern Passenger Station at Seattle.

rangement of the usual facilities. The main entrance is through the tower vestibule, which opens directly into the general waiting room on one side. From the other side of the building a broad corridor leads across the building, giving access on one side to the checking counter of the baggage room, and on the other side to the ticket office, the parcel check room and news stand. There is a passage between these two latter, so that the ticket office is open on four sides, and is accessible to the public from three.

The general waiting room is 75 ft. x 105 ft. between centers of walls and extends up through the second story. The ceiling is paneled plaster, with the cornice resting on fluted columns of plaster with ornamental capitals and marble bases and pedestals. These columns are spaced 15 ft. on centers, and except where doors, windows or offices occur, the intervening bays are finished in ornamental plaster designs, above a high marble wainscot having a narrow belt of glass mosaic at its top. The finish of the tower vestibule, corridor and women's waiting room is of similar design. The floors are terrazza with ornamental designs in mosaic.

The second floor is on a level with the

driveway from the viaduct and a 15-ft. corridor leads back from the entrance to a transverse balcony corridor on the north side of, and overlooking, the general waiting room. On the left or east of the entrance corridor are the kitchen and dining room, while the corresponding space on the right side will be occupied by offices. The entrance corridor has terrazza floor, plaster walls with marble base, and plaster ceiling with plaster cornice and beams. The balcony corridor is finished in harmony with the general waiting room and the finish of the dining room is similar to the corridor, except that there is an oak wainscoting and oak trimmings and counters. The kitchen, pantry and serving room have a terrazza wainscot.

The west walk of the approach extends along the west front of the headhouse to a concrete stairway leading down to an entrance into the tower vestibule on the first floor. The third floor of the building is arranged for offices and the corridor floors are finished with terrazza and the office floors with vertical-grained fir. A ventilating system for the toilet rooms, slop sink rooms, dining room and kitchen will be controlled by a motor-driven disc exhaust fan on the fourth floor of the tower, blowing through an opening back over the roof. The building will be heated by steam and lighted by electricity.

The baggage and express rooms are each 75 ft. wide and the mail room 47 ft. 3 in. They have cement floors, unplastered side walls and concrete arch ceilings. As already mentioned, their roof forms the approach from the viaduct. The driveway above is asphalt and the walks, which are 16 ft. wide, are concrete. An ornamental stone parapet on which are ornamental lamp posts 7 ft. high and 15 ft. apart guards each side of the approach.

The walks on all four sides of the building are roofed over by marquees of ornate design, those on the north and west fronts of the headhouse being supported by chains from above, and the remainder by gas pipe columns resting on concrete block footings. The marquees are composed of a framework of structural steel trusses and purlins, overlaid with $^{7}/_{16}$-in. factory ribbed glass. A row of electric lamps, spaced 15 ft. apart, ornaments their outer edge.

There will be eight standing tracks for the station in addition to the five tracks on the east, two of which are the main line. It has not been decided what protection for passengers will be provided, though in all probability it will be umbrella sheds. The platforms between tracks and around the building are composed of 12 in. of cinder filling thoroughly tamped, above which is 4 in. of concrete, including a ¾-in. finish.

The plan shows the location of the new freight houses for the Great Northern and Northern Pacific, together with team tracks, driveways, etc. They will be 50 ft. wide and 1,000 ft. long, the north end of the buildings for 200 ft. being two stories and the balance one story. They will be of brick on concrete and pile foundation. The track sides will be open and equipped with rolling steel doors from end to end. The approach to the freight terminals will be from the present tracks along the water front, which will be retained to handle the business for the docks. The yards and freight terminals at Seattle are only intended for local requirements as all Oriental freight will be handled at the Interbay terminals.

The entire work has been under the direction of Mr. A. H. Hogeland, Chief Engineer of the Great Northern. Mr. A. Stewart, Resident Engineer, Seattle, has had direct supervision of the work, and Mr. A. D. Stevens, Tunnel Superintendent, has had charge of the construction of the tunnel. Reed & Stem, St. Paul and New York, are the architects for the station.

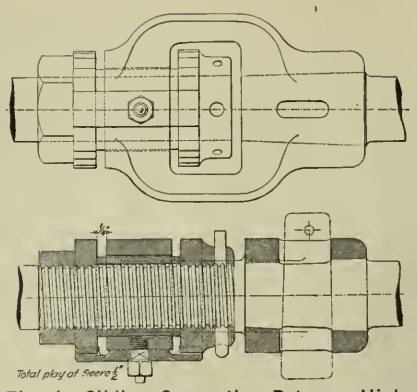



Fig. 4—Sliding Connection Between High and Low Pressure Valve-Spindles.

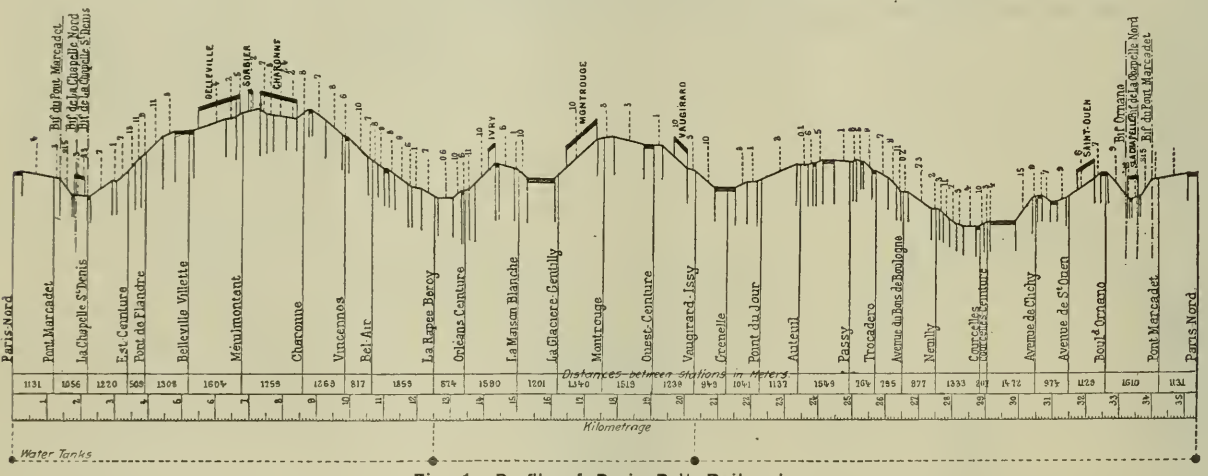



Fig. 1—Profile of Paris Belt Railroad.

## New Locomotives for the Paris Belt Railroad.*

The "Petite Ceinture," or Belt Line, of Paris, has recently put into operation 15 locomotives specially designed and built for the service by the Northern of France. These engines have been built to handle the increasing passenger traffic. The conditions to be met by the designers were the following. The trains are made up of eight cars:

| | Weight, tons. |
|---|---|
| 2 baggage cars | 16.0 |
| 5 second class carriages, with 72 seats | 67.5 |
| 1 first class carriage, with 40 seats | 14.5 |
| These carry 570 passengers, sitting and standing | 39.9 |
| Total train load | 137.9 |

These weights are in metric tons so that the train load is about 150 tons of 2,000 lbs. The circuit of Paris is 19.57 miles on the outer track, and is made in 65 minutes, of which 50 minutes is net running time with 15 minutes for station stops, of which there are 29. The average running speed is therefore 18 miles an hour, including stops. The distance between stations varies from 1,640 ft. to 5,775 ft. The profile which is given in Fig. 1 shows grades of 1 per cent. and 1½ per cent. There are a number of tunnels in which the adhesion is poor. The designers were given a free hand with the view of getting an engine of low first cost, easy of maintenance, and capable of giving the service required with a moderate coal and water consumption. It was, however, specified that the weight per axle should not exceed 36,375

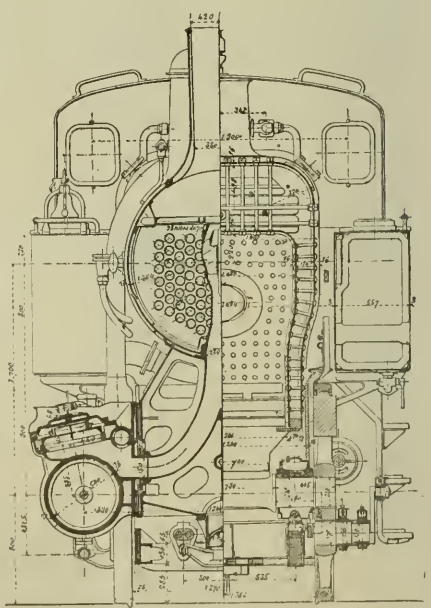


Fig. 3—Sectional Elevation—Paris Belt Locomotive.

*Abstract of an article by J. Koechlin, Chief Designer of the Northern of France, in the *Revue Générale des Chemins de Fer*, May, 1904. Translated by Lawford H. Fry.

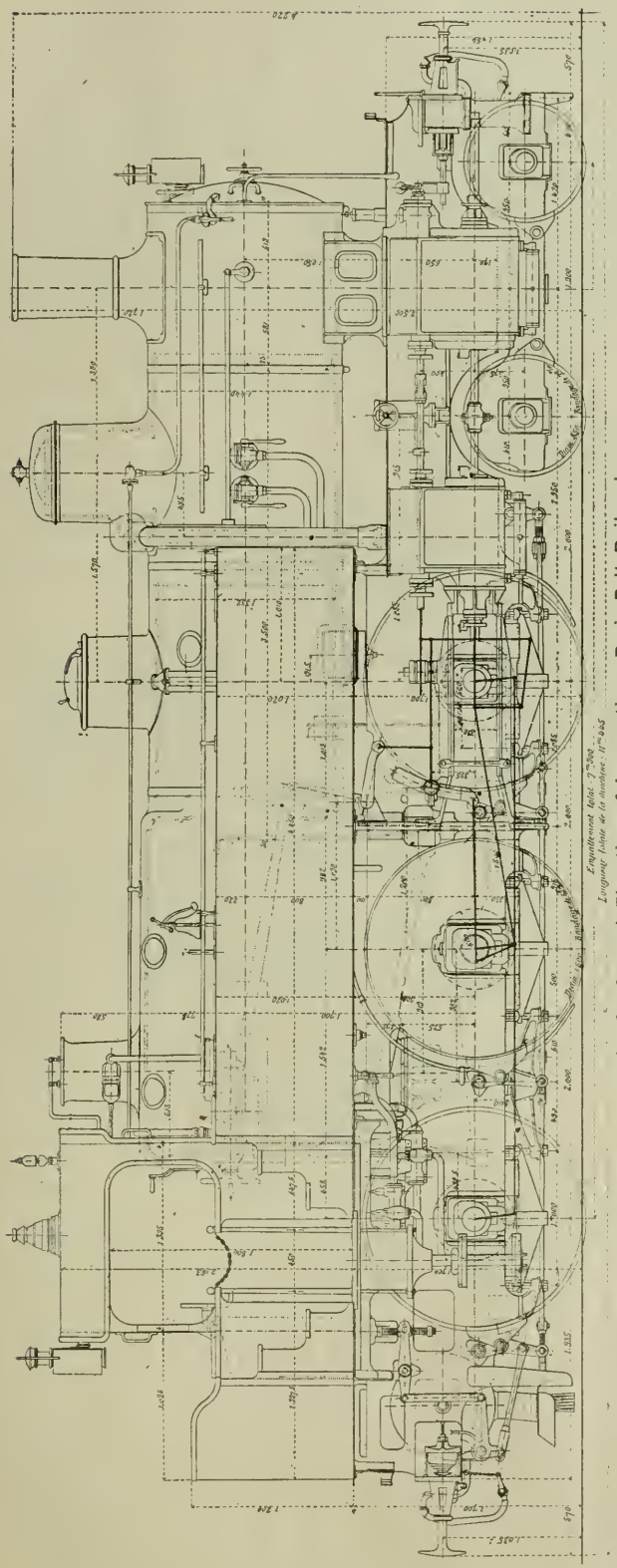


Fig. 2—General Elevation of Locomotive—Paris Belt Railroad.

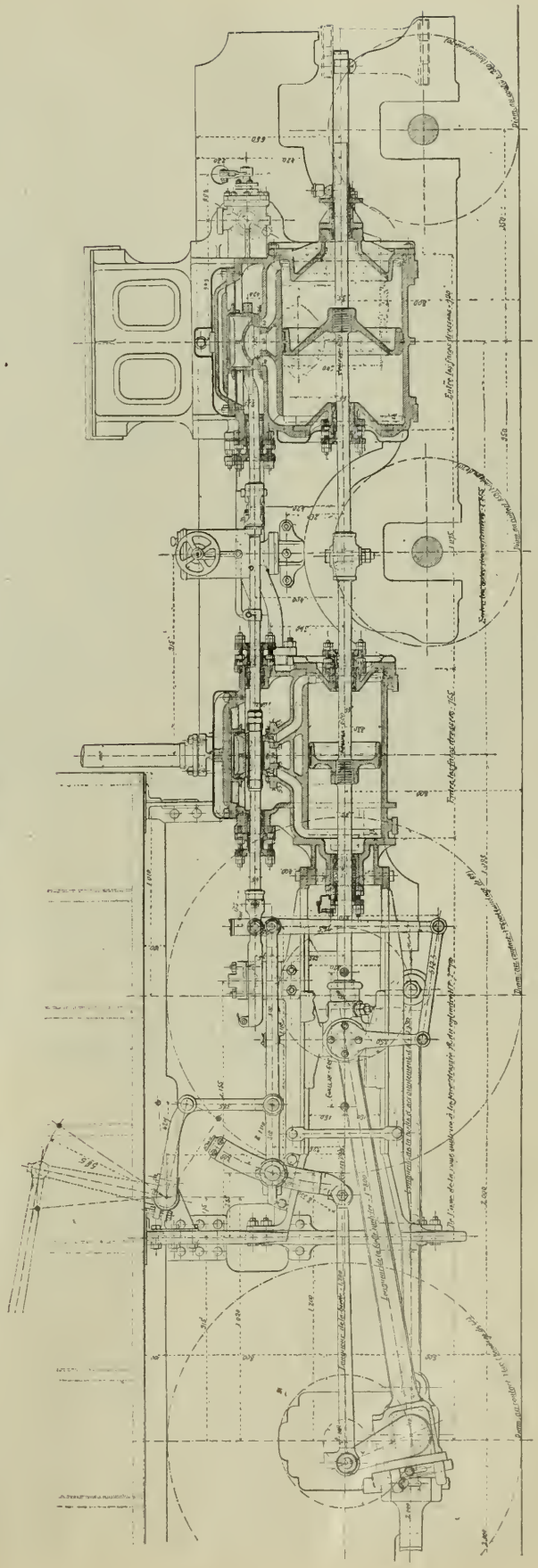


Fig. 6—General Arrangement of Valve Motion—Paris Belt Locomotive.

lbs., and that the engine should turn on a table 31 ft. in diameter.

In order to find out what type of engine was best suited to the onerous conditions of service a number of tests were made with several engines of different types. These engines were run over the road with the dynamometer car of the Northern of France, and tests were made to determine the least possible time in which the circuit could be made without an unduly high fuel consumption. The tests showed that it was desirable to have an engine with large driving wheels, and of considerable boiler capacity. The locomotive as designed and built is shown by Figs. 2 and 3, the principal dimensions being tabulated below. The type is 4-6-0 tandem compound, with side tanks and no tender, the weight on all driving axles being brought up to the maximum limit of 36,375 lbs. on each axle. The coal bunkers hold 6,600 lbs. and the water tanks have a capacity of 1,320 gal., which is enough to make a complete circuit without taking in water. The tractive effort is 22,000 lbs. It was considered advisable to use compound cylinders as these gave the best results in the tests. The compound cylinders have the advantage of developing a large tractive effort without the use of the inconveniently large cylinders necessary on a single expansion engine. They also give an economically long expansion of the steam and allow a gentle exhaust which gives good results with the fire.

The boiler is of moderate dimensions with a large grate and carries a high pressure. The boiler working pressure is 227 lbs. per sq. in., being chosen high in order to obtain a high tractive effort on starting, without the use of live steam in the low pressure cylinders. Serve tubes are used as being the best for an engine working with a high rate of combustion. Brake-shoes are applied to all wheels, including the truck. All dead weight beyond that necessary to keep the truck on the track, has been rigorously avoided, because all momentum acquired on starting must be dissipated in making a stop. The boiler has been made comparatively small to keep down the weight. This is practicable in the present service, for if the boiler pressure drops on starting, the blower can be used when steam is shut off to make a stop, and the pressure can thus be brought back to the normal.

It having been decided to use compound cylinders, the choice lay between two or four cylinders and between two or four valve motions. The two-cylinder compound has the disadvantage of making tractive power on the two sides unequal on starting, and in the Belt service there is a great deal of starting. The four-cylinder type of compound was therefore chosen, and to facilitate rapid inspection and to keep down the weight, a single outside valve motion was chosen. The use of four compound instead of two single expansion cylinders means an increase in weight of about 5,700 lbs., but the advantages of compounding fully justify this extra weight. By using the tandem compound system it became desirable to have an intermediate receiver of sufficient capacity to maintain a nearly equal pressure of admission to the low-pressure cylinders. For this purpose the right and left hand low-pressure steam chests are joined and are made of large capacity. In order to give sufficient pressure in the receiver there must be a difference between the cut-off in the high and low-pressure cylinders. As both valves are driven by the same mechanism it is necessary to delay the low-pressure exhaust by a special arrangement which is described in detail below. The main dimensions are:

| | |
|---|---|
| Diameter high-pressure cylinder | 13 in. |
| Diameter low-pressure cylinder | 21¼ in. |
| Stroke | 23⅝ in. |
| Boiler pressure | 228 lbs. |
| Driving wheel, diameter | 63 in. |
| Weight on driving wheels | 104,000 lbs. |
| Weight, total, in working order | 139,300 lbs. |
| Tractive effort: | |
| (*a*) Compound | 22,500 lbs. |
| (*b*) With live steam in l.-p. cylinders | 28,900 lbs. |
| Heating surface: Tubes (fire side) | 1,396 sq. ft. |
| Fire-box | 109 sq. ft. |
| Total | 1,505 sq. ft. |
| Grate area | 25.2 sq. ft. |
| Capacity of side tanks | 1,320 gals. |
| Capacity of coal bunkers | 6,600 lbs. |

The steam distribution shows some special features. The valve motion is arranged to give considerable difference between the cut-off in the high and in the low-pressure cylinders, and has a special arrangement of starting valves. It has been found that in order to obtain the maximum economy with a compound locomotive with ordinary slide valves the steam pressure in the receiver must not exceed from 35 to 40 lbs. per sq. in. The reason for this was explained recently by M. Nadal in the *Revue de Mécanique*. To obtain these conditions in a locomotive of the above type under ordinary running conditions, that is to say with an average cut-off of 40 per cent. in the high pressure cylinders, it is necessary to have a cut-off of about 60 per cent. in the low pressure cylinders. By reducing the lap of the low pressure valves the difference between the high and the low pressure cut-off can be made about 8 or 10 per cent., but with these figures the pre-admission becomes considerable. In order to give a difference of 20 per cent. when both valves are driven from the same valve motion, a play of about one-half inch is arranged in the sleeve connecting the low pressure valve spindle to the high pressure spindle. This arrangement is shown in detail in Fig. 4. At the same time the low pressure lap is reduced by half the amount of play given to the low pressure valve.

Table 1 shows the phases of the steam distribution in both cylinders for 40 per cent.

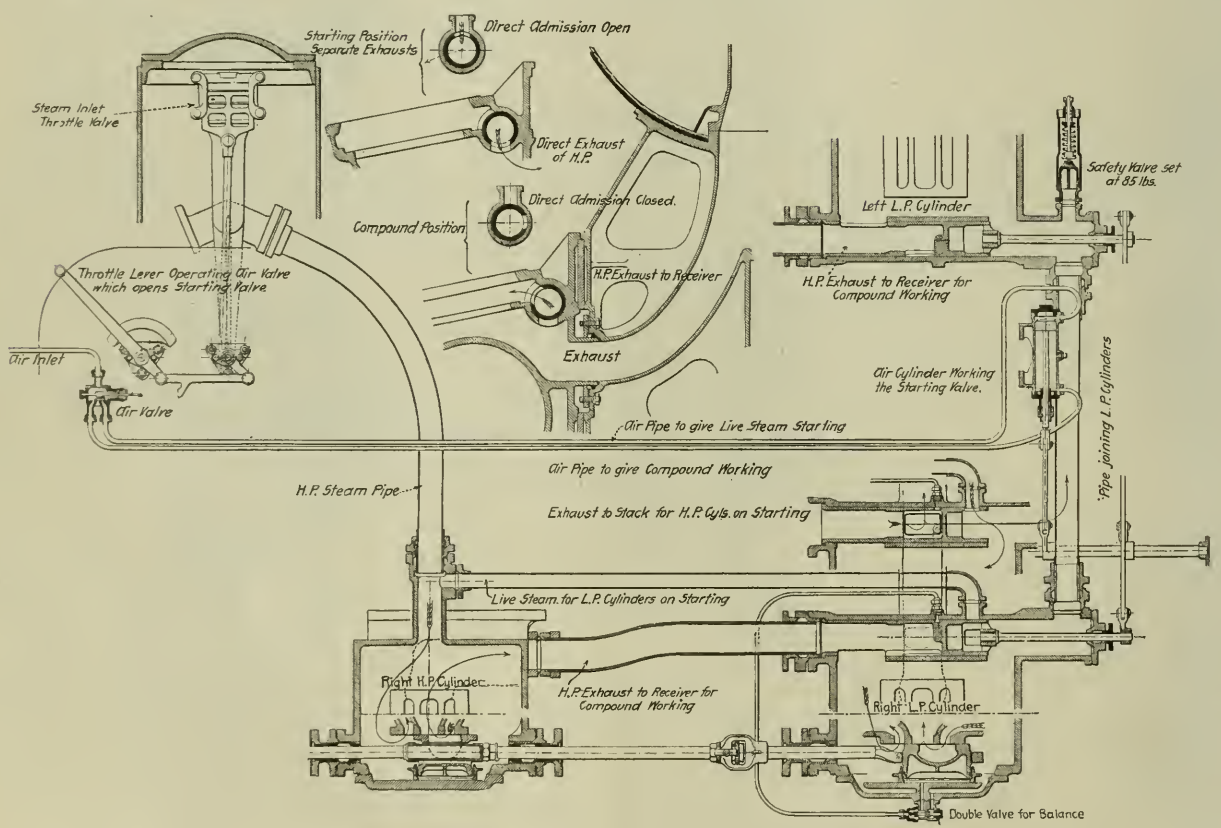

Starting Position Separate Exhausts
Direct Admission Open
Steam Inlet Throttle Valve
Direct Exhaust of H.P.
Direct Admission Closed.
Compound Position
Throttle Lever Operating Air Valve which opens Starting Valve
H.P. Exhaust to Receiver
Air Inlet
Air Valve
Exhaust
Left L.P. Cylinder
Safety Valve set at 85 lbs.
H.P. Exhaust to Receiver for Compound Working
Air Cylinder Working the Starting Valve.
Air Pipe to give Live Steam Starting
Air Pipe to give Compound Working
Pipe joining L.P. Cylinders
H.P. Steam Pipe
Exhaust to Stack for H.P. Cyls. on Starting
Live Steam for L.P. Cylinders on Starting
Right H.P. Cylinder
H.P. Exhaust to Receiver for Compound Working
Right L.P. Cylinder
Double Valve for Balance

Fig. 5—Diagram Showing Steam Distribution and Starting Valve.

cut-off in the high pressure cylinder and also for 60 per cent. high pressure cut-off.

Table No. 1.

| | Cut-off, 40% in h.-p. cyl. | | Cut-off, 60% in l.-p. cyl. | |
|---|---|---|---|---|
| | H.-p. | L.-p. | H.-p. | L.-p. |
| Lap of valve, inside, ins.. | −0.12 | −0.12 | −0.12 | −0.12 |
| Lap of valve, outside, ins. | 1.00 | 0.75 | 1.00 | 0.75 |
| Maximum steam port opening, ins. ..... | 0.43 | 0.43 | 0.71 | 0.71 |
| Lead, ins. ..... | 0.20 | 0.20 | 0.20 | 0.20 |
| Cut-off, p. ct. of stroke, % | 40 | 60 | 60 | 75 |
| Expansion in per cent. of stroke, %. ..... | 35 | 22.5 | 25 | 15 |
| Anticipated exhaust in per cent. of stroke, %. | 25 | 17.5 | 15 | 10 |
| Maximum exhaust port opening, ins. ..... | 1.38 | 1.30 | 1.38 | 1.58 |
| Exhaust in per cent. of stroke, %.... ..... | 80 | 85 | 87.5 | 91 |
| Compression in per cent of stroke, %..... | 18 | 13 | 11.5 | 8 |
| Pre-admission in per cent. of stroke, %. ..... | 2 | 2 | 1 | 1 |

It can be seen from the table that while this arrangement does not increase the low pressure steam port opening, it has the advantage of increasing the time that this port is open. It is found that, because of the stopping of the valve at each end of its stroke, the maximum port opening lasts from 10 to 40 per cent. of the stroke, while if there

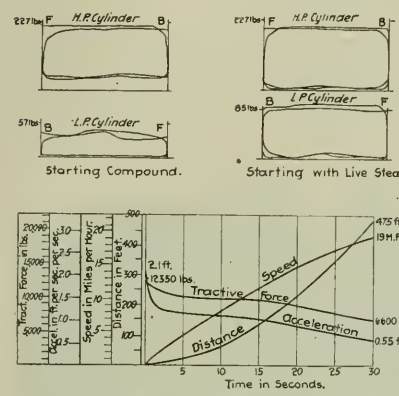



Fig. 7—Indicator and Acceleration Diagrams—Paris Belt Locomotive.

were no play in the valve spindle the valve would gradually close the port from 10 to 40 per cent. of the stroke. This arrangement has proved entirely satisfactory in service, giving a satisfactory steam distribution and working well at speeds up to 45 miles an hour. It must be borne in mind that the speed at which the spindle is moving when it picks up the valve, is very slight, the high pressure valve being near the end of its stroke, and, further, the weight of the valve and spindle which have to be put in motion, is not great.

The cylinders are designed to be large enough to start the train with live steam admitted to the high pressure cylinders only, but in order to start under difficulties or to make an exceptionally quick acceleration, a starting valve is arranged to admit live steam to the low pressure cylinders and at the same time to permit the high pressure cylinders to exhaust direct to the stack.

Fig. 5 shows this starting valve in diagram form. Fig. 6 shows the general arrangement of the valve motion. A 2 in. pipe is run from the high pressure steam pipe to the low pressure steam chest. The valve in this pipe is operated by an air motor. No special movement is needed to open this valve, but if the throttle lever is pulled all the way open a tappet operates the air valve, which works the starting valve and lets live steam into the low pressure steam chest. At the same time the high pressure exhaust is opened to the stack. If the throttle lever is moved slightly in the closing direction the air valve is released and automatically closes the low pressure live steam valve putting the engine into position for compound working.

The Northern of France made a number of tests of these locomotives with their dynamometer car. It was found that live steam could not be admitted to the low pressure cylinders for more than 10 or 15 seconds without lowering the boiler pressure.

The curves in Fig. 7 show the results of starting tests with normal trains of 220 tons (2,000 lbs.) including engine, live steam being admitted for the first few revolutions only and the engine then being worked compound. These figures may be compared with the Paris Metropolitan engines, which require from 18 to 20 seconds for the first 250 ft. The diagrams of Fig. 7 show that the new engines make the first 250 feet in from 17 to 21 seconds on a level, according as they start with live steam or as a compound. It must be borne in mind, however, that the Metropolitan trains weigh 95 tons empty, or about half the weight of those for the new engines. The Manhattan elevated electric trains run 650 feet in 30 seconds from the start, while in the same time these new Belt engines make 625 feet. It may be added that in ordinary service the engines are started as compounds without using live steam.

The Northern company's Department of Tests took advantage of the trials to figure out the work done by the locomotive when the time allowed for starting was varied. It was important to know what was the cost of gaining a few minutes in a run including a large number of stops such as that of the circuit of Paris. The following figures were obtained. They correspond to:

The original service before being accelerated.

The accelerated service with the new engines.

An ultra-accelerated service using all the power of the new engines.

Several trains were run in these three classes of service. The increase in the power developed is shown in Table 2.

have passed the station if the brakes had not been applied.

The figures in the table show that for a gain of 15 minutes in a run of 67 minutes, or say 22 per cent., the drawbar pull of the locomotive is increased 75 per cent.

The figures also show that the new locomotives are capable of developing 1,000 h.p., for a short time at least. Even if we take the nominal horse-power at only 800, the weight of the engine in working order is only 172 lbs. per horse-power, or 143 lbs. for the engine empty.

It is interesting to see how large a percentage of the work produced by the engine is dissipated by the brakes, nearly 57 per cent. of the total power developed on the fastest run has to be thrown away by applying the brakes. The figures show how difficult it is, mechanically speaking, to accelerate a schedule by increasing the speed, and how extremely desirable it would be in a suburban service to have some means of storing up the enormous quantity of work which is destroyed and absolutely lost in the process of braking. In a service as outlined above made up of starts and stops following in rapid succession it is advantageous to keep down the weight of the train as much as possible, and this has been well considered in designing the engines described.

## American Railway Association.

The fall meeting of this Association was held at Philadelphia October 26. Mr. C. G. Waldo, Second Vice-President, presided, and about 135 delegates were present. Mr. Geo. A. Post, Chairman of the General Committee on Arrangements for the American Railway Appliance Exhibition, to be given at Washington at the time of the International Railway Congress in May, 1905, stated that it is the desire of the manufacturers to erect a building on a small section of the government reservation, near the Washington monument. To permit this it will be necessary to get leave from Congress. It is hoped that Congress will act favorably, in which event an exhibition will be given which will be of the greatest interest to the delegates, both American and foreign, attending the Congress.

Several amendments to the by-laws were adopted. The Executive Committee reported that the membership now comprises 273 members, operating 217,372 miles, and that the associate membership comprises 10 members, operating 266 miles.

The Association adopted a resolution providing that eight delegates from the Asso-

TABLE NO. 2.

| | Slow. | Accelerated. | Ultra-accel. |
|---|---|---|---|
| 1. Class of service ..... | | | |
| 2. Effective running time ..... | 67 min. 47 sec. | 60 min. 27 sec. | 52 min. 36 sec. |
| 3. Maximum indicated horse-power..... | 524 | 637 | 1,005 |
| 4. Speed corresponding to maximum power, m. p. h..... | 27.6 | 33.5 | 36.0 |
| 5. Average speed for the circuit of Paris ..... | 17.2 | 19.3 | 22.1 |
| 6. Percentage of speed increase over slow train..... | .... | 12.2 | 28.8 |
| 7. Average drawbar pull for the circuit in pounds..... | 4,907 | 5,664 | 7,331 |
| 8. Percent. of increase of drawbar pull over slow ..... | ... | 15.4 | 49.5 |
| 9. Total work, at d.-b., during circuit, millions of ft.-lbs. | 264 | 334 | 463 |
| 10. Percentage of increase in work..... | ... | 26.5 | 75.4 |
| 11. Work dissipated by brakes during circuit in millions of ft. lbs. ..... | 124 | 174 | 262 |
| 12. Percentage of increase in work of braking..... | ... | 40.3 | 111.5 |
| 13. Work of braking in per cent. of total work..... | 47.0 | 52.0 | 56.7 |

The maximum horse-power shown in line 3 is calculated from actual indicator diagrams. The total work in line 9 is found by multiplying the tractive effort by the distance run under steam in making a circuit of Paris. The work dissipated in braking is the sum of the work done in making the 29 stops on one circuit. The work dissipated in stopping is calculated by the formula $\frac{M V^2}{2}$ where M is the mass of the train drawn and V the speed at which the train would

ciation be accredited to the seventh session of the International Railway Congress; these delegates to be the President and Secretary of the Association, and six other persons to be selected by the President. The Association also voted to increase the membership of the American Section from 26 to 28 members.

The Executive Committee reported that 57 railroads in North America are now members of the Congress, entitled to 327 delegates. These, in addition to the

eight delegates of the American Railway Association and the 16 delegates of the United States Government, will make a total of 351 delegates from America, outside of the official delegates from Canada and Mexico. It was also reported that advice had been received from the Department of State that 18 countries have announced their intention to be represented at the Congress, as follows: Argentine Republic; Belgium; British India; Cuba; Denmark; Dominican Republic; Great Britain; Greece; Guatemala; Honduras; Mexico; Netherlands; Paraguay; Peru; Roumania; Servia, Siam, and the Transvaal.

An addition to Rule 6, of the Code of Per Diem Rules, was adopted, to take effect Jan. 1, 1905, as follows: "In case the road so delivering or authorizing the delivery of a foreign car connects directly with the road which does not pay per diem, penalty shall accrue as if delivery had not been made."

The Committee on Safety Appliances presented a code of rules governing the determination of physical and educational qualifications for those seeking employment and for candidates for promotion, and after a short discussion, at the request of the committee, they were referred back to it for further consideration.

Mr. Theo. Voorhees, First Vice-President of the Philadelphia & Reading, was elected First Vice-President.

The next meeting of the Association will be held in New York City, and as provided in the amendment to the by-laws adopted by the Association, that meeting will be held on Wednesday, April 5, 1905.

## The Young Valve and Gear for Locomotives.

For more than three years a new design of locomotive valve mechanism has been quietly undergoing test and perfection on the Chicago & North Western. Its development has been directly under the supervision of its designer, Mr. O. W. Young, of Chicago, whose idea, briefly, is a system of rocking valves—the Corliss principle adapted to locomotive practice. During the period mentioned two North Western locomotives have been equipped with the mechanism, the first being a light American type, and the later one a Class D, Atlantic type passenger locomotive, which has been thoroughly and satisfactorily tested under all conditions, including fast passenger service.

The primary object Mr. Young desired to attain was to produce a valve mechanism that would enable locomotives to attain and maintain higher speeds than are possible with present practice; and to do it not only without sacrifice of economy from present practice, but with improved performance if possible. The accompanying drawings and photograph show pretty clearly the design and arrangement of the valves and gear. There are two valves to each cylinder, similar in form and position to Corliss practice and driven by the Corliss wrist motion through the usual link and rocker. Each valve controls admission and exhaust for its end of the cylinder, and is formed with two openings through its body. One, the larger, is vertical and is for the exhaust. The smaller is transverse and permits freer circulation of the live steam in reaching the lower port, part of the steam passing around the ends of the valve.

The valve has four longitudinal packing strips and an equal number at the ends, the latter being to enclose the exhaust cavity. As mentioned above, the live steam circulates around and through the valve. The packing strips are held outward against the bushing by spring pressure, thereby readily accommodating themselves to any irregularities in the seat. Small rectangular grooves are formed on the inner sides of the longitudinal strips to enable the small amount of steam that will find lodgment there to balance the pressure on the edges opposite and thus permit the strips to move freely in their grooves. This also reduces the bearing surface of the strip against the groove and thereby reduces the liability of its sticking from the presence of gum and foreign substances.

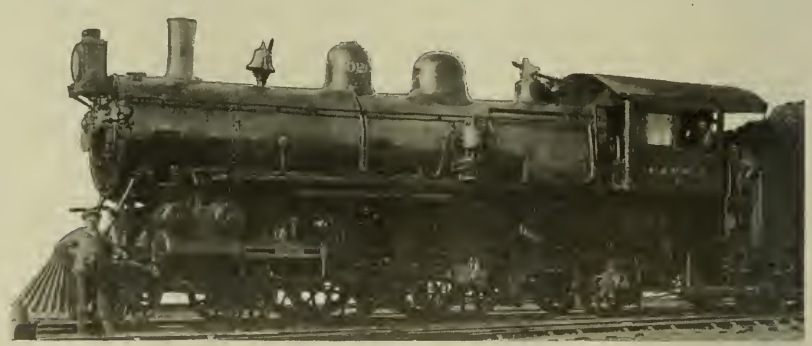
Wrought-iron spindles are pressed into and keyed to the valve body at each end. The valve chest has but one removable head, the other being formed integral with the body, with an opening through which the driving spindle of the valve passes and which forms a bearing for it. There is no provision for packing this spindle in its passage through the end wall of the steam chest. It is given a slight taper and is shouldered at the inner and outer ends of the journal. The joints which these shoulders form with the end wall are ground, and the inner, which is the larger and therefore receives the greater part of the thrust, has five or six grooves cut across it to permit oil from the steam chest to reach the bearing. This provides all of the lubrication that is necessary, and as the taper of the journal is such that in automatically taking up any wear in the bearing no binding will result, the bearing requires no attention whatever between shoppings of the locomotive. No trouble from leakage has been experienced with it.

The presence of a shallow groove in each steam chest bushing will be noted. This groove is placed so that the steam strip will overlap it when the valve reaches the extremity of its travel. As the most severe stress is imposed on the valve gear at the time of reversal of motion, by letting live steam under the strip at this point it largely relieves the pressure from above, thereby reducing the stress in the gear and consequently the wear.

The wrist-plate is shown in the details, and also the bearing for it; and in the combination and arrangement of these two is embodied one of the most ingenious and important features of the design, namely, the provision for a variation of the lead to conform to changes in cut-off. As viewed in the drawing the bearing has two horizontal arms supporting the journal on which the wrist-plate moves. The whole piece—the wrist-plate bearing—is supported in bearings, one of which is bolted to the outside of the rear steam chest and the other to the saddle. A downwardly-projecting arm, approximately at right-angles to the others, is connected through a short adjustable rod to a tumbling shaft supported across the back of the saddle, and which in turn is connected by a special reach rod to the main tumbling shaft. This reach rod is pivoted to a short arm fixed rigidly on the latter, and which is horizontal in mid-gear. The end of this arm moves in the arc of a circle, therefore as the tumbling shaft moves it draws this reach rod back slightly and results in raising the center about which the wrist-plate oscillates. This changes the relations of the valves to the ports, thereby affecting the lead.

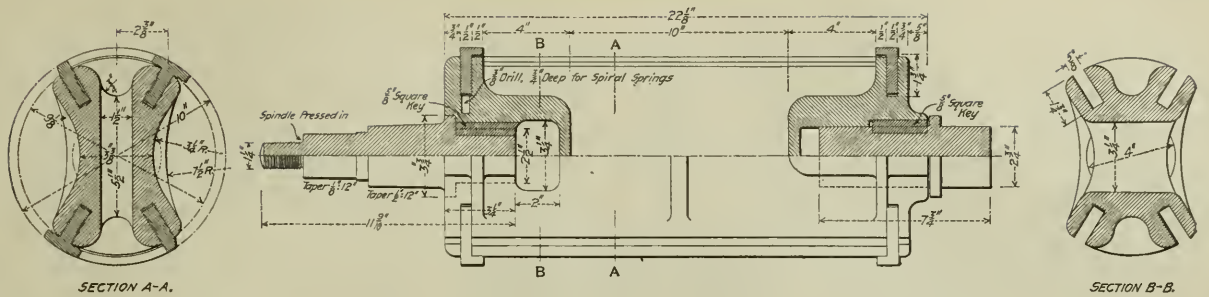
Steam enters the chest through the port just above the middle of the inner side, part passing out through the top port to the passage cored around the bushing leading to the cylinder port; and part passing around and through the valve and out through the port at the bottom of the chest opening directly into the cylinder port. The exhaust passes out into the steam chest through these same ports and escapes through the large port near the bottom. The action of the lead-change mechanism is such that a constant or slightly increased steam lead can be obtained for the shorter cut-offs. The exhaust lead is also increased as the cut-off is shortened, the design being such that a lap at long cut-offs is changed to a clearance at short cut-offs.

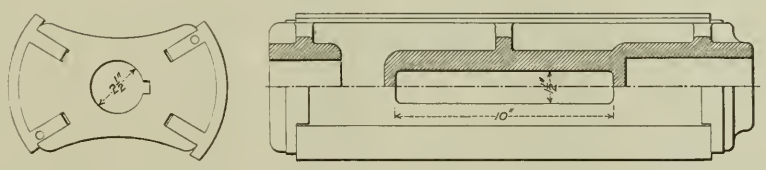
A series of indicator cards is shown which were taken in regular service from the locomotive shown in the photograph. This locomotive has 20-in. x 26-in. cylinders, 81-in. drivers, 200 lbs. boiler pressure and a 4¾-in. exhaust nozzle. During the first test the engine had a 10-car train weighing 535 tons, and on the second day four mail cars weighing 200 tons. Cards 1 to 12 were with the heavy train and 13 and 14 with the other. It will be observed that at no time with the heavy train was the throttle fully open, although a speed of 75 m.p.h. was reached. At starting, a five-eighths throttle opening was used. This opening was increased to seven-eighths but shortly reduced to one-half and was never again increased beyond three-quarters. An interesting feature of these cards is the low back pressure, which in some cases, and notably at 55 m.p.h., is zero, and at 63 m.p.h. is only 2 lbs. The data for cards 13 and 14 show the capabilities of the locomotive in the way of speed. The speeds were read from a Boyer recorder and checked by a revolution counter. In all of the cards, even that at 95 m.p.h., the valve events, with the exception of release at the extremely high speeds and the extremely short cut-offs, are readily discernible. The short cut-offs at which some of the cards are taken is notable, card 4 being the shortest, at 2½ in.



Chicago & North Western Passenger Locomotive Fitted with the Young Valve and Gear.

Another set of cards shows a comparison between the steam distribution of the Young valve and gear and a Chicago & North Western standard piston valve for this class of locomotive. The data for these cards are found in Table I. Valve motion diagrams are also shown for full-gear and at 25 per cent. cut-off. The principal results are given in Table II. The results especially to be



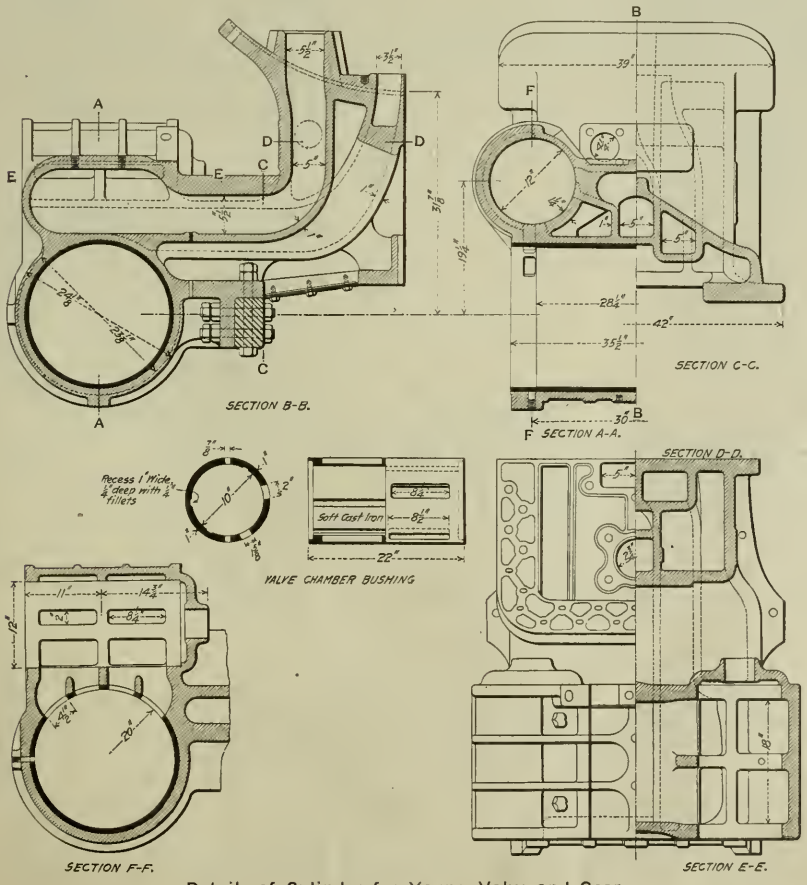

Details of Young Valve.

noted and compared are the exhaust events at 25 per cent. cut-off, particularly the length of time the port is open. The result of the change of exhaust lead of the Young valve for the short cut-off may be noted in the diagram.

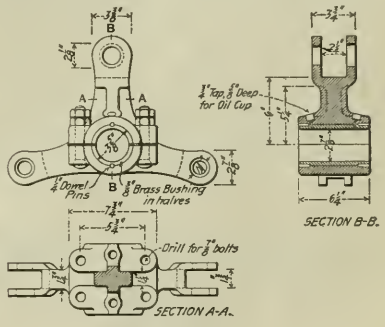
In the matters of performance and maintenance the results have been most gratifying. The locomotive has never lost a trip or made a failure since this mechanism was put on it. So constantly is it kept in service by reason of its excellent performance and uniformly good condition, that last week it had a record of 1,200 miles in 60 hours. In this connection the following, taken from a letter written by Mr. Robert Quayle, Superintendent of Motive Power and Machinery of the Chicago & North Western, is of interest. This letter was made up as a sort of circular reply to the many inquiries that have come from numerous sources, and covers the entire matter briefly. It says:

"The construction of the valves requires a special cylinder casting and therefore they cannot be used without a complete change. The actual cost of these cylinders, including the valves and changes in the motion, should not exceed 30 per cent. more than the cost of cylinders, valves, chests, etc., for a D or piston-valve locomotive. If, however, these cylinders were made standard to a road, I do not think they would cost more than $150 more per locomotive.

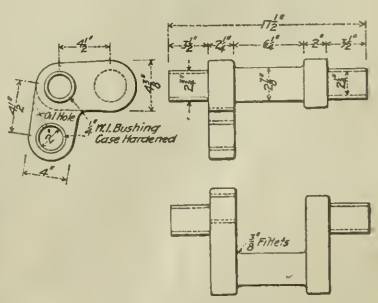
"In June, 1901, the first engine was equipped, and like all first attempts there were certain details shown up which needed improvement. The general results with this engine justified a second trial, and in September, 1903, a set of cylinders with the special valves and their motion were applied to a 20-in. x 26-in. Atlantic type (passenger) engine with 81 in. over the tires and 91,000 lbs. on the drivers. The experiments with this engine lasted some six or eight weeks, and in November, 1903, the engine was put regularly into service on the Galena division. The engine has been a 'tramp' up to a very recent date; has had all kinds of service, all kinds of engineers handling her,




Details of Cylinder for Young Valve and Gear.




Wrist Plate.




Wrist Plate Bearing.

Table I.—Valve Events.

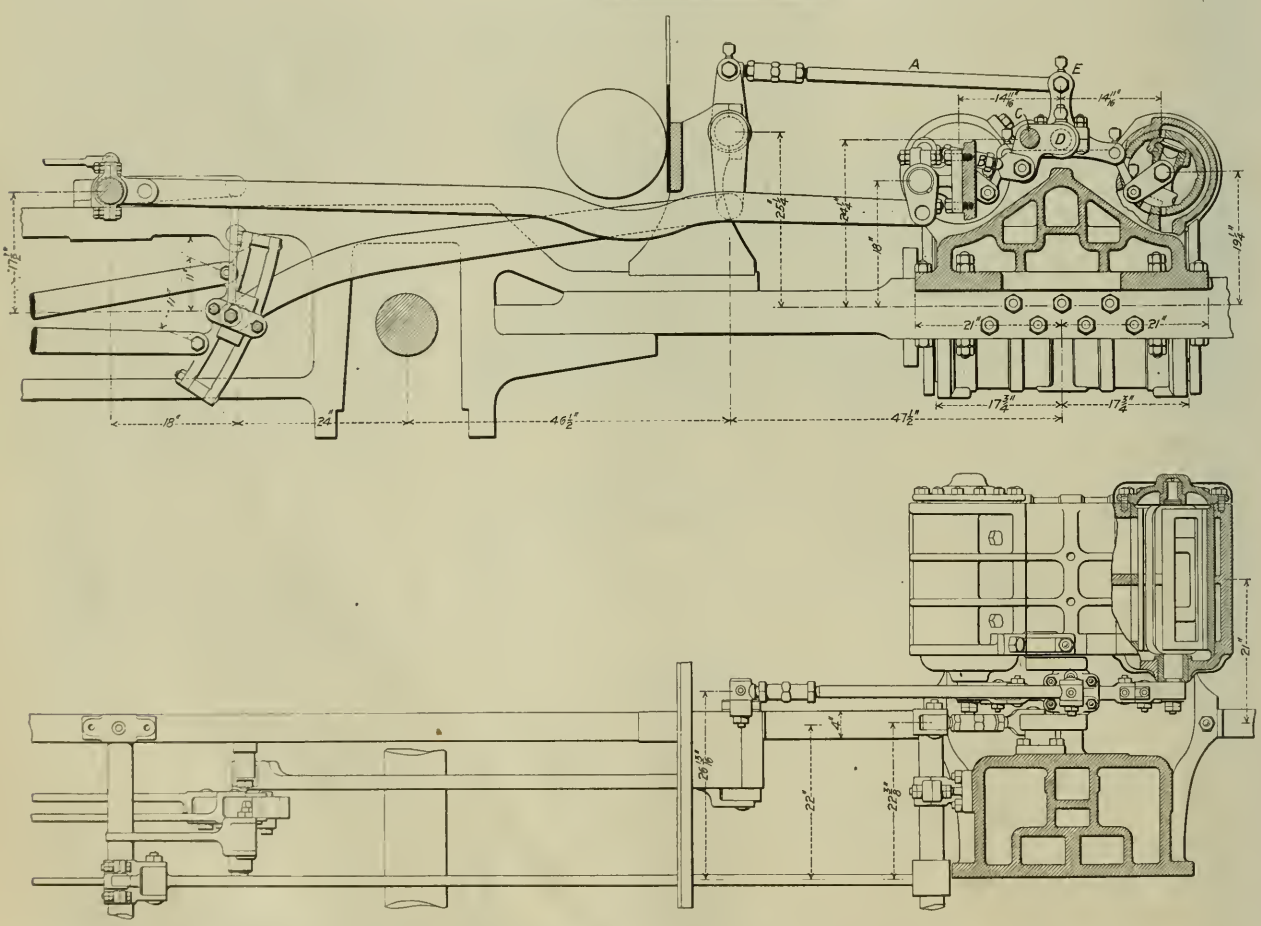
| | Slide valve. Full gear. | Slide valve. 25 per cent. cut-off. | Young valve. Full gear. | Young valve. 25 per ct. cut-off. |
|---|---|---|---|---|
| | | Steam. | | |
| Lead | — 1/16 in. | 1/4 in. | — 1/16 in. | 1/16 in. |
| Max. port opening occurs | 6 1/2 in | 3/4 in. | 1 1/4 in. | 1 1/2 in. |
| Width of port opening | Full (1 3/4 in.) | 1/4 in. | Full (1 in.) | 13/32 in. |
| Port starts to close | 14 in. | 2 in. | 19 in. | 2 in. |
| Port fully closed | 21 3/4 in. | 6 3/4 in. | 22 3/4 in. | 6 1/2 in. |
| | | Exhaust. | | |
| Port starts to open | — 1 1/2 in. | — 8 1/2 in. | — 1 in. | — 9 1/2 in. |
| Maximum port opening occurs | 3/4 in. | 1 in. | 0 in. | — 1 in. |
| Width of port opening | Full (1 3/4 in.) | 1 1/2 in. | Full (1 in.) | Full (1 in.) |
| Port starts to close | 20 1/4 in. | 4 in. | 22 in. | 14 1/4 in. |
| Port fully closed | 24 3/4 in. | 19 in. | 24 7/8 in. | 20 1/2 in. |

provements shown by the indicator cards are not entirely realized in actual performance records. In a series of comparisons made by the indicator the water rate per indicated horse-power was reduced from 22.9 lbs. to 19.3 lbs. The indicator cards also show the cause for the slight wear on the machinery, as the cards are remarkably full, the expansion lines being clear and distinct at all points of cut-off. Most of the work in passenger service is done at less than 6 in.

Table II.—Data from Indicator Cards Showing Comparison of Steam Distribution of Young Valve and Gear, and Chicago & North Western Standard Piston Valve.

| | Engine No. 1015 with Piston Valve. 1. | 2. | 3. | 4. | 5. | Total. | Average. | Engine No. 1026 with Young Valve. 1. | 2. | 3. | 4. | 5. | Total. | Average. | Per ct. of gain.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Card No. | | | | | | | | | | | | | | | |
| Revolutions per minute | 138 | 180 | 186 | 242 | 336 | 1,082 | 216 | 120 | 168 | 204 | 264 | 312 | 1,068 | 214 | .... |
| Miles per hour | 32 | 42 | 43 | 58 | 78 | 253 | 50.6 | 29 | 40 | 49 | 63 | 75 | 256 | 51.2 | .... |
| Inches of cut-off | 5 1/2 | 5 1/2 | 7 1/2 | 6 1/2 | 7 1/2 | 32.5 | 6.5 | 5 1/2 | 3 1/2 | 6 1/2 | 4 1/2 | 5 1/2 | 25.5 | 5.1 | .... |
| Initial pressure | 178 | 162 | 150 | 160 | 150 | 800 | 160 | 162 | 162 | 155 | 158 | 150 | 787 | 157 | .... |
| Pressure at cut-off | 118 | 120 | 95 | 96 | 92 | 521 | 104 | 134 | 142 | 136 | 128 | 125 | 665 | 133 | .... |
| Difference between initial and cut-off pressures | 60 | 42 | 55 | 64 | 58 | 279 | 56 | 28 | 20 | 19 | 30 | 25 | 122 | 24 | 57% |
| Pressure at release | 40 | 40 | 41 | 37 | 43 | 201 | 40 | 39 | 33 | 55 | 33 | 50 | 210 | 42 | .... |
| Initial back pressure | 3 | 5 | 6 | 8 | 15 | 37 | 7.4 | 0 | 0 | 8 | 2 | 8 | 18 | 3.6 | 51% |
| Mean back pressure | 18 | 21 | 20 | 22 | 33 | 114 | 22.8 | 4 | 10 | 14 | 16 | 24 | 68 | 13.6 | 40% |
| Mean effective pressure | 50 | 46 | 42 | 38 | 33 | 209 | 41.8 | 69 | 53 | 72 | 48 | 50 | 292 | 58.4 | 40% |
| Indicated horse-power | 144 | 171 | 164 | 191 | 231 | 901 | 180 | 166 | 178 | 293 | 256 | 316 | 1,209 | 242 | 34% |
| Pounds of steam per hour per I. H.-P.: At cut-off | 15.8 | 17.7 | 19.8 | 21.9 | 24 | 99.2 | 19.8 | 15.4 | 13.2 | 16.9 | 14.4 | 19.5 | 79.4 | 15.9 | 25% |
| Pounds of steam per hour per I. H.-P.: At release | 22.3 | 24.4 | 21 | 24.3 | 27.6 | 119.6 | 23.9 | 14.6 | 15.5 | 17.7 | 16.5 | 22.4 | 86.4 | 17.3 | 28% |

*For engine 1026.



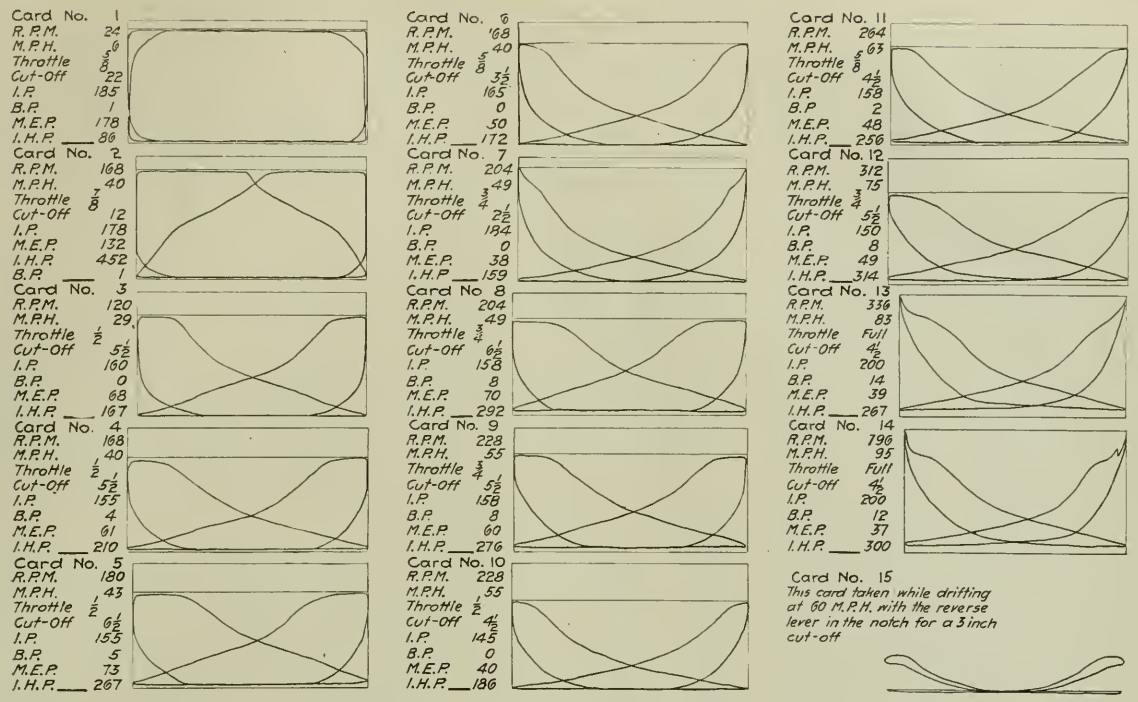

General Arrangement of the Young Valve and Gear.

and practically continuous service. It has so far made approximately 90,000 miles. The tires have not been turned, the eccentric straps have been closed once about 1/16 in. each, there is no pound in the boxes and the tool marks are still on the motion pins. These results are especially interesting to the motive power official, demonstrating as they do that the wear and tear on the machinery is so remarkably less than the engine with the D or piston valves. The engine is always ready for service, the roundhouse foreman reporting that for his part of it, five of this type would easily equal seven of the piston valve engines. There is one run between Chicago and Clinton with usually ten heavy cars on which this engine is the *only one* that can make the time.

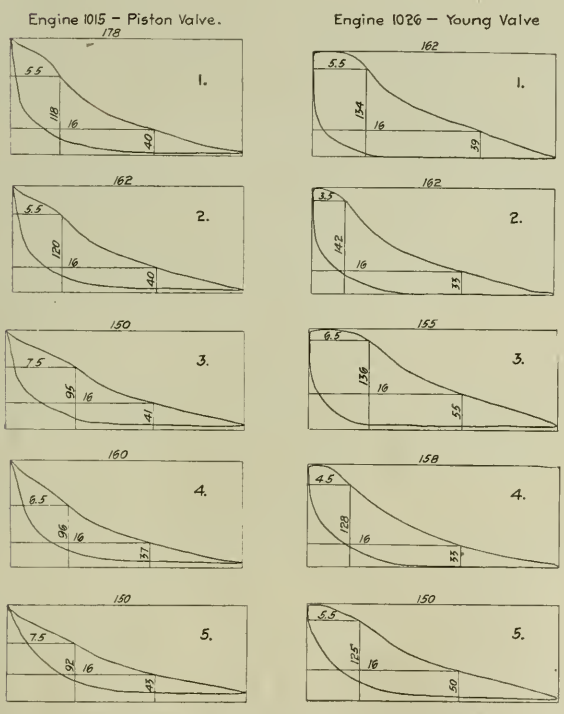
"The train despatchers know the value of this engine, also, as they do not hesitate to rely on it to make up time or take an unusually heavy run. As a consequence the im-

cut-off. On account of the high and full cards it is evident that the crank effort is more uniform and higher than with a slide-valve engine. Besides causing less wear on the machinery, this gives a more even torque when starting and consequently less slipping.

"The engine is one which will bear thorough investigation. While our experiments have been made in passenger service, I consider that the performance in freight ser-




Indicator Diagrams—Young Valve and Gear.



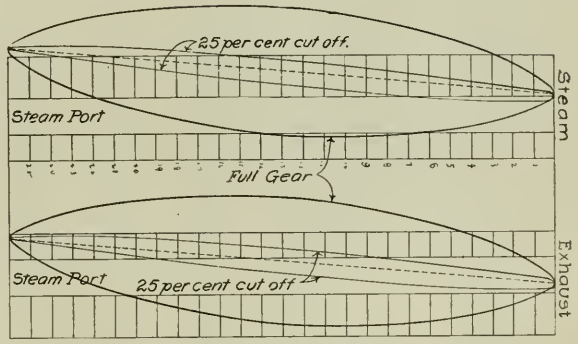

*Engine* 1015.

| | |
|---|---|
| *Cylinders* | 20¼x26 |
| *Clearance* | 5½ *per cent.* |
| *Boiler pressure* | 200 *lbs.* |
| *Nozzle* | 4¾ *in.* |
| *Drivers* | 78 *in.* |

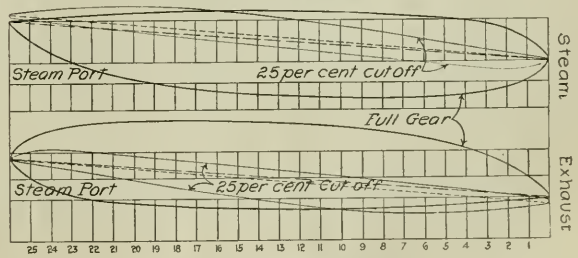
*Engine* 1026.

| | |
|---|---|
| *Cylinders* | 20x26 |
| *Clearance* | 6 *per cent.* |
| *Boiler pressure* | 200 *lbs.* |
| *Nozzle* | 4¾ *in.* |
| *Drivers* | 81 *in.* |

**Comparison of Steam Distribution of Young Valve and Gear and C. & N. W. Standard Piston Valve.**




*Link and Slide Valve Motion.*


Steam Port
25 per cent cut off
Full Gear
Steam
Exhaust
Steam Port
25 per cent cut off
25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

*Young Oscillating Valve Motion.*

**Comparative Valve Gear Diagrams.**

vice will show even better results from both an operating and economical standpoint."

It is but fair to add that the application to the 1,026 is only the second, and the results obtained with it suggest to the designer a number of points wherein he expects further to improve and perfect the mechanism and thereby increase its efficiency.

There is a general outcry, and has been for some months, in Belgium against the irregularity of the train service; the newspapers are full of complaints, including partisan attacks against the responsible minister. It is evident that passenger traffic has grown altogether out of proportion to station and yard accommodations. Recently on the arrival of a train in Liége from Brussels all the passengers gave three cheers, formed a procession, carried the conductor in triumph at its head, marched to the engine and presented the engineman with a bouquet, after which a congratulatory telegram was sent to the Railroad Minister. Some one inquiring what all this meant, he was answered that it was because at last a Brussels train had got in on time!

## Train Resistance.

BY CHESTER A. CRANDELL, M.E.

For the purposes of this article, train resistance will be defined as the number of pounds of drawbar-pull exerted in moving one ton of train weight under the specified conditions. Train resistance, thus defined, is dependent for its value upon a number of variables. The greatest accuracy must, therefore, be observed in its calculation, so-called approximations being seldom anything but misleading. The discussion of this subject will be separated into three divisions. First, a comparison of the calculated with the actual train resistance will be made. Second, an analysis of the several factors which influence train resistance will be presented, together with a comparison of the magnitudes of their influences. Third, the best-known formulæ will be compared with each other. The first two heads will be subdivided to consider separately passenger and freight trains.

*Actual and Calculated Train Resistance Compared.*—For the purposes of this comparison, the results of two locomotive trials have been plotted. One of these trials was made with a passenger and the other with a freight train; both being conducted under what are considered to be representative conditions.

*Passenger Train.*—Fig. 1 was plotted from the results given by a passenger train consisting of 11 cars weighing in all 377.23 tons. Two curves are shown, the one marked "Drawbar Pull" being referred to the ordinates whose scale appears at the left of the figure. The other curve, marked "Velocity," is referred to the right-hand scale. The various conditions of grade and curvature are noted on the figure. In order to avoid the errors incident to the changing of scales, the ordinates of both curves are the actual lengths taken from the dynamometer record.

Table 1.

| Seconds, from start. | Velocity in m. p. h. | Acceleration, ft. pr sec, per sec. | Seconds, from start. | Velocity in m. p. h. | Acceleration, ft. pr sec, per sec. |
|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | | | |
| 10 | 3.64 | 0.50 | 160 | 40.91 | 0.24 |
| 20 | 7.28 | .50 | 170 | 42.20 | .10 |
| 30 | 10.90 | .50 | 180 | 43.30 | .18 |
| 40 | 14.10 | .50 | 190 | 44.50 | .16 |
| 50 | 17.60 | .40 | 200 | 45.30 | .18 |
| 60 | 20.00 | .34 | 210 | 46.50 | .20 |
| 70 | 22.70 | .34 | 220 | 47.70 | .18 |
| 80 | 25.00 | .34 | 230 | 48.64 | .12 |
| 90 | 27.70 | .34 | 240 | 49.35 | .12 |
| 100 | 30.00 | .30 | 250 | 49.73 | .04 |
| 110 | 31.59 | .26 | 260 | 50.20 | .08 |
| 120 | 33.60 | .24 | 270 | 50.45 | .08 |
| 130 | 35.90 | .28 | 280 | 50.91 | .04 |
| 140 | 37.90 | .26 | 290 | 51.58 | .08 |
| 150 | 39.15 | .28 | 300 | 52.27 | .12 |

The accelerations as calculated from the inclination of the velocity curve (Fig. 1) are given in Table 1, and shown graphically in Fig. 2.

All the necessary data being now at hand, a basis upon which to compare the theoretical with the actual results must be decided upon. It is obivous that to reduce the actual conditions to those on a level tangent would be to destroy their value as data. Therefore the conditions for the theoretical calculations will be assumed to be the same as those existing in the actual case.

Let $R_t$ = Total train resistance in lbs. per (2,000 lb.) ton.

Let $R_a$ = Train resistance due to acceleration in lbs. per ton.

Let $R_v$ = Train resistance due to velocity in lbs. per ton.

Let $R_g$ = Train resistance due to grade in lbs. per ton.

Let $R_c$ = Train resistance due to curvature in lbs. per ton.

Let v = Velocity in miles per hour.

Let a = Acceleration in ft per sec., per sec.

Let T = Weight of train in (2,000 lb.) tons.

Then $R_t = R_v + R_a + R_g + R_c$.....[1]

Using Sprague's formula:

$$R_v = 4 + \frac{v}{6} + \frac{v^2}{3T} \text{.....[2]}$$

gives the results found in column headed $R_v$, Table 2.

Table 2.

| Seconds from start. | Lbs. per ton. Sprague's formula, $R_v$. | $R_a$. | $R_g$. | $R_c$. | $R_t$. |
|---|---|---|---|---|---|
| 0 | 4.00 | 0.0 | 0.0 | 0.875 | 4.00 |
| 10 | 4.62 | 31.08 | 0.0 | 0.875 | 36.58 |
| 20 | 5.26 | 31.08 | 0.0 | .875 | 37.22 |
| 30 | 5.93 | 31.08 | 0.0 | .875 | 37.84 |
| 40 | 6.53 | 31.08 | 0.0 | .875 | 38.49 |
| 50 | 7.20 | 25.86 | 0.0 | .875 | 33.94 |
| 60 | 7.68 | 21.12 | 0.0 | .875 | 29.68 |
| 70 | 8.23 | 21.12 | 0.0 | .875 | 30.93 |
| 80 | 8.72 | 21.12 | 2.1 | 0.0 | 29.84 |
| 90 | 9.30 | 21.12 | 2.1 | 0.0 | 32.52 |
| 100 | 9.80 | 18.61 | 2.1 | 0.0 | 30.51 |
| 110 | 10.09 | 16.15 | 2.1 | 0.0 | 28.34 |
| 120 | 10.59 | 14.90 | 2.1 | 0.0 | 27.59 |
| 130 | 11.13 | 17.40 | 2.1 | 0.0 | 30.63 |
| 140 | 11.47 | 16.15 | 2.1 | 0.0 | 29.72 |
| 150 | 11.87 | 17.40 | 2.1 | .665 | 32.04 |
| 160 | 12.30 | 14.90 | 2.1 | .665 | 29.97 |
| 170 | 12.67 | 6.22 | 2.1 | .665 | 21.66 |
| 180 | 12.89 | 11.37 | 2.1 | .665 | 27.03 |
| 190 | 12.95 | 9.94 | 2.1 | .665 | 25.66 |
| 200 | 13.37 | 11.37 | 3.803 | .665 | 27.51 |
| 210 | 13.66 | 12.40 | 3.803 | .665 | 30.53 |
| 220 | 13.96 | 11.37 | 3.803 | 0.0 | 29.13 |
| 230 | 14.19 | 7.45 | 3.803 | 0.0 | 25.44 |
| 240 | 14.36 | 7.45 | 3.803 | .500 | 26.11 |
| 250 | 14.46 | 2.48 | 3.803 | .500 | 17.44 |
| 260 | 14.59 | 4.96 | 0.0 | 0.0 | 19.55 |
| 270 | 14.67 | 4.96 | 3.186 | 0.0 | 22.82 |
| 280 | 14.77 | 2.48 | 3.186 | 0.0 | 20.44 |
| 290 | 14.95 | 4.96 | 3.186 | .500 | 23.60 |
| 300 | 15.11 | 7.45 | 3.186 | .500 | 26.25 |

$R_a$ must now be found. This may be calculated as follows:

We know that

$$F = ma \text{.....[3]}$$

or the force exerted upon the drawbar of a train will be equal to the mass of the train multiplied by the acceleration produced.

Obviously this force is exerted only because there is a resistance to acceleration due to the inertia in the mass of the train. Therefore, the resistance being measured by the force required to overcome it, may be substituted for "F" in equation [3] or

$$R_a = ma$$

As $R_a$ is measured in pounds per ton, $m = \frac{2,000}{32.2}$

$$\text{Therefore } R_a = \frac{2,000}{32.2} a$$

or $R_a = 62.1\ a$, at any instant.....[4]

The results given by equation [4] are tabulated in the column headed $R_a$, Table 2.

The resistance due to an up grade of one foot per mile is obviously

$$\frac{1}{5,280} \times \text{Weight}$$

or $R_g = \frac{1}{5,280} \times 2,000 \times$ (number of feet per mile rise).

Solving $R_g = .3788$ (number of feet per mile rise).....[5]

The results of calculation by equation [5] are given in the column headed $R_g$, Table 2.

For the resistance due to curves, Mr. George R. Henderson gives:

$R_c = 0.5$ (number of degrees of curve).

The results of these calculations are given in the column headed $R_c$, Table 2.

Now (equation [1]) we have

$$R_t = R_v + R_a + R_g + R_c$$

Therefore, adding the results in the previous columns of Table 2, gives the values in the last column, $R_t$, which are plotted in Fig. 3, and compared with the actual drawbar-pull curve from Fig. 1.

A glance at Fig. 3 shows immediately that the heavy pull in starting a train due to its inertia is not recognized in the formula. Indeed, no account is taken of this element, which may be called starting resistance, in any of the formulæ which have come to the author's attention, with the exception of that proposed by *Engineering News*. That it is of the greatest importance is at once evident, since, for all ordinary track conditions, this starting resistance measures the maximum pull which the locomotive will be called upon to exert.

A familiar method of overcoming some of the effects of this starting resistance is the common practice of "taking slack." In theory, this brings the starting resistances of the several cars to different points on the coördinate axis of time and thus distributes the instants of maximum drawbar-pull. That is, by the time the starting resistance comes into play on the last cars, the resistance of the first cars has dropped to a normal value.

*Freight Trains.*—In the case of freight trains where the ratio of the weight to the number of cars becomes much smaller than in passenger trains, the train resistance formulæ give results which differ widely from the actual values.

Fig. 4 presents the actual curves from the dynamometer record of a freight train trial. It is analogous to Fig. 1, and shows the velocities and drawbar-pulls of a 91 car freight train weighing 1,015 tons.

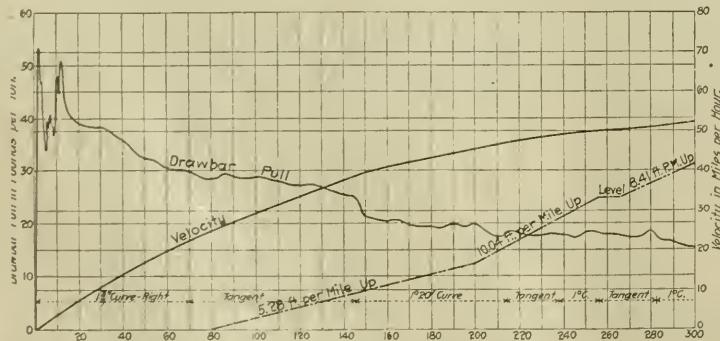



Fig. 1—Drawbar Pull and Velocity Curves of Passenger Train.

Table 3.

| Seconds, from start. | Velocity in m. p. h. | Acceleration, ft. pr sec, per sec. | Seconds, from start. | Velocity in m. p. h. | Acceleration, ft. pr sec, per sec. |
|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 160 | 14.34 | 0.0265 |
| 10 | 1.75 | .1192 | 170 | 14.71 | .0260 |
| 20 | 3.31 | .1063 | 180 | 14.90 | .0140 |
| 30 | 4.58 | .0865 | 190 | 15.10 | .0140 |
| 40 | 5.85 | .0860 | 200 | 15.40 | .0200 |
| 50 | 7.22 | .0930 | 210 | 15.50 | .0060 |
| 60 | 8.30 | .0530 | 220 | 15.60 | .0060 |
| 70 | 9.25 | .0660 | 230 | 15.60 | 0.0 |
| 80 | 9.85 | .0400 | 240 | 15.60 | 0.0 |
| 90 | 10.55 | .0470 | 250 | 15.60 | 0.0 |
| 100 | 11.15 | .0400 | 260 | 15.70 | .0070 |
| 110 | 11.70 | .0390 | 270 | 15.80 | .0070 |
| 120 | 12.30 | .0400 | 280 | 15.80 | 0.0 |
| 130 | 12.88 | .0400 | 290 | 15.80 | 0.0 |
| 140 | 13.45 | .0395 | 300 | 15.88 | .0050 |
| 150 | 13.95 | .0330 | | | |

Table 3 gives the accelerations as calculated from the inclination of the velocity curve in Fig. 4, these accelerations being plotted in Fig. 5.

Fig. 6, which is analogous to Fig. 3, gives very strikingly the great error in the the-

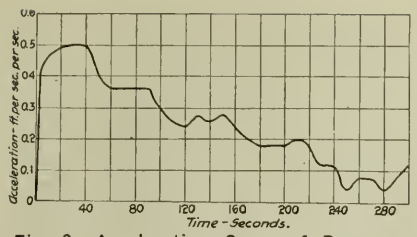



Fig. 2—Acceleration Curve of Passenger Train.

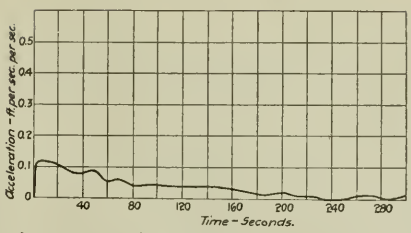



Fig. 5—Acceleration Curve of Freight Train.

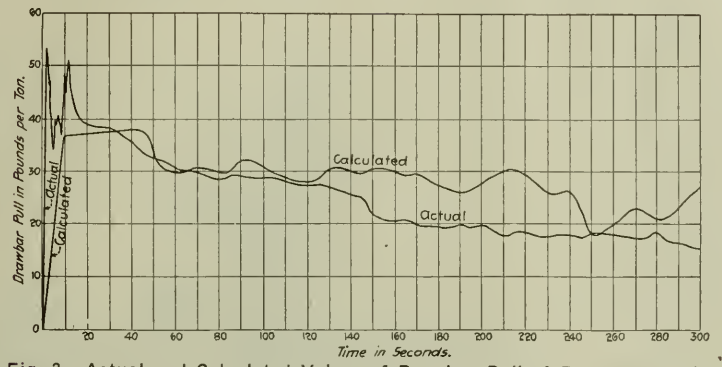



Fig. 3—Actual and Calculated Values of Drawbar Pull of Passenger Trains.

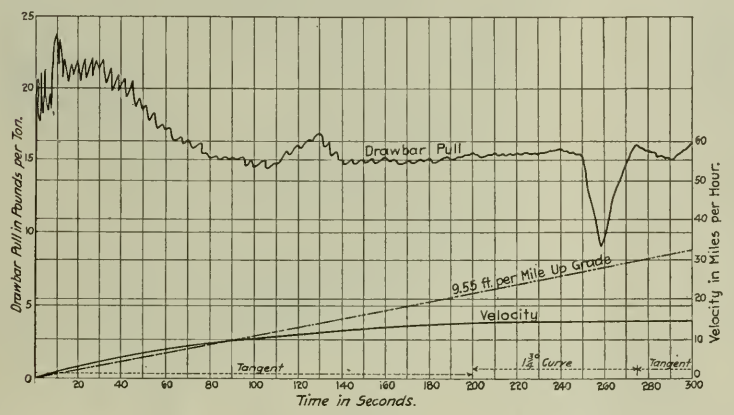



Fig. 4—Drawbar Pull and Velocity Curves of Freight Train Weighing 1,051 Tons.

Fig. 6—Actual and Calculated Values of Drawbar Pull of Freight Trains.

oretical resistance as applied to freight trains.

The curve marked "calculated" is plotted from the values of $R_t$, Table 4, as given by using Sprague's formula for $R_v$; while the curve marked "actual" is the drawbar-pull curve of Fig. 4.

Table 4.

| Seconds from start. | Lbs. per ton. Sprague's formula, $R_v$. | $R_a$. | $R_g$. | $R_c$. | $R_t$. |
|---|---|---|---|---|---|
| 0 | 4.00 | 0.0 | 3.62 | 0.0 | 7.62 |
| 10 | 6.92 | 7.41 | 3.62 | 0.0 | 17.99 |
| 20 | 9.55 | 6.62 | 3.62 | 0.0 | 19.85 |
| 30 | 11.75 | 5.37 | 3.62 | 0.0 | 20.74 |
| 40 | 13.86 | 5.34 | 3.62 | 0.0 | 22.82 |
| 50 | 16.27 | 5.77 | 3.62 | 0.0 | 25.66 |
| 60 | 17.58 | 3.29 | 3.62 | 0.0 | 24.49 |
| 70 | 18.70 | 4.10 | 3.62 | 0.0 | 26.42 |
| 80 | 20.74 | 2.48 | 3.62 | 0.0 | 26.84 |
| 90 | 21.96 | 2.92 | 3.62 | 0.0 | 28.50 |
| 100 | 23.01 | 2.48 | 3.62 | 0.0 | 29.11 |
| 110 | 23.95 | 2.42 | 3.62 | 0.0 | 29.99 |
| 120 | 25.10 | 2.48 | 3.62 | 0.0 | 31.20 |
| 130 | 26.04 | 2.48 | 3.62 | 0.0 | 32.14 |
| 140 | 26.99 | 2.45 | 3.62 | 0.0 | 33.06 |
| 150 | 27.94 | 2.05 | 3.62 | 0.0 | 33.61 |
| 160 | 28.57 | 1.645 | 3.62 | 0.0 | 33.84 |
| 170 | 29.21 | 1.615 | 3.62 | 0.0 | 34.45 |
| 180 | 29.58 | 0.869 | 3.62 | 0.0 | 33.29 |
| 190 | 29.95 | 0.869 | 3.62 | 0.0 | 33.66 |
| 200 | 30.43 | 1.240 | 3.62 | .875 | 36.17 |
| 210 | 30.61 | 0.373 | 3.62 | .875 | 33.48 |
| 220 | 30.80 | 0.373 | 3.62 | .875 | 35.67 |
| 230 | 30.80 | 0.0 | 3.62 | .875 | 35.30 |
| 240 | 30.80 | 0.0 | 3.62 | .875 | 35.30 |
| 250 | 30.80 | 0.0 | 3.62 | .875 | 35.30 |
| 260 | 30.99 | 0.435 | 3.62 | .875 | 35.93 |
| 270 | 31.20 | 0.435 | 3.62 | .875 | 36.14 |
| 280 | 31.20 | 0.0 | 3.62 | 0.0 | 34.82 |
| 290 | 31.20 | 0.0 | 3.62 | 0.0 | 34.82 |
| 300 | 31.33 | 0.310 | 3.62 | 0.0 | 35.26 |

*Analysis of Theoretical Train Resistance.*—In considering the comparative influences of the several factors in train resistance, the subject will again be subdivided to afford a separate consideration of passenger and freight trains.

*Passenger Trains.*—The curves of Fig. 7 were plotted from the results of Table 2, and serve to show the comparative magnitudes of the several influencing elements. The most notable feature of this figure is the great influence of the acceleration resistance, $R_a$.

The previous treatment of this subject, which has been confined chiefly to the velocity resistance, $R_v$, has left the impression that velocity is .the controlling factor. Fig. 7, however, serves to show that it is to the acceleration rather than to any instantaneous

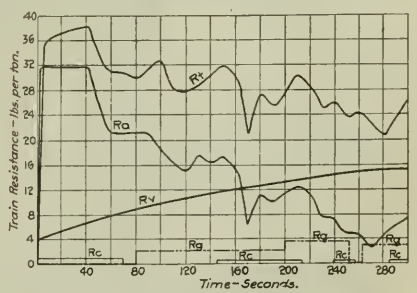



Fig. 7—Curves Showing the Magnitude of the Several Elements of Passenger Train Resistance.

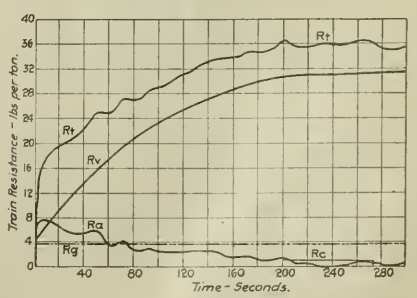



Fig. 8—Curves Showing the Magnitude of the Elements of Freight Train Resistance.

value of the velocity that the curve $R_t$ chiefly owes its characteristics.

Owing to the difficulty of properly measuring or calculating the acceleration, and to the misconception which has prevailed as to the magnitude of its influence, this important factor in the case of passenger trains has been frequently neglected in computations. It needs but a glance at the respective velocity curves of Figs. 1 and 4 to show that it is largely the difference in accelerations which causes so wide a discrepancy in the drawbar-pull lines of these figures.

*Freight Trains.*—In the case of freight trains where the acceleration is small, the velocity resistance, $R_v$ chiefly influences the value of $R_t$, as is shown in Fig. 8. $R_a$, which is so important a factor in passenger train resistance, becomes here of lesser importance.

In summing up, it may be said that the starting resistance, which is neglected in most of the formulæ, should be considered; and that it may safely be taken as varying inversely with the length of the train from 1½ to 2 times the average total resistance. The acceleration resistance, $R_a$, is in the case of passenger trains, the most important factor, and should in no case be omitted. In the case of freight trains, $R_v$ is the determining factor, but the present formulæ give results so erroneous as to be rather misleading than useful.

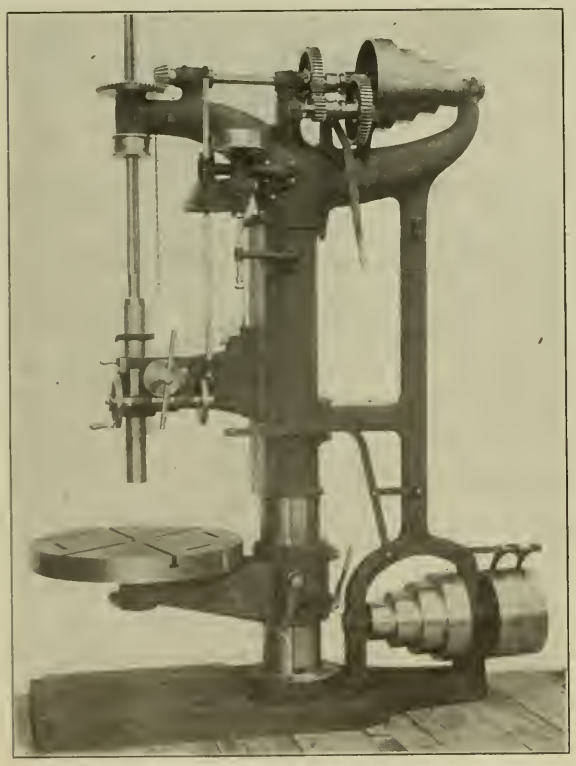


Fig. 1—The Hamilton Upright Drill.

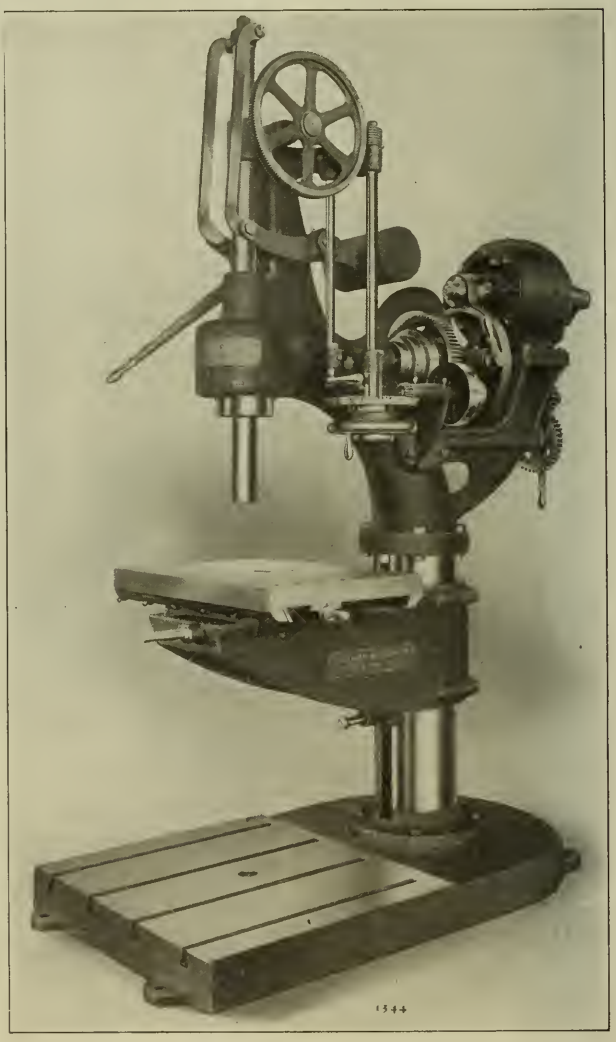


Fig. 2—Niles-Bement-Pond Upright Drill.

By a law passed in 1903 it was provided that when the net earnings of the Danish State Railroads should exceed 2 per cent. on the capital invested, a certain proportion of such net earnings, varying with their amount, but in no case to exceed 0.6 per cent. of the capital, should be divided among the employees, who were divided for that purpose into 14 classes. The first fiscal year under this law gave to the lowest grade of employees $15 each as their share of the profits; firemen received $23.28; enginemen $31; station-masters, $40.90; the highest grades of officers, $286.75. The net earnings were 4 per cent. on the capital, which is much more than heretofore, though the interest of the employees in the profits is credited with only a part of the improvement.

## Railroad Shop Tools.

*(Continued.)*

### UPRIGHT DRILLS.

The 42-in. upright drill press Fig. 1 is made by the Hamilton Machine Tool Company, Hamilton, Ohio. The base of this machine is heavily ribbed and is provided with large I slots. The column is 10½ in. in diameter and it is bolted to the bed and supported by a lock brace as shown. The sliding head has a travel of 31 in. and it is counterbalanced and has a long bearing on the column. It can be locked in any desired position by bolts and is raised and lowered by means of a rack and pinion. The smallest diameter of the spindle is $2^5/_{16}$ in. It is counterbalanced and has both hand and power feeds. The spindle has eight changes of speeds and is provided with three changes of power feed for each speed. It has a traverse of 16 in. and is provided with quick approach and return movement, by means of a rack and pinion. Ball bearings are used to take up the end thrust of the spindle. The lock gears are engaged and disengaged by means of a lever placed within easy reach of the operator. The top shaft runs in split bearings lined with babbitt metal. Power feed is obtained by two cones of gears and changes in feed can be made while the machine is in motion by shifting the sliding shaft or pull pin which is placed just beneath the gears, as shown in the illustration. The friction mechanism is operated from the front of the machine by means of a nut. An automatic stop is provided which can be set to any desired depth by the graduations on the spindle sleeve. The table arm has a vertical adjustment of 17 in. and can be swung around to clear the base. It is raised and lowered by means of a rack and pinion in connection with a worm gearing, which is encased within the table arm. The table can be revolved in its socket. The table is 36 in. in diameter and has T slots. The greatest distance from the spindle to the table is 43 in. and the maximum distance from the spindle to the base is 59 in. The height of the machine to the top of the cone is 9 ft. 8 in. and the floor space required is 92 in. x 90 in., and the net weight is about 4,500 lbs. Friction geared tapping attachments can be applied to these machines when desired.

The 50 in. vertical drilling machine, Fig. 2, is made by the Niles-Bement-Pond Company, New York. It was designed especially for heavy drilling and railroad shop use. The maximum distance from the column to the center of the spindle is 25 in. and the greatest distance from the spindle to the base plate is 58 in. A maximum distance of 31½ in. is allowed for, between the top of the

table and the spindle. An 18-in. traverse is provided for the spindle. The spindle is 3⅜ in. in diameter and is counterbalanced and has three changes of power feed and a rapid hand motion. The table is 26 in. x 36 in. and is provided with both longitudinal and horizontal adjustments. It is also provided with vertical power adjustment and it can be swung around the column and out of the way when it is desired to use the base plate for drilling. The 2½ h.p. motor for driving this drill has a speed range from 350 to 1,750 r.p.m. by field control, and in combination with the changes by gears, the spindle speeds range from 8½ to 220 r.p.m. The motor as applied to the rear of this machine gives it a very pleasing and symmetrical appearance. When belt driven the machine is furnished with countershaft-pulleys 16 in. in diameter for a 3½ in. belt, and they should run at 160 r.p.m.

The latest design of electrically driven upright drilling and tapping machine made by Gould & Eberhardt, Newark, N. J., is shown in Fig. 3. This machine has two spindles, one for drilling and one for tapping. The near spindle in the illustration is for drilling. After a piece is drilled, the work is shifted by means of the compound traverse table, to bring it into line with the tapping spindle. Holes up to 1½ in. can be tapped with this machine. The ingenious Gould & Eberhardt system of speed indicators for the cone pulley belt is used, as shown in the illustration. The set of figures on the lower brace indicates the position of the belt for such sizes of drills as do not require the back gears. The figures on the upper brace are for use with the back gears. The back gears are operated by a single movement of a lever and the feed is driven by its own belt, and is thus independent of the drill spindle speed. Variable feed is obtained by two friction disks and an index on the adjusting rod shows the settings to give the proper feed for the different sizes of drills. Automatic and hand feeds operating in either direction are fitted to both the quill and the drilling head. A novel arrangement of electric drive is used. Both belts are open but one of them is made to operate the reverse motion for withdrawing the tap. This is accomplished by a pair of gears which connect the armature shaft with the driving pulley shaft, and so reverse the motion of the latter. A pair of friction clutches operated by a rod enable the operator to engage either motion as desired. To compensate for wear, the spindle is fitted with double conical bearings in the quill. The quill is square externally, as the clamping surface of a square quill is considered to be effective and to give great rigidity in boring deep, rough holes. In addition to the compound traverse table shown, a portable compound chuck is sometimes furnished, by which the machine is made available for use as a profiling machine. It is also largely used for end and side milling, the power of the machine being sufficient, and its stability and rigidity ample for certain work of this nature. This machine is made in 25, 32, 27, 43, 48 and 52 in. sizes.

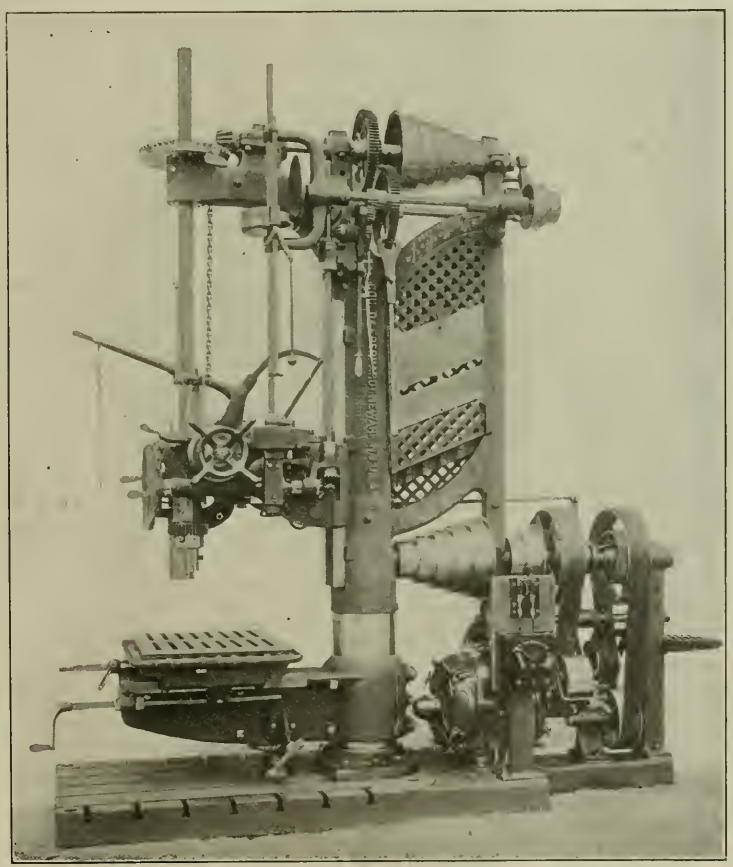


Fig. 3—Gould & Eberhardt Upright Drill.

*(To be continued.)*

Russia appears to be relapsing into barbarism—that kind of barbarism which exists in the United States. A recent press despatch says that attempts at train wrecking in Russia average one in three days and that 11 per cent. of these attempts result in damage.

## Concrete and Concrete-Steel.*

The writer can see no good reason why concrete-steel bridges with spans of 500 ft., or more, cannot be built with perfect safety and often with economy; he has designed and submitted bids on spans as great as 300 ft., and although the plans and prices were satisfactory, other and weightier considerations, from the point of view taken by the officials, induced them to prefer steel structures. It is unfortunate from an engineering standpoint that very few bridge sites are located so as to make long spans economical, or even possible, and in most cases, to meet the conditions of grade and high water, it is necessary to have comparatively short spans with minimum rise of arches. A considerable contraction of waterway by piers, or approaches, is not such a serious matter as many imagine, as the water between the obstructions will about make up in velocity what it lacks in area. At Topeka, Kan., the waterway was contracted from 850 to 540 ft., or 36.5 per cent., with no serious consequences until the unprecedented high water of 1903, when about 160 ft. of earth-fill on the north end went out, because the grade was so low that the water overflowed the bank and washed it out, but the water kept on rising notwithstanding, and reached its maximum stage after the embankment disappeared.

Concrete-steel bridges are rapidly gaining in favor. They cost more than light iron bridges with plank floors, but in many localities they will cost no more, and frequently less, than good steel bridges carrying a pavement. The advantages of a concrete-steel bridge as compared with a concrete bridge are not due so much to diminished sections or cost as to the greatly increased security which the steel affords in providing against settlements or other conditions which cannot be calculated or foreseen. Under normal conditions the steel is not strained to much more than one-quarter of its elastic limit, so that a very large reserve force is always available for emergencies. The claimed and generally recognized advantages of a concrete-steel bridge, as compared with a steel bridge, are as follows: They make handsomer structures, and architectural ornamentation can be applied to any extent desired; if properly designed and constructed, they have vastly greater durability and greater ultimate economy; they are comparatively free from vibration and noise; they are proof against tornadoes and fire, and also against floods, if the foundations are protected from scour; the cost of maintenance is confined to the pavements; home labor and home material are utilized to a much greater extent in building them, so that the greater part of the money which they cost is left among the people who pay for them.

*Fire Protection.*—It has been quite well established by several large fires, as well as by comparative tests, that concrete and concrete-steel are superior to hollow tile for resisting intense heat. Comparative tests of a hollow, hard, tile arch and a Roebling concrete arch, made Nov. 19, 1897, in New York city, resulted in the collapse of the tile arch in 3 hr. 16 min. after the fire was started and when 2,300 deg. Fahr. had been reached. The concrete arch was not damaged. A fire in Pittsburg, Pa., May 3, 1907, destroyed Horne & Company's store having fireproofing of hard clay tile, and the Horne office building with fireproofing of porous terra cotta, but the concrete-steel floor arches of the Methodist Book Building were

*Abstract of a paper by Edwin Thacher, M. Am. Soc. C. E., presented before the International Engineering Congress, St. Louis, October, 1904.

denuded of plaster, otherwise only slightly damaged.

*Protection of Steel in Concrete.*—Will concrete protect from oxidation iron or steel embedded therein? This is an important question, for, if not, concrete-steel construction will deteriorate, and in time fail, and as all engineers at least are not fully satisfied on this subject, such testimony as the writer has been able to collect will be of interest.

Spencer B. Newberry, Assoc. M. Am. Soc. C. E., mentions a concrete-steel water main, on the Monier system, at Grenoble, France, 12 in. diameter, 1 ft. 6 in. thick, containing steel framework of ¼ in. and $^1/_{16}$ in. steel rods, taken up after 15 years' use in damp ground. The adhesion was found perfect and the metal absolutely free from rust. He also mentions a concrete-metal retaining wall in Berlin which was examined after 11 years' use and the metal found free from corrosion, except in some cases where the rods were within 0.3 or 0.4 in. from the surface. Professor Newberry explains how the effect of concrete in preserving metal is not due to the exclusion of air, and even though the concrete be porous and not in contact with the metal at all points, it will still filter out and neutralize the carbonic acid and prevent corrosion.

G. Bouscaren, M. Am. Soc. C. E., removed, in 1875, several links from the anchorage of a suspension bridge partly built by Roebling in 1855, and they were found to be in a perfect state of preservation.

L. L. Buck, M. Am. Soc. C. E., states that he found rust on the anchorage of the Niagara Suspension Bridge where limestone was in contact with the metal, but where limestone was not in contact, and no movement had taken place, the metal was found in perfect condition after 25 years.

E. L. Ransome, Assoc. Am. Soc. C. E., saw, in Chicago, Ill., workmen breaking up slabs of limestone concrete which had covered sidewalk vaults for eight or ten years. The slabs had iron rods embedded which were rust free.

William Sooy Smith, M. Am. Soc. C. E., speaks of a small piece of iron set in mortar taken from the base of the obelisk in Central Park, New York city, which was bright after 2,300 years; he also says that in removing a bed of concrete at a lighthouse in the Straits of Mackinac, 20 years after it was laid, and 10 ft. below water surface, embedded iron drift-bolts were found free from rust.

Albert A. Trocon, M. Am. Soc. C. E., speaks of a bridge over the Osage River, Missouri, built on iron cylinder piers filled with Louisville cement limestone concrete, which was wrecked by high water after seven years' service. The center pier was overturned, leaving the bottoms of the cylinders, after the water subsided, in plain view. The concrete was removed from these cylinders for a depth of 8 or 10 ft., and the iron was found absolutely free from rust.

Professor Charles L. Norton made a large number of experiments with concrete bricks, 3 by 3 by 8 in., in which steel rods, sheet steel and expanded metal were embedded. The specimens were enclosed in tin boxes with unprotected steel, and exposed for three weeks. One portion was exposed to steam, air and carbon dioxide, another to air and steam, another to air and carbon dioxide, and another was left on the table in the testing-room. His conclusions were as follows:

First.—Neat cement is a perfect protection.

Second.—Concrete should be dense without voids or cracks, and be mixed wet.

Third.—The corrosion found in cinder concrete is mainly due to iron oxide in the cinders and not to the sulphur.

Fourth.—Cinder concrete, if free from voids and well rammed, is about as effective as stone concrete.

Fifth.—It is important that the steel be clear when embedded in concrete.

Sixth.—It is essential that the steel be coated with cement before embedding in concrete, the unprotected pieces of steel being found to consist of more rust than steel.

M. Breuillié, a French engineer, made some interesting and valuable experiments on concrete-steel slabs subjected to high-water pressure. The slabs were 36 by 39 by 11.8 in., with steel rods and wires embedded at different depths in the slabs. The slabs were subjected for six days to intermittent water pressure of from 39.4 to 50.0 ft. The water penetrated every part of the slabs. The slabs were then left in the open air, and the condition of the metal tested from time to time and always found in perfect condition. He observed that the metal was dull after contact with the concrete; that adhesion was destroyed where the water had penetrated; that bars, having a slight layer of rust when embedded, were free from rust in 15 or 20 days; that water after passing through the slabs contained less mortar salts than before; that under pressure of 50 ft., adhesion was destroyed but bars did not rust. He concludes that a salt is formed by the action of the cement on iron, which is dissolved by water.

Professor Norton gives the result of further tests on the protection of steel embedded in concrete. Specimens of steel, clean and in all stages of corrosion, were embedded in stone and cinder concrete, wet and dry mixtures, and exposed to moisture, carbon dioxide and sulphurous gases. Some were treated in tanks supplied intermittently with steam, hot water, moist air, dry air, and continuously with carbon dioxide for from one to three months. Under the conditions followed, unprotected steel vanished into streaks of rust, but protected by an inch or more of sound concrete, the steel was absolutely unchanged, and he concludes that steel embedded in concrete, mixed wet and well, whether stone or cinder concrete, will be perfectly protected for all time.

Mr. Ransome mentions that in tearing up some sidewalk in Bowling Green Park, New York city, which had been in use 20 years, some embedded steel rods were found to be in perfect condition. Other examples could be given, but the writer considers the above sufficient to clearly establish that concrete is a perfect protection for embedded steel.

*Cement Paint.*—Cement paint is said to be largely used by the railroad companies of France, to protect the metal work of bridges from rust and locomotive gases. The metal is brushed and dampened and given two coats of liquid cement and sand. It was used for protecting the steel beams of the Boston Subway, and is used largely in European distilleries for painting iron spirit tanks, the adhesion being increased by allowing the metal to rust somewhat before applying the paint. The writer knows of some cases in the United States where cement paint was used without success, as it failed to adhere to the entire surface, and if there is any sure way of making it do so the writer hopes the discussion will bring it out, for if satisfactory adhesion of cement can be secured, either with or without sand, it will undoubtedly prove to be the best paint and the most perfect protection for exposed steelwork known. For protecting steel bars buried in earth, the writer has wrapped them with canvas soaked in thick Portland cement grout with a heavy coating of grout over the canvas, and believes it will be permanently effective.

*Finish.*—The greatest objection to the use of concrete for the exposed surfaces of structures in which beauty is an important consideration is the difficulty of producing a satisfactory finish. Concrete, as it usually comes from the moulds showing the joints, knots and grain in the casing, has more the appearance of a piece of rough carpenter work than of finished masonry, and some special treatment is necessary. Concrete is faced frequently with masonry, brick or tile, but this dodges the case without meeting it. Plastering is resorted to frequently, but not always with success. E. Duryea, Jr., M. Am. Soc. C. E., mentions some examples which gave good results. The portals of two tunnels in Los Angeles, Cal., were plastered with two coats of 1 cement, 4 sand and 1 lime paste; where finished rough it did not show hair-cracks, but when finished smooth it did show them. The concrete pedestals of Kaskaskie Viaduct, Chicago & Eastern Illinois Railway, are plastered with 1 cement, 1 sand, and are in first class condition. The piers of the Arkansas River Bridge, Kansas City Southern Railroad, were plastered with three coats, the first two, 1 cement, 3 sand, and the third, 1 cement, 1 sand, and are in good condition. Mr. Duryea considers a mixture of 1 cement, 3 sand, 1 lime paste the safest and best, and that excessive troweling should be avoided, and the plastering kept damp for two weeks. A concrete bridge at Oconomowoc, Wis., built by Stamsen and Blome, of Chicago, Ill., had a mortar face composed of 1 part cement, 1 part granite screenings and 1 part torpedo sand. On the second day after completion the moulds were removed and the surface rubbed with a soft stone and water. The Inman arch Hohenzollern had a facing of 1 part cement and 5 parts broken limestone. After setting 12 hours the loose cement was removed by water and brushes.

*Impermeable Concrete.*—Impermeable concrete, or concrete made impermeable by some kind of waterproofing coating, is frequently required, either for inclosing a space which must be kept dry, or for storing water or other liquids, and quite a number of valuable experiments have been made for the purpose of discovering the most effective way to accomplish this result.

In 1902, Mr. J. B. McIntyre and A. L. True, Jun. Am. Soc. C. E., of the Thayer School of Civil Engineering, made 97 experiments to determine if possible a concrete which would be impermeable to water under high pressures. The specimens were 10 in. in diameter and 0 in. high, with ¾-in. pipe inserted to a depth of 4 in. The specimens were subjected to a pressure of 20, 40 and 80 lbs. per sq. in. for two hours. All specimens containing from 30 to 45 per cent. of 1:1 mortar were impermeable, some of the specimens containing from 40 to 45 per cent. of 1:2 mortar, and some specimens of 1:2:4 and 1:2½:4 were also impermeable under a pressure of 80 lbs. per sq. in., equivalent to a head of 184 ft. They recommend 1:2:4 or 1:2½:4 concrete for moderate pressures.

Various coatings have been used to render concrete water-tight. For cistern work two coats of Portland cement grout has been found sufficient. About 1 in. of rich Portland cement mortar has usually been found effective under high pressure. A coating of asphalt alone, or asphalt with tarred or asbestos felt laid in alternate layers between layers of concrete, has often been used with success. Coal-tar pitch and tarred felt in alternate layers has been used extensively and successfully in New York City for waterproofing. Captain William C. Langfitt, Corps

of Engineers, U. S. A., has used successfully a waterproofing wash composed of one pint of an alum and lye solution mixed with 10 lbs. of cement, thinning with water until the mixture spreads easily with a brush. It should be applied while the concrete is green and until it lathers freely. The solution consists of 1 lb. of concentrated lye, 5 lbs. of alum, and 2 gal. of water. Eugene W. Van C. Lucas, M. Am. Soc. C. E., Captain, Corps of Engineers, U. S. A., used boiled linseed oil with success, coating the surface until the oil ceased to be absorbed.

*Stone Dust vs. Sand.*—A large number of tests have been made on mortars and concretes in which stone dust and sand have been used in direct comparison, and there can be no doubt that stone dust is much superior to any sand. Harry Taylor, M. Am. Soc. C. E., Captain, Corps of Engineers, U. S. A., tested 1,650 briquettes of 1:3, 1:4 and 1:5 mortars, at 1, 3, 6 and 12 months, using standard crushed quartz, Plum Island sand and crusher dust. The briquettes with crusher dust had a mean strength 72 per cent. greater than with crushed quartz, and 2.3 times greater than with Plum Island sand. A 1:5 mixture with stone dust was stronger than a 1:3 mixture with crushed quartz.

*Wet or Dry Mixtures.*—Until within the past few years the majority of engineers in the United States preferred and used a dry mixture of concrete, but now this has been superseded almost completely by a medium, or very wet mixture, often so wet as to require no ramming whatever. Mr. A. S. Cooper, Government Engineer, as long ago as 1895, called attention to the advantages of a wet mixture. He found by experiment that dry mortars give the best results in short-time tests, and wet mortars in long-time tests. Alfred Noble, Past President, Am. Soc. C. E., and George W. Rafter, M. Am. Soc. C. E., have also made a large number of tests of briquettes with dry, medium and excess mortars, and, although the dry mortars gave slightly the best results for these small specimens, they prefer the wetter mixture for actual work. H. W. Parkhurst, M. Am. Soc. C. E., made some valuable experiments on medium, dry and wet mixtures, and found the medium mixture most dense, wet next and dry least, and concludes that the medium mixture is the most desirable, one that will not quake in handling, but will quake under heavy ramming. He found medium 1 per cent. denser than wet, and 9 per cent. denser that dry concrete; he considers thorough ramming important. The writer has seen concrete put in so wet that it would not only quake but flow freely, and after setting it appeared to be very dense and hard, still he thinks the present tendency is for too much, rather than for too little water, and that thorough ramming is desirable.

*Impurities in Aggregates.*—It has been known for some years that quite a large percentage of clay in sand or gravel had no bad effect on mortars and concrete, but loam was considered fatal, and the writer has had some experience which seemed to justify such a conclusion; but quite recently some tests have been made by J. C. Hain, Assoc. M. Am. Soc. C. E., Chicago, Milwaukee & St. Paul Railroad, which seem to show that sand containing loam is equal to or superior to clean sand. Tests were made on 1:2 and 1:3 mortar, comparing clean sand with sand containing 2, 5, 10 and 20 per cent. of loam (rich surface soil). For the 1:2 mortar, clean sand gave slightly better and more uniform results, but for the 1:3 mortar, sand containing up to 20 per cent. of loam by weight gave as high average results as clean sand, though the latter gave much more uniform results. Tests were also made with sand from different pits and containing from 2.5 to 7.7 per cent. of loam and clay, and those containing the highest percentage of impurities give the best results. Tests made by the Board of Public Works of Porto Rico on briquettes of 1:2 mortar give 25 per cent. better results with washed than with unwashed sand. Before accepting sand containing a large percentage of foreign matter, the writer believes that thorough tests should be made of that particular sand, washed and unwashed.

*Retempering.*—Many engineers believe retempering to be injurious to Portland cement concrete, and forbid it in their specifications, but many tests have been made that show this to be a benefit rather than otherwise. Tests made by Thomas S. Clark, Resident Engineer, Manhattan Power Station, New York City, on 1:3 Rosendale and Portland mortars retempered after 1 hour, and tested at ages of 28, 56 and 112 days, show that the Rosendale mortars lost an average of 35 per cent. in strength by retempering, and that the Portland cement mortars gained an average of 8 per cent. in strength by retempering. Mr. G. T. Skeels, Assistant City Engineer, Sioux City, Iowa, made tests on 50 briquettes of 1:2 Portland cement mortar, which were continuously mixed for from 15 min. to 8 hr. 55 min., water being added from time to time, and tested after 15 days. The briquettes that gave the highest test were from mortar which had been continuously mixed for 4 hr. 55 min., and were 31 per cent. stronger than the specimens from mortar mixed for 15 min. Specimens from mortar mixed for 8 hr. 55 min. were 24 per cent. weaker than those from mortar mixed for 15 min.

*Delay in Placing.*—The Kinipple system of laying concrete under water consists in allowing concrete to partly set, so that when thrown into foundations the cement will not separate, but the concrete is soft enough to form a compact structure. He found it equal in every respect to concrete deposited in air, and found by experiment that 1:3½ concrete does not lose strength by delay of eight hours in placing, and if rammed into moulds will form a monolithic mass. A 1:3½ mixture was left three hours to set, and a 1:6 mixture, five hours before being deposited. The best results were obtained when the concrete was mixed with a minimum of water and rammed into boxes, and deposited when it had the solidity of stiff clay; he has deposited concrete in this manner through from 50 to 70 ft. of water with complete success.

Mr. Ransome says he has experimented with several brands of Portland cement, and found that they were invariably improved in tensile strength by a delay of from 1 to 4 hours between mixing and placing.

*Freezing.*—Walter A. Rogers, M. Am. Soc. C. E., of the Chicago, Milwaukee & St. Paul Railroad, made some interesting tests on 12-in. cubes of Portland cement concrete 1:3:4, exposed to freezing weather. The capacity of the testing machine was only 185,000 lbs., and it is unfortunate that the cubes were not of smaller size, or a more powerful machine used, but the results are of some value. Two cubes left in office, and tested after 28 days, stood over 185,000 lbs. Two cubes exposed to — 15 deg. Fahr., and tested after 28 days, crushed at 115,000 lbs. Two cubes exposed to — 15 deg. Fahr., for 28 days, and then kept in warm room for 28 days more and tested, stood over 185,000 lbs. Two cubes mixed with salt-water (1 pint of salt to 10 quarts of water) and exposed to — 15 deg. Fahr., and tested after 28 days, stood over 185,000 lbs. Mr. Rogers concludes that freezing before setting does not injure Portland cement concrete, even if, after having frozen hard, it is exposed to alternate freezing and thawing, and that the use of salt largely counteracts the effect of cold in causing slow hardening. Similar tests were made on cubes of Louisville cement concrete and with the same conclusions, except that salt was not beneficial. Mr. James S. Costigan read a paper before the Canadian Society of Civil Engineers, giving the result of 15 sets of tests on cement briquettes exposed to different conditions of freezing and thawing, and found but little, if any, loss of strength by freezing.

A large number of tests have been made which appear to show that freezing does injure Portland, or Natural cement concrete. Percy L. Barker and Henry A. Simonds, as a result of 7,150 tests, conclude that Portland cement mortar suffers no surface disintegration, but that strength is sometimes injured as much as 40 per cent. by freezing. Specimens mixed with water containing 1 part salt to 15 parts water by weight gave best results and suffered but little loss of strength by freezing. Experiments made by E. H. Conner at Cairo, Ill., found that the addition of salt increased the strength of Portland cement concrete. Mr. A. G. Fogg, who experimented on Portland cement mortar exposed to alternate freezing and thawing, concluded that a quick-setting mortar may freeze in 12 hours without injury, but that it is not safe to allow a slow-setting mortar to freeze in less than four days. None of these tests are conclusive, and none of them, as far as the writer has been able to discover, prove that Portland cement mortar or concrete is permanently injured by freezing or alternate freezing and thawing. It is well known that freezing greatly delays setting, and it is manifestly unfair to compare a test-piece which has been frozen for 27 days and thawed out on the 28th day, with one which has remained in the testing room 28 days, and to conclude that freezing has injured the concrete to the extent of the difference shown. It would be much nearer the truth to assume that setting was suspended for the length of time that the specimen was frozen, and to allow the frozen specimen the same length of time in the testing room as the unfrozen specimen before testing and comparing results. Very few engineers place much reliance on the tensile strength of concrete, and compression tests on cubes would have much greater value than tension or transverse tests. The tests made by Mr. Rogers, of the Chicago, Milwaukee & St. Paul Railroad, previously referred to, are in the right direction, and if his machine had been able to crush the specimens in all cases, it would have nearly settled the question of the advisability of laying concrete in freezing weather, and the Committee on Uniform Tests of Cement of the American Society of Civil Engineers cannot do a better service than to continue experiments on that line.

It is quite customary in laying concrete in freezing weather to either heat the materials before mixing, or to let steam and hot water into the mixing box, the concrete being deposited quite frequently when very hot. W. W. Maclay, M. Am. Soc. C. E., made many experiments, from which he concluded that this is not good practice. Two sets of briquettes of 1:2 mortar were made, one at 40 deg. and the other at 100 deg., exposed to freezing weather, and tested in 28 days. The 100 deg. specimens gave a strength of only 30 per cent. of the 40 deg. specimens. Experiments on 1:2:5 concrete gave similar results, and experiments on neat cement worse results. He considers that materials should not be heated except to thaw the frost out of the stone and sand. All specimens mixed

cold seemed to set and not to freeze in temperature of 13 deg., but hot concrete, on the contrary, invariably froze, and specimens placed in water always dissolved. He considers that no good work can be done under water in winter when the materials are heated. Those tests were made 27 years ago with Burham cement, and mostly with neat cement at age of seven days, and are not conclusive. Further tests in this direction are much needed, using modern concrete tested in compression, and subjected, as nearly as possible, to the same conditions met with in ordinary winter practice. Heated concrete laid in freezing weather is usually deposited in wooden moulds, which protect it to a great extent against frost. It is also covered at night, and, as far as practicable, as the work progresses during the day, and there is considerable evidence which appears to show that such work is good. The Melan Bridge, at Mishawaka, Ind., previously referred to (three spans of 110 ft. each,) Alonzo J. Hammond, Engineer in Charge, was built between Oct. 26, 1903, and Feb. 25, 1904, in temperature ranging from 0 to 55 deg. above. The concrete was heated by admitting hot water to the mixer, and was deposited at about blood heat, and retained sufficient heat after 48 hours to melt snow. The center arch was completed on Feb. 13, 1904, temperature about 25 deg. Fahr.; on February 14, the temperature dropped to 0 deg., and on March 1, or 15 days after completion, an ice jam took out the centering and left the arch unsupported. No bad effects could be observed, and the settlement of the arch was but little more than for the other spans when the centerings were removed later in the regular way. If the concrete had not been heated, it would be interesting to know whether the result, under such trying conditions, would not have been much worse.

*Theories for Reinforced Concrete Beams.*—Quite a number of theories or formulas have been advanced for the calculation of concrete-steel beams, most of them based on the common theory of flexure, with no allowance made for tension in the concrete, and the belief is quite general among the highest authorities on reinforced concrete in all parts of the world, that such theories are the safest and best. The writer has compiled the results of quite a large number of experiments on beams, in which the ratio of length to effective depth ranged from 6.0 to 22.2, the ultimate strength of metal, from 50,000 to 100,000 lbs. per sq. in., the area of metal, from 0.31 to 3.9 per cent., and the age of concrete, from 23 to 90 days, and in each set of tests compared the results agreed with theory as closely as would have been the case with steel beams; but such results cannot always be expected, as the modulus of elasticity of concrete, which enters into the calculation, is rather an uncertain quantity, depending on the quality of ingredient, mixture, mixing and placing, age and stress. Professor Brik makes a distinction between the modulus of elasticity and modulus of deformation, and considers that the latter, which is less than the modulus of elasticity by the amount corresponding to permanent set, should be used. Permanent set also causes internal stresses in beams after the load has been removed, so that any theory may be regarded only as an approximation.

The French Government appointed a commission of experts to establish a building code for concrete-steel structures. The steel reinforcement is considered as taking the whole tensile stress. The Prussian regulations for reinforced concrete buildings, issued by the Minister of Public Works of Prussia, provide that the steel shall be considered as taking the entire tensile stress in beams. The regulations of the Bureau of Buildings of the Borough of Manhattan require the same thing, and, as far as the writer knows, this is true of all other cities which have formulated rules on the subject.

The opinion that the tensile strength of concrete should not be considered, is much strengthened by the result of experiments on concrete-steel beams, made by F. E. Turneaure, Assoc. M. Am. Soc. C. E., and given at the annual meeting of the American Society for Testing Materials, July, 1904. The beams were tested with the tension side up, and cracks first appeared at a certain amount of deflection, whether steel was present or not. With 1:2:4 concrete minute cracks were first observed at an elongation of 0.0001 to 0.00015; they were visible to the naked eye (if the beam was dry) at an elongation of 0.0004 to 0.0005 (12,000 to 15,000 lbs. per sq. in. in the steel), and then generally extended across the tension surface and some distance along the sides of the beam. These results show clearly that the steel loses its tensile resistance at an early stage of the loading.

## The Railroad Cross-Tie Problem.

BY S. WHINERY, CIVIL ENGINEER.

The cross-tie problem is always one of interest to railroad men. Assuming that on the 200,000 miles of steam railroad in the United States an average of 2,750 ties are used per mile, that the average life of these ties is eight years, and their average cost, in the track, 45 cents, the cost of cross-ties amounts to the enormous sum annually of over 30 millions of dollars. The question of the substitution for wooden cross-ties, of those made of some other material, particularly of metal or concrete, is being largely and increasingly discussed.

Having recently given some attention to the subject of cross-ties and other forms of track support, and the comparative merit of different kinds of ties, perhaps a summary of the conclusions reached and some of the reasons leading to them may be of interest to the readers of the *Railroad Gazette;* at least it may help to clear conceptions of the problems involved. It is not possible in an article of reasonable length to discuss the subject in much detail, nor in a strictly scientific manner.

The merits and the defects of the wooden cross-tie are well known. Its practically exclusive use in the United States ever since our railroad system began, furnishes us with very satisfactory data as to its efficiency, cost and economy. In any discussion of other kinds of ties we may therefore use it as a standard for comparison. Until some other kind of cross-tie shall be found to be, upon the whole, better and cheaper, there will be no advantage in adopting a substitute. The object of this article is mainly to inquire into the relative efficiency and economy of substitutes proposed for the wooden tie. Under the head of efficiency, is, of course, included the element of safety.

Disregarding for the present the question of cost and economy we may first summarize the qualities requisite in a cross-tie, as follows:

1. Sufficient area of bearing surface upon the ballast to safely transmit to the roadbed the weight and impact of the rolling stock.
2. Sufficient strength, resilience and endurance to give satisfactory service under the conditions to which it is exposed.
3. Capacity to hold the rails to "gage" and in a position perpendicular to the plane of the track.
4. Sufficient frictional resistance or "grip" in the ballast to prevent lateral movement of the track.
5. The interval between supports to the rail must be so short that deflection of the rail under its loads will be practically nil.
6. The attachment between rail and tie must be secure and efficient, and should be as simple and as accessible for adjustments and repairs as possible.
7. Facility of Maintenance: The tie should be of such form and section as will permit the ballast to be properly and securely tamped under it, and the track kept in line and surface.

The standard wooden tie meets these requirements fairly well. We may call its dimensions 8 ft. long, 8 in. wide and 6 in. thick. Its average effective width, owing to the large number of "pole" ties used, may be safely placed at 8½ in. With 16 such ties used to each rail-length of 30 ft., the bearing surface on the ballast is equivalent to 2.93 sq. ft. per linear foot of single track, or 1.46 sq. ft. per linear foot of rail. Under our modern locomotives such a tie may easily have to transmit to the ballast a weight of at least two tons per sq. ft. of this bearing surface. Considering the impact character of this load, it is as great as should be permissible, and any substitute for the present cross-tie should afford equal bearing surface per linear foot of track.

Wood, particularly white oak and long-leaf yellow pine, possesses in a high degree the qualities of strength, elasticity and toughness necessary to stand the severe conditions to which a railroad tie is subjected.

The wooden tie has sufficient rigidity to hold the rails perpendicular to the plane of the track, and, barring the yielding of the spikes, has a surplus of strength to hold the rails to gage. With good metal tie plates the defect in the lateral holding power of the spikes is largely overcome, and by the use also of screw spikes this defect would probably disappear except where soft wood ties are used. In frictional resistance to lateral track movement the wooden tie is not always satisfactory, particularly on curves, where the tendency to lateral deformation of track is greatest. Certainly no substitute possessing this quality in a lesser degree should be considered acceptable.

With 16 ties used per rail-length the rail is supported at intervals of less than two feet. Even with our heaviest rail-sections the rail supports should not be more than two feet apart. The weight of rolling stock is rather more than keeping pace with the increased resistance of heavy rail-sections, and we cannot, therefore, safely increase the distance between supports.

With the ordinary driven spike the attachment of rail to wooden ties is not very satisfactory. Besides the liability of the spikes to be withdrawn, the frequent driving of them into the wood destroys the fiber, impairs its holding power, and promotes the decay of the wood. Without the use of tie plates the cutting of the rail into the wood is a serious defect. These weaknesses become more serious as the life of the tie is prolonged by preservative treatment. But with good tie plates and screw spikes these defects may be largely mitigated. The width and spacing of the wooden tie affords ample facility for manipulating and tamping the ballast under it and for keeping the track in line and surface.

It will not be claimed, however, by any one, that the wooden tie is, in any of the requirements enumerated, better than it should be, and if we are looking for a substitute it must be equal to, or at least must compare favorably with the wooden tie in all these particulars. Any fair comparison between them (omitting still the question of cost and economy), must be upon the basis of equal capacity to meet the same essential requirements.

In figuring the strength of a tie we must consider the nature of the stresses to which it is exposed. In use the ordinary cross-tie

acts as a continuous beam. We may reverse the ordinary conception and consider it as a beam supported at two points (the rails), and uniformly loaded with the pressure of the ballast due to the weight of the wheels of the rolling stock upon the rail. The ends of the beam overhang the supports at each end, forming cantilevers. Under the action of the uniform load (i.e., the pressure of the ballast) the beam tends to take the form shown in Fig. 1. It is subjected to strains acting in opposite directions. At the center of the track the strain tends to break the tie by tension on its upper fibers, while directly under the rails, the strain in the opposite direction tends to break it by tension on its lower fibers. Where the tie is 8 ft. long and the gage of the track is 4 ft. 8½ in., the strain at the middle of the tie is about one and one-half times that under the rail.

But while thoretically correct, too much importance must not in practice be attached to this conception of the strains to which a tie is subjected for the reasons—first, that unless the distribution and tamping of the ballast under the tie is uniform the load will not be uniform, and, secondly, the frictional resistance among the fragments of the ballast may be such that under any deformation of the tie, the loading would not be uniform. The principle involved has, however, an application to concrete ties that cannot be neglected, which will be considered later. It has also an interesting application, worth noting, in the case of all ties. The ordinary cross-tie being of the same size and strength from end to end, it is obviously desirable to reduce as much as possible, and to equalize the maximum strains to which it is subjected. In other words, the total strain should be divided as equally as practicable between that at the center and that under the rail. Now if the tie be made 8.4 ft. long this will be theoretically accomplished, and the strain on the middle of the tie will be reduced about one-sixth. This seems to be a matter of sufficient importance to deserve more attention than it has received, particularly since increasing the standard length of ties from 8 ft. to 8 ft. 5 in. would usually not increase their market price.

In practice, however, in comparing the strength of various kinds of ties, we may safely consider them as simple beams placed upon supports, an equal distance apart and uniformly loaded throughout their length; or what is still simpler, and more scientific, we may say that the strength of two ties is in direct ratio to the moment of resistance of their sections. Now the moment of resistance of a wooden tie 8 in. wide and 6 in. deep, allowing an extreme fiber strain of 1,000 pounds per sq. in., is about 48,000 inch-pounds, and we may adopt this as a standard in comparing the strength of other ties proposed as substitutes for the wooden tie.

The substitutes for the wooden tie that have been seriously considered fall into four general classes:

1. The steel or iron beam tie.
2. The cast-iron tie or track support.
3. The concrete tie reinforced with steel.
4. The combined concrete and steel beam tie.

1. Many experiments have been made abroad and not a few in this country with cross-ties taking the general form of steel or iron beams. But the section adopted has not been, as a rule, one to develop the greatest strength per unit of area of metal used. An inverted trough or channel has been most frequently chosen. It may be readily shown that this section does not afford an economical disposition of the material used. This will be referred to later. Everything considered, the common "I" beam may be taken

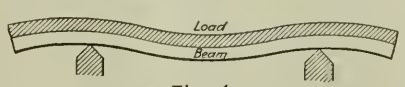



Fig. 1.

as the general form which, with the load acting through and parallel to its web, develops the greatest strength per unit area of metal used. We may, therefore, reasonably assume that if it lends itself to the purpose equally well in other respects than strength, it is the most promising section to use in designing a metal cross-tie. Fig. 2 shows an attempt at such a design. This tie has the same length as the standard wooden tie—8 ft.—and if placed in the track 2 ft. from center to center of ties, it gives the same bearing surface on the ballast as the wooden tie—2.93 sq. ft. per linear foot of track. Allowing an extreme fiber strain of 10,000 lbs. per sq. in. the section has a moment of resistance of about 47,000 inch-pounds, being practically equal therefore in bearing surface and strength to the standard wooden tie. It has a tie-plate riveted to the upper flange, of such form and dimensions that the rail may be secured to it by bolts which may be inserted, removed or adjusted without disturbing the tie. The frictional resistance to lateral displacement of track would not be equal to that of the wooden tie. The rivet heads below the base plate would have some value in this respect, and if found necessary anchor lugs could be riveted to the bottom plate without materially increasing its cost. The tie complete would weigh about 171 pounds. Its cost delivered on the road where it is to be used would vary with the prices of material, labor and transportation. At the present time that cost, including a reasonable profit to the manufacturer, would probably not be below $4.25. Such a tie ought to prove as efficient and satisfactory in service as the standard wooden tie. What its useful life would be is a question which we have not sufficient data from experience to answer satisfactorily. Judging from such data as we have, it would probably be safe to predict a life of 25 years, if properly painted and cared for.

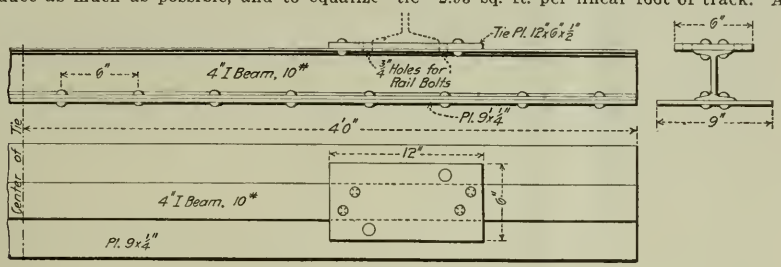



Fig. 2—Design for Steel Tie.

Quantities and weights:

| | | |
|---|---|---|
| 1 I-beam 8 ft. long at 10 lbs. | 80 | lbs. |
| 1 bottom plate 8 ft. x 9 in. x ¼ in. | 61 | " |
| 2 tie plates, 12 in. x 6 in. x ½ in. | 20 | " |
| 40 rivets at ¼ lb. | 10 | " |
| Total | 171 | lbs. |

Moment of resistance fiber stress 10,000 = 46,506.
Cost: 171 lbs. at 2½ cts. ..... $4.27

Comparing this tie with the steel or iron ties that have been most used experimentally, its greater weight will be at once observed. But the material used is well disposed to develop its greatest strength, and this strength is certainly not greater than that of the wooden tie with which it is to be compared. The steel and iron ties that have been mostly tried have been so deficient in strength and rigidity that their failure under heavy rolling stock was to be expected, and such failure cannot be considered as a valid argument against the tie here proposed. The superiority of the section over the common inverted trough form is very notable. Thus a tie of the latter form having a top plate 9 in. x $^{5}/_{16}$ in., with vertical sides ½ in. thick and $4^{11}/_{16}$ in. deep, has a sectional area over 40 per cent. greater and a moment of resistance nearly 40 per cent. less than our I-beam tie. Its form is, besides, very objectionable from the point of view of tamping the ballast under it.

2. Cast-iron is obviously unsuitable for cross ties, but cast-iron supports for the rail, usually in the form of inverted "pots" have been quite extensively used abroad, and apparently with good success where the service is comparatively light. They have been, however, deficient in bearing area on the ballast, measured by the standard we have set up, and probably also deficient in strength to carry the heavy rolling stock of American trunk lines. Their form is an objectionable one for tamping ballast under them, and the rail fastenings are not satisfactory. An attempt by the writer to design a promising cast-iron track support for comparison with the wooden tie has resulted in the form shown in Fig. 3. It gives the same bearing surface as the wooden tie. The opposite supports are tied together so as to preserve the gage and to give some rigidity to the structure, and the castings are made strong enough to probably bear the stress upon them. The rail fastening bolts can be removed and replaced without disturbing the casting in the ballast. The width of the casting, 14 in., is as great as allowable (where the supports are but 24 in. apart) to permit of proper tamping. This consideration excludes the wider spaced circular form of "pot," used abroad, which would be otherwise desirable. To facilitate tamping under so wide a surface the edges are slightly curved upward. The transverse ribs cast on the bottom not only increase the strength, but serve as anchors in the ballast to prevent shifting of the track laterally.

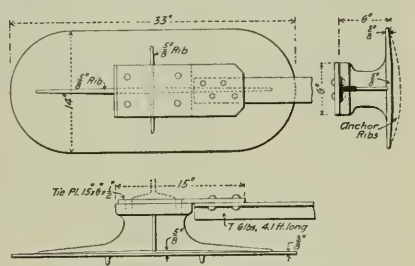



Fig. 3—Cast-Iron Track Support.

Weights:

| | | |
|---|---|---|
| 2 castings at 90 lbs. | 180 | lbs. |
| 1 steel tie and plate | 52 | " |
| Total | 232 | lbs. |

Cost:

| | |
|---|---|
| 180 lbs. c.-i. at 2¼ cts. | $4.05 |
| 52 " steel at 2½ cts. | 1.30 |
| Total | $5.35 |

The weight of one pair of these supports, and the connecting tie rod taking the place of one cross-tie, would be about 232 pounds, of which 52 pounds would be steel. A fair

estimate of the cost of the pair would be about $5.25, delivered.

No reason is apparent why this desigu should not give fairly satisfactory results in practice, though the wisdom of using cast-iron where it is constantly subjected to such shocks as result from the passage of our modern rolling stock may well be questioned. The cast-iron would be less liable to rust than steel, and, possible breakage excluded, such a support should last a long time. Even allowing for their liability to break, 30 years effective service might be reasonably expected.

*(To be continued.)*

## Poor's Statistics for 1903.

The advance sheets of Poor's Manual for 1904 contain the usual statistics of the railroads in the United States for the fiscal year ending in 1903. A summary of some of these figures is given below. The total length of railroads completed on Dec. 31, 1903, is given at 207,604 miles, an increase for the year of 4,595 miles.

| | 1903. | 1902. |
|---|---|---|
| | Miles. | Miles. |
| Mileage of railr'ds. | 206,885.99 | 199,684.64 |
| 2d track, sid'gs, &c | 79,376.03 | 75,150.75 |
| Total Track .... | 286,262.02 | 274,835.39 |
| Steel rails in track | 271,012.70 | 257,437.11 |
| Iron rails in track. | 15,249.32 | 17,398.28 |
| | No. | No. |
| Locomotives ..... | 44,529 | 41,626 |
| Cars—Passenger .. | 28,648 | 27,364 |
| Bag., mail, etc... | 10,182 | 9,726 |
| Freight ..... | 1,524,150 | 1,503,949 |
| T'l revenue cars. | 1,562,980 | 1,541,039 |
| *Liabilities:* | | |
| Capital stock ..... | $6,355,207,335 | $6,078,290,596 |
| Bonded debt ..... | 6,722,216,517 | 6,465,290,839 |
| Unfunded debt ... | 448,199,448 | 310,345,867 |
| Current accounts.. | 648,434,976 | 479,957,935 |
| Sink'g & other f'ds. | 115,201,683 | 140,679,814 |
| Total liabilities.. | $14,289,259,959 | $13,474,565,051 |
| Excess of assets... | 572,851,585 | 479,542,767 |
| Total ..... | $14,862,111,544 | $13,954,107,818 |
| *Assets:* | | |
| Cost, R.R. & equip. | $11,233,311,285 | $10,865,683,376 |
| Other investments. | 2,653,851,625 | 2,345,515,940 |
| Sundry assets .... | 552,036,399 | 455,053,773 |
| Current accounts . | 422,912,235 | 287,854,729 |
| Total assets .... | $14,862,111,544 | $13,954,107,818 |
| | Miles. | Miles. |
| Miles.R.R. operated | 205,237.12 | 197,887.36 |
| Rev. train-mileage: | | |
| Passenger ..... | 429,014,116 | 403,213,178 |
| Freight ..... | 548,680,595 | 508,210,140 |
| Mixed ..... | 22,288,855 | 22,990,130 |
| Total ..... | 999,983,566 | 934,413,448 |
| Passengers carried. | 696,949,925 | 655,130,236 |
| Passenger mileage.. | 20,895,606,421 | 19,706,908,785 |
| Tons freight moved. | 1,306,628,858 | 1,192,136,510 |
| Freight mileage ... | 171,292,198,079 | 156,624,166,024 |
| Earnings: Pass'g'r. | $429,705,287 | $396,513,412 |
| Freight ..... | 1,344,150,719 | 1,197,212,452 |
| Miscellaneous ... | 135,001,820 | 127,089,036 |
| Total ..... | $1,908,857,826 | $1,720,814,900 |
| Net earnings..... | 592,508,512 | 560,026,277 |
| Other receipts .... | 89,485,484 | 77,663,483 |
| Total avail. rev. | $681,993,996 | $637,689,760 |
| *Payments:* | | |
| Interest on bonds.. | $239,426,707 | $222,614,909 |
| Other interest .... | 8,680,451 | 9,733,560 |
| Dividends on stock. | 164,549,147 | 151,019,537 |
| Miscellaneous .... | 61,326,614 | 57,408,351 |
| Rentals: Interest. | 38,675,121 | 40,622,542 |
| Dividends ..... | 26,125,268 | 27,154,215 |
| Miscellaneous .. | 21,326,600 | 19,970,212 |
| Total payments | $560,113,908 | $528,523,326 |
| Surplus ..... | $121,880,088 | $109,166,434 |

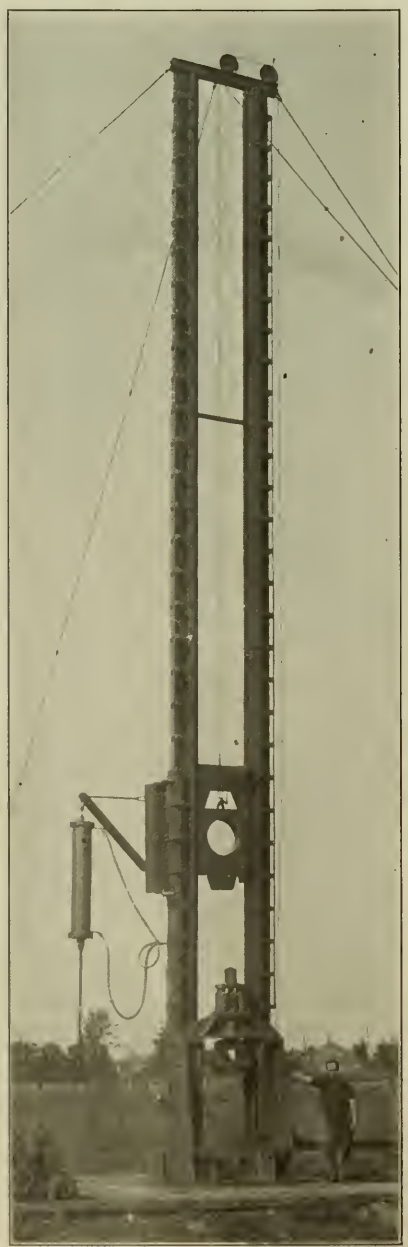
Total receipts increased 188 millions, or about 10 per cent.; freight earnings 147 millions and passenger 33 millions. The following table shows the average mileage operated, capital per mile, and bonded debt per mile of all steam railroads in the United States for the past five years.

| | Mileage worked. | Capital stock per mile. | Bonded debt per mile. |
|---|---|---|---|
| 1899..... | 187,781 | $30,579 | $30,061 |
| 1900 ..... | 192,162 | 30,205 | 29,967 |
| 1901..... | 195,887 | 30,521 | 30 811 |
| 1902..... | 199,685 | 30,139 | 32,377 |
| 1903..... | 206,876 | 30,719 | 32,494 |

Gross earnings per mile of road in 1903 amounted to $9,301, and net earnings to $2,887, as compared with $8,696 and $2,830 respectively in 1902. The average ton-mile rate was 7.85 mills, as against 7.64 mills in 1902, and 7.56 mills in 1901. This average shows a steady increase since 1899. The average revenue per freight train mile was $2.444 against $2.356 in 1902, and $2.228 in 1901. The average receipts per passenger per mile in 1903, 1902, and 1901, were respectively, 2.05 cents, 2.01 cents, and 2.03 cents. The average interest rate on bonds was 4.13 per cent. in 1903, 4.07 in 1902, and 4.21 in 1901, while the average dividend on stock was 2.83 per cent. in 1903 as compared with 2.93 per cent. in 1902 and 2.62 per cent. in 1901. The ratio of operating expenses to earnings, 68.96 per cent., is the highest since 1897, when it was 69.74.

## Master Car Builders' Drop-Testing Machine.

The accompanying illustration represents the Master Car Builders' drop-testing machine as it is now installed at the laboratory of Purdue University, Lafayette, Indiana.



M. C. B. Drop-Testing Machine at Purdue University.

Its drop weighs 1,640 lbs., and is of forged steel. Its weight meets the requirements of the Master Car Builders' specifications for coupler testing as well as those of the International Association for Testing Materials, with reference to axle testing. It can be made to meet the requirements of the last named association for rails by applying discs to the cylindrical opening which serve to increase the weight of the drop to 2,000 lbs. The drop is handled by a wire cable served by a reversible hoisting engine within the locomotive laboratory, at the right of the machine as it appears in the illustration. The anvil or base of the machine weighing 17,000 lbs. is carried by a nest of coiled springs which in turn are mounted upon a suitable foundation plate. It is assumed that the spring support of the anvil makes it possible to easily reproduce the machine; that is, that the resisting qualities of a similar anvil, similarly supported, will be the same whether the machine rests upon a rock foundation or upon soft soil. The machine rises to a total height of 55 ft.

The machine was developed by the Master Car Builders' Association. At its annual meeting in 1898, this association appointed a committee to define fully the contour lines of M. C. B. couplers, and to propose specifications which might guide railroad companies in the purchase of new couplers. This committee consisted of Messrs. W. W. Atterbury,[1] W. P. Appleyard,[2] and W. S. Morris.[3] The report which it presented at the next meeting dealt with the coupler question in a very comprehensive manner, recommending among other things that couplers offered to railroads be subjected to a series of tests under a drop-testing machine. The committee not only defined the nature of these tests, but presented a design for a machine to be employed in carrying them out, and gave results of tests which had been secured by the aid of an improvised machine to demonstrate the reasonableness of the specifications they proposed. It was in the work of Mr. Atterbury's committee that the present M. C. B. drop-testing machine had its origin, and it is a high tribute to this body, that though the question of drop-testing has been extensively studied since the date of its first report, the conceptions underlying the design of the machine which was then defined have not since been changed. As time went on, the original drop-testing machine, which had been at Altoona, was improved in matters of detail, and became useful not only in testing of couplers, but in testing of draft gears as well. Meantime, the chairmanship of the coupler committee had been transferred to Mr. R. N. Durborow,[4] who in this manner became responsible for the later development of the machine.

Its installation at Purdue places it upon neutral ground and under the same auspices as the association's air-brake testing rack and the brake-shoe testing machine.

[1]Now General Manager, Pennsylvania Railroad.
[2]Now Superintendent of Equipment, Pullman Co.
[3]Late Superintendent of Motive Power, Erie Railroad.
[4]Superintendent Motive Power, Pennsylvania Railroad.

The Prussian State Railroads have let contracts for steel rails and ties to the combined Prussian steel works at $26.65 per ton of 2,204 lbs. for rails, and $25 for ties on cars at the rolling mills. As an experiment heavy rails for 31 miles of track are to be rolled 15 meters (49 ft. 3 in.) long. The standard length is 39 ft. 4 in. The Austrian Northwestern Railroad has contracted with the combined rail mills of the country for its rail supply for 1905 at a price $4 per ton higher than at the last letting, when the Austrian and Hungarian works bid against each other.

RAILROAD GAZETTE

## AMERICAN LOCOMOTIVES IN FRANCE.

About five years ago manufacturing conditions in America and Europe were such that American locomotive builders were able to sell a number of engines to European railroads. On most of the roads, the American engines were received with some prejudice, and many indefinite accusations of extravagant fuel consumption were made against them. Authoritative figures are now at hand, in the reports of tests made on the French State Railway, given elsewhere in this issue and in the issue of October 28, which satisfactorily disprove the allegations of extravagance.

The coal consumption per horse-power hour for the French and the American locomotives, as shown by the full series of tests, was as follows:

| Number of Engine. | Class. | Lbs. Coal per h.p.h'r. |
|---|---|---|
| 2754 | French single-compound .... | 4.40 |
| 2901 | American single-expansion .. | 4.45 |
| 3729 | French compound ..... | 3.24 |
| 2802 | American compound ..... | 3.30 |

Showing little difference between the French and the American engines in fuel economy. When the American locomotives were put into service in Europe, they were of a type unfamiliar to the men handling them, and they also had to contend with an unreasonable prejudice against an imported locomotive. That this handicap is not yet removed, is shown by the tone of Mr. Nadal's report. His remarks on the American locomotives are introduced as follows:

> American locomotives have the reputation of being less economical than those of Europe, and this reputation appears to be justified by the results given by those on the French State Railways, *at least when they were first put into service.*

This conveys the impression that the American locomotives are less economical than the French, but the clause which we have italicised seems to indicate pretty clearly that the American engines, being properly broken in, are giving results which are substantially equal to those obtained with the French engines. This conclusion is justified by the coal consumption just shown. Mr. Nadal's other criticisms also lack support.

The American locomotives are criticized on five points:

1. Low boiler efficiency and excessive priming. But here are the figures of coal consumption; if the American boilers are not so efficient as the French, the American cylinders must be correspondingly more efficient or it would be impossible to obtain the same fuel consumption per horse-power hour. The actual figures for fuel consumption are not given in the summary, but the water consumption per horse-power hour is given and also the amount of water evaporated per pound of coal. By dividing the former by the latter the coal per horse-power hour is obtained. The American boilers are accused of priming badly, but any boiler will prime if the water is carried too high. That some of the American boilers can be run without priming, is shown by the tests of the single-expansion engine. In indicator diagrams of these tests, the expansion line, according to Mr. Nadal's analysis, shows a leaky piston valve, but no priming. A curious feature in connection with the alleged priming of the boiler of the compound, is that in his analysis of the expansion line of the indicator diagrams, Mr. Nadal does not find any indication of excessive water in the cylinders. The expansion curve is pronounced normal, and similar to those observed with the French single-expansion engines, in which no priming was observed. The statement that priming occurred on the American engines is probably based on the apparently high evaporative duty of the coal, and on a discrepancy between the indicated steam consumption and the measured water consumption. The figures show that about 12.5 per cent. more water was measured into the tender tank than should have been evaporated by the coal or used by the cylinders. Mr. Nadal assumes that this excess water is carried away from the boiler and through the cylinders with the steam. It seems curious that this amount of water should be carried by the steam without either showing its presence on the indicator cards or being observed directly in the exhaust. The loss of the excess water can be more readily explained by supposing a leak in the feed water connections or in the tender, or even an error in calibrating the tank. If the engine really did prime as suggested, it makes the Vauclain cylinders compare very favorably with the de Glehn, since with steam containing 12.5 per cent. of moisture, there is less than 2 per cent. difference in the coal consumed per horse-power hour.

2. Boiler Leaks.—Some trouble was experienced when the boilers were first put into service, but this was not of a permanent nature and was corrected.

3. Utilization of the Steam.—Mr. Nadal says:

> The operation of the steam in the cylinders would be as economical as in European engines if running conditions would allow of . . . a cut-off at 20 or 30 per cent. of the stroke. It appears that in America it is usual to cut off at 40 or 50 per cent. This does not give sufficient expansion, and consequently the steam consumption is high.

That is to say, in America the valves are set to allow the locomotive to develop normally a larger percentage of its maximum power. In this country extreme economy of fuel is not so desirable as securing a large amount of power. The valve setting on the American engines did not result in a high steam consumption. The water consumption per horse-power hour was found from the tests to be:

| Engine No. | Class. | Lbs. Water per h.p. h'r. |
|---|---|---|
| 2754 | French single-expansion piston valve ..... | 29.80 |
| 2901 | American single-expansion piston valve ..... | 29.63 |
| 3729 | French compound ..... | 23.59 |
| 2802 | American compound ..... | 26.67 |

As previously explained, the figure for the American compound is too high, owing to water losses which are not due to the cylinders. The dry steam consumption per horse-power hour, as calculated by Mr. Nadal from the indicator diagrams, is

| | Lbs. of Dry Steam. |
|---|---|
| French compound ..... | 22.58 |
| American compound ..... | 22.33 |

These figures show the American engines to be more economical as regards the operation of the steam in the cylinders. With the American cylinder design, with large ports and ample steam passages, there is less wire-drawing than in the French engines, so that with increasing speed the loss of power is low. For example, the de Glehn compound, at 30 miles an hour, develops a tractive effort of 7,060 lbs., while at 60 miles an hour the tractive effort is only 3,640 lbs., a reduction of 48.4 per cent. The Vauclain compound under similar conditions only reduces the tractive effort 21.5 per cent., the change being from 7,160 lbs. at 30 miles an hour, to 5,620 lbs. at 60 miles an hour.

4. Leaky Slide Valves.—In the summary, the American piston valves are criticized as leaking. But in the analysis of the individual tests, Mr. Nadal says that "the Vauclain piston valve is shown to be steam tight, at least during expansion, and it is during this period that any leakage is most likely to occur." The single-expansion piston valve is shown by the diagrams to have allowed a leakage of about 6 per cent., but in spite of this, the water consumption per horse-power hour is lower than that of the French piston valve.

5. Resistance.—In the summary it is suggested that the American engines are less carefully built than the French, and that their resistance is consequently higher. There is no definite statement that this is so, but it is strongly hinted at. As before, however, the figures given fail to prove this charge. From the power developed, and from the known resistance of the train, Mr. Nadal determined for each type of locomotive a formula giving the resistance per ton of locomotive and tender in terms of the speed. These formulæ are given in Table VIII., accompanying the translation of the original articles printed in another column. One formula is used for the French and American single-expansion piston valve engines, and another formula is used for the French and American compounds, but in neither case is any difference made between the French and American engines. That is to say, the tests show that the resistance of the American engines is no higher than that of their French competitors.

The "characteristic factors" calculated by Mr. Nadal and given in Table IX. are interesting. It will be seen that when judged by these factors, the American engines stand easily ahead of the French. Compared on the basis of horse-power effective at the tender drawbar, the steam consumption is

| No. | Class. | Lbs. Steam per effective h.p. h'r. |
|---|---|---|
| 2754 | French single-expansion..... | 46.56 |
| 2901 | American single-expansion .. | 41.84 |
| 3927 | French compound ..... | 36.11 |
| 2802 | American compound ..... | 33.49 |

This steam consumption is that which will be required when the locomotives are working at their maximum normal power. During the tests the French single-expansion engine averaged 575 horse-power, or 85 per cent. of the normal power, which is 675 h.p. The competing American single-expansion did the same work, developing 575 h.p., but this is only about 63 per cent. of its normal power, and it was therefore not working under such economical conditions as its competitor. Taken as a whole, the figures obtained from the tests show that even under somewhat un-

favorable circumstances the American locomotives can compete satisfactorily with the European.

## CARS AT THE WORLD'S FAIR.*

The passenger cars at St. Louis, three trains of them, constitute the main feature of the transportation exhibit. They have the beauty that is appreciated by every visitor, and their utility is apparent to many who will pass a row of big locomotives with the carelessness of ignorance; although, of course, the engines are the main feature to all who put energy first and grace second. A superficial look at the cars discloses no marked differences between the cars of 1893 and those of to-day. Those exhibited at Chicago were large and roomy, convenient in use, and tasteful in design and ornamentation, and there was not much opportunity for further progress. Steel platforms and framing have become common, steam heating has been made more perfect, and wide vestibules are now fashionable everywhere —so much so that they frequently appear in local trains, where vestibules are something of a nuisance. Dining cars are much more numerous on American railroads, but not noticeably better. Beyond these features no important changes have been made in the 11 years since the Chicago fair.

Automatic couplers for steam-pipes and air-pipes are still too young to make much of a show. Electric lighting has been extended, but its progress is still slow. The desire to use it is persistent, however, as is manifest from the fact that every car on exhibition has lights of this kind, though most have gas fixtures also. It looks as though the next world's fair—if it doesn't come ahead of time—would see electric lights in all new passenger trains and most old ones.

The first car that the sightseer encounters is the beautiful private car shown by F. M. Hicks & Co. (described in our issue of Sept. 9, page 82, news section). After one gets over the surprise of seeing such an elegant affair from a shop supposed to deal only in second-hand wares he indulges in mild curiosity as to how any builder can afford to make such luxuries to "keep in stock." Have we already become a nation of millionaires, so that 30,000-dollar traveling dwelling houses are a regular article of everyday commerce? The fact that the custodian of this car is a young woman of engaging manners and possessing a thorough knowledge of its merits, may, however, indicate that the owners do not expect to sell it by any of the ordinary salesman's wiles!

The American Car & Foundry Company shows a complete train, baggage, mail, day cars, parlor and dining cars, built for the Missouri Pacific; and an inspection of the interiors shows the latest modes in all of the details on which designers exercise their ingenuity for the purpose of introducing a little variety where sameness is in large measure compulsory. The prevailing color scheme is mahogany, with a good deal of light to relieve its heaviness. The headlinings are light colored, a sensible idea which seems to be slowly growing in favor. In a car that is always well lighted at night this is not perhaps an important question, but if the illuminant is of poor quality or deficient in quantity, as is still the case in many places, a light colored interior materially mitigates the annoyances of the passengers who wish to read after dark; and a white reflecting surface saves gas or electric power in any event.

All of these cars have windows wide enough to cover the space of two seats, and are arched at the top. This affords on the outside a pleasant change from the unrelieved row of rectangles of the time-honored day car, but inside there is at once a suggestion of inconvenience from possible disagreement between the two passengers sitting in adjacent seats, where one wishes to have the window open and the other desires it closed. But inasmuch as the ordinary arrangement (in which each passenger's comfort depends largely on the way the passenger in front manages his window) is by no means ideal, one would hesitate to declare the new arrangement less desirable than the old. To provide for very cold weather these windows are made with two panes of glass in each sash, instead of having two sashes, as in sleeping cars. The sashes have spring lifts of course; no passenger of ordinary size could think of lifting one of them by main strength. The day cars in this train both have wash-bowls. All the cars are fitted for both electric and gas lighting ("axle light" and Pintsch). In the dining car the dining-room portion is divided into two parts, the smaller of which is called, by courtesy, a private dining-room. In conveniences this train is all that one could ask for; and in interior colors and decorations it affords a not unpleasant variation from the conventional plain-wood effects so common of late years.

The train exhibited by the Pullman Company occupies two tracks, being composed of 10 cars. Every car in this train is a model of good taste. As was said in a preceding paragraph, comparisons made now with 1893 cannot be expected to show radical changes. The best trains made then were the work of competent designers and were acknowledged to be not only pleasing and satisfactory productions, but highly creditable to their creators. The accepted canons of art are not new, and the talents of American architects, decorators and upholsterers are not exactly an "infant industry," so it is not surprising if we find nothing more beautiful to-day than was shown 11 years ago. Comparisons, however, are hardly to the point. The artistic features of this Pullman train are so uniformly excellent that the observer scarcely thinks of the other fine cars that he has seen; such others may be different, but they cannot be more chaste, or refined. Much of the inlaid wood work and of the gold and gilt decorations is a trifle too rich for every-day consumption, but it is neither loud nor sickish.

This train was described in the *Railroad Gazette* of May 27, page 398; or, rather, it was there described as well as it could be described by half-tone engravings from photographs and by the use of the conventional architects' vocabulary. For any real appreciation of the beauties of these cars it is necessary, of course, to see them; for the color effects constitute the main test. As before intimated the general impression of tasteful design which strikes the observer on entering the first car is well sustained throughout the train. Leaded glass is perhaps used a trifle too freely, and the use of art glass in lamps is more justifiable as a decoration than it is for utility; the high windows in the dining car may or may not prove a desirable improvement, and the coloring of panels in the ceilings with a strong orange tint is perhaps justifiable only by the necessity of having variety; but, on the whole, these small criticisms are obliterated by the excellent general impression. The fixing of the lamps, in a number of these cars, on the sides somewhere near the level of the eye, instead of near the roof, seems to be due primarily to the desire for change, and secondarily, to a commendable purpose to more fully serve the convenience of passengers who wish to read; but the success of the arrangement depends, of course, not on a general decorative scheme, but on the correct placing of each individual light, which feature must be tested by time.

The coach and the chair car in this train have transverse partitions at the ends, such as are seen in many parlor cars (with the opening at one side), cutting off the body of the car from the view of a person entering at the door and also cutting off drafts of wind; but to avoid delay and inconvenience when the car is used for way travel the partitions are hung on hinges so that they can be opened like a door, leaving a direct passage to and from the platform. One of the cars in this train is a private car, with the usual bedrooms, kitchen, rooms for servants, etc., and it has a shower bath. Enameled tiling is freely used in bath rooms and in toilet rooms throughout the train.

The third train is an "Empire State Express" of four cars, exhibited by the New York Central. The parlor car is from the Pullman shops, but the others are from Barney & Smith. As the Empire State Expresses in actual service are at all times examples of the best cars in use, little that is new is to be expected here. In the day cars every seat is numbered, after the fashion of parlor cars. The finish is oak, with neat inlaid stripes. The headlining is light olive and the sides are covered with figured green plush. The window sashes have spring lifts. All of the cars in this train have both electric lights and Pintsch gas, seven incandescent electric lamps being fixed along each edge of the clear story. One of the day cars has a kitchen, and tables can be fixed between any two seats; and the floors are covered with linoleum.

The only standard car exhibited, aside from the foregoing, is a side-door suburban passenger car exhibited by the Illinois Central. This car is already well known to the readers of the *Railroad Gazette*, having been described in the issue of Sept. 4, 1903.

Notices of the city and interurban electric cars, and of some other things shown at the Exposition, must be deferred until a future issue.

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A steam-electric case has arisen before the Massachusetts Railroad Commission which has its meanings outside of the bounds of that State. The immediate matter involved was a petition of the Worcester & Webster Street Railway Company to connect by a short link with the Worcester & Southbridge —the former being, through an intermediary railway corporation, under lease to the New York, New Haven & Hartford. The opposition at the hearing alleged that the plan in-

*Continuation of articles on the St. Louis Fair printed Sept. 23 and Oct. 28.

volved the abandonment of electric tracks This, alone, raises an interesting point as against the insistent Massachusetts policy of allowing consolidation—by lease or otherwise —only if service at least as good as before the lease is maintained. But more important than this was the undisputed assertion that since the lease not only had steam service at Auburn been diminished but also the electric service cut down from half-hour to hourly cars and the electric plant allowed to deteriorate. This, if we are not mistaken, is one of the many instances where the New Haven company has bought control of trolley lines to "block" parallels. If that process is to be attended with abandoned tracks and vitiated service the policy may "go" in Connecticut and Rhode Island, with their flabby and nerveless railroad commissions, but in Massachusetts it will find a horse of another color.

## The Block System in Iowa.

The space interval is the only rational, scientific and satisfactory method of running trains and protecting them from collision. The time-interval and flag-lantern-torpedo combination is cumbersome and troublesome at best, and is unworkable where trains are fast and frequent. But the fact that these truths are generally recognized does not insure millennial conditions, for it is easy to use the block system in a partial manner or to adopt its theory without enforcing correct practice, and without using well known electrical safeguards; and so we have situations like that in Iowa, illustrated in the discussion at the September meeting of the Iowa Railway Club. We print a brief abstract of it in another column.

Anyone familiar with practice under the block system on a road where it is regularly and consistently carried out, would say that the most of this Iowa discussion was useless, and possibly even vicious, many erroneous views being expressed and considerable time being used up in refuting fallacious arguments; but as those who took part in the discussion evidently were men engaged in the practical operation of trains, it cannot be said that anything which shall clear up points that are obscure to them is wasted; and a thorough airing of the subject ought to be of much permanent benefit. There can be no doubt that many trainmen accept the block system as a necessary evil and feel considerable opposition to it for months or years after they have begun to work under it, especially if the regulations for permissive blocking, or any of the rules, are administered in anything but the most accurate and businesslike manner. This being so there is ample room, if we are to continue the American theory of making employees more like men and as little as possible like machines, for instructive discussion.

The speakers brought out both bad and good points concerning practice in Iowa. Among the former were the following:

1. Permissive blocking is common. Permissive blocking is not necessarily vicious, but the utterances of some of the speakers indicated that as they had observed it, it was so, enginemen not running strictly under control. Unfortunately Iowa is not the only State in which this bad practice may be found.

2. With block stations at A, B, C, Station B is closed at night and trains which have to meet there are provided with telegraphic orders at A and C. While this is a suspension of the block system, it is to be observed that giving meeting orders for such movements is a great improvement over the practice of depending on time-table rules alone.

3. Operators, even the best of them, make mistakes, letting two opposing trains get together.

4. Trains doing work at stations are not suitably protected by fixed signals, and so the conductor must either send out flagmen or depend upon the station operator to notify approaching trains at the next station back; sometimes he thus depends when he has not assured himself that the operator understands the situation and so gets into trouble.

5. Operators are young and inexperienced and consequently commit errors which would be avoided by older men, such as conductors and enginemen.

All of these weaknesses exist because of the real or supposed need of keeping expenses within a predetermined limit. None of them are inherent in the system. As against the argument that the block system with these imperfections is worse than no block system at all, we have the testimony of many superintendents who have had 10 or 15 years' experience in just this kind of practice, that it is well worth its cost, taking it as it is. But in so far as these weaknesses are due to disobedience of rules, every railroad man in Iowa or in any other State, knows that the first duty is to correct the discipline, whatever the system. The block system is valuable in what may be called its reflex influence, for it makes so clear the value of good discipline, and makes it so much easier to begin, that many superintendents are shamed into putting their discipline on a better basis who would not have done so—at least not without further delay —if they had not been compelled, by the introduction of a new system, to study the rationale of discipline.

But the practice of Iowa furnishes encouragement also. One member declared that the block system was the true method even with only one train a day each way. There is genuine appreciation of the principle. The principle is sound, however clouded our practice and opinions may be. And this speaker was not indulging in hyperbole. Imagine a road 40 miles long, A to B, and no intermediate telegraph offices. The danger to our one train is from the single opposing train and from extras. Assume that No. 1 leaves A at 10 a.m. and arrives at B at 12 noon; and that No. 2 starts from B for A at 2 p.m. Is it not better for No. 2 to wait till No. 1 arrives at B, regardless of the clock, than to wait until a given time? Or, if an extra is to follow from A, is it not better for it to wait until No. 1 reaches B, provided the delay can be borne, thus relieving No. 1 of a lot of unnecessary flagging, than to have this flagging done day after day, and year after year, when, most of the time, no extra is following? This illustration is an extreme case; if there are intermediate telegraph stations, and freight trains every day, and if meeting points have to be made frequently, the argument is by these circumstances only made stronger.

That the advantages of the block system are intelligently understood in Iowa is shown by the remark of one of the speakers that when patches of fog are likely to obscure the view, enginemen prefer to wait for a clear signal rather than run on a caution card. This gives evidence that the caution rule is enforced and that the advantage of a clear signal for a whole block is appreciated. Another bit of significant testimony was that concerning cases where a despatcher sends out extras and forgets to give them all the meeting orders that they need. This is a kind of blunder which has usually escaped publicity; but since the Government began issuing its bulletins, cases appear every now and then. One member, speaking, no doubt, from experience, declared that this protective feature alone was sufficient to justify the use of the block system.

Last, but not least, the running of 65 work trains on two fifty-mile sections, for three summers, without a collision, is a fact worth recording in favor of the block system, albeit much permissive blocking was, no doubt, done.

Of the discussions of block signaling which appear in print, a large part is somewhat academic in its nature, for the reason that the cost of collisions is not often allowed to be made public in a way specific enough to be intelligently compared with the cost of the block system; and also because the cost of the collisions which would have occurred on block signaled roads, if the signals had not been adopted, must remain an unknown quantity; but bits of experience like those here recounted serve partly to supply this deficiency, hence we print them. The final argument against the block system was that it made men more careless. No particulars were mentioned, but the reference was, we suppose, to the determined way in which men will omit to flag back when they know that they are protected by a block signal. Mr. Campbell gave a simple answer to this, namely, that by proper discipline—which we judge, from the tone of his remarks, was not found difficult when the superintendent set about it with determination —the men were made to obey the rules. Another answer would be to make the block signaling so perfect that flagging can be dispensed with. That is the way they do it in England. The plea that improvements make men careless may easily be made too much of. The establishment of double track instead of single tends to make conductors and enginemen less alert and thoughtful than they were when they had to spend half their time in making astronomical calculations (or something akin to that kind of work); but no one is going to postpone building a second track on that account.

## Chicago, Milwaukee & St. Paul.

This company had a net income in the fiscal year ending June 30, 1904, of $10,718,400, about 2½ per cent. greater than the corresponding figure for 1903. The company has added 224 miles of line to its system. This consists of short branches and cut-offs pretty well scattered. It has completed its line into the coal fields in Illinois. It has added 47 miles of second track, completing this year the double tracking on the La Crosse Division from Brookfield Junction to Watertown Junction. It is building third and fourth tracks from Chicago to Milwaukee. Grade reduction in many places and track elevation in cities have been the feature of the year. For the former $1,129,000 was spent and for the latter $2,544,000.

The changes in the equipment roster have been small; 2,000 new freight cars were bought, 23 passenger train cars and 47 locomotives. This is a very small purchase of new equipment for so large a road. As it now stands about 5 per cent. of the freight car equipment and 5 per cent. of the locomotives are less than one year old. The company has been hard hit by the high price of coal. In order to avoid a repetition of the severe experience in this particular of the past few years, the company has entered vigorously into the policy of buying coal mines. In pursuit of this policy it has acquired title to coal lands, or coal patents, in Illinois aggregating 30,109 acres.

The expenditures for new work for the year amounted to $9,307,000. Of this amount $5,520,000 was charged to capital account. The remainder, namely, $3,787,278, was

charged to renewal and replacement fund, which in turn, of course, is supplied out of earnings.

The money for this expenditure was taken from current funds and resources. No new capital was raised during the year. The change in the balance sheet is indicated below:

| | |
|---|---|
| *Debit.* | |
| Increase of liabilities— | |
| Common stock | $650,000 |
| Profit and loss | 3,299,919 |
| Decrease of assets— | |
| Trust funds | 62,035 |
| Special funds | 32,817 |
| Materials | 445,171 |
| Current assets | 2,520,028 |
| | $7,009,970 |
| *Credit:* | |
| Increase of assets— | |
| Cost of road | $4,464,316 |
| Bonds, stocks, etc | 1,056,254 |
| Treasury securities | 213,000 |
| Decrease of liabilities— | |
| Funded debt | 650,000 |
| Current liabilities | 626,400 |
| | $7,009,970 |

Funded debt decreased $650,000, while capital stock increased a like amount. This was due to the conversion of convertible bonds into stock.

The income account is given below:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Gross receipts | $48,330,334 | $47,662,737 | $667,597 |
| Exp. and taxes | 31,876,589 | 31,598,174 | 278,415 |
| Net earnings | $16,453,744 | $16,064,563 | $389,181 |
| Other income | 316,430 | 510,030 | *193,600 |
| All income | $16,770,175 | $16,574,593 | $195,582 |
| Charges | 6,051,775 | 6,101,335 | *49,560 |
| Balance | $10,718,400 | $10,473,258 | $245,142 |

*Decrease.

If we add to the stated net income the $3,787,278 of expenditures for improvement work charged to renewal and replacement fund and deduct $389,878, the net amount this fund was drawn down during the year, we find that the actual earnings on the common stock were 18.4 per cent.

The increase in gross earnings was insignificant, something over 1 per cent. It was about 5 per cent. in 1903 and 8 per cent. in 1902. The increase was fairly well distributed among passenger, freight and mail and express. The increase in freight revenue, however, does not represent an increase in freight business. There was actually a decrease of ton miles hauled of about 2 per cent., while the average ton-mile revenue increased from 8.65 mills to 8.91 mills. Agricultural products and coal tonnage increased, but the increases here were more than offset by declines in ore and forest products, agricultural implements and other commodities not specified. The decrease in ore tonnage reached nearly 500,000 tons, and this may be taken as the real cause for the decline in the total tonnage.

Expenses apparently have been kept in hand, but closer examination shows that the maintenance expense has been seriously curtailed to offset the very large increase in the expense of conducting transportation. The detail is:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| M. of way | $5,128,248 | $7,347,048 | $2,218,800 D. |
| M. of equip | 4,651,783 | 3,893,834 | 757,949 I. |
| Cond. transp. | 18,597,342 | 16,829,795 | 1,767,547 I. |
| Gen'l expenses | 1,190,907 | 952,309 | 238,598 I. |
| Taxes | 1,600,732 | 1,470,187 | 130,545 I. |
| | $31,169,012 | $30,493,173 | $675,839 I. |

The company has borrowed heavily from maintenance to pay current bills of transportation, while the freight business has actually fallen off, as noted above, about 2 per cent. The maintenance outlay for equipment while higher than last year is far from liberal. It is: Per locomotive, $1,493; per passenger car, $531; per freight car, $38.

This curtailment of maintenance outlay is noticeable from another point of view, namely, the per cent. of new equipment charged to expenses. For freight cars it was but 1 per cent., for passenger train cars but ½ per cent., and for locomotives 2 per cent. On the other hand transportation expense has increased $1,767,000, or over 10 per cent. In three years transportation expense has increased $4,665,000, while gross earnings have increased $4,961,000, or only about $300,000 more than the actual direct expense of handling the business. If we take transportation and general expense together, we find that they have increased $5,049,000, or actually $87,000 more than gross earnings in the same time.

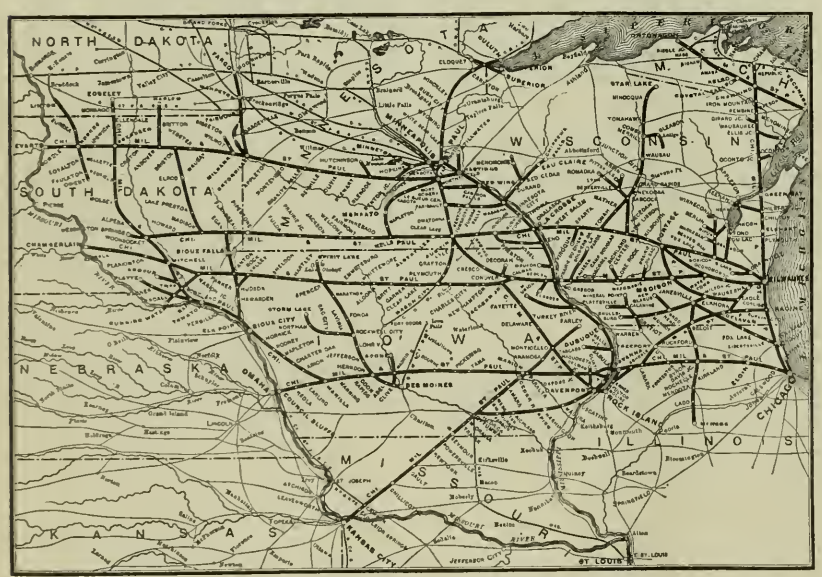
Two things are conspicuous in this: (1) Gross earnings do not increase at the rate we might expect them to in a growing country; (2) the expenses have increased excessively. Transportation expense in 1901 was 33 per cent. of gross earnings. In 1904 it was 38 per cent. The explanation lies in wages and the fuel bill. As "St. Paul" serves as a fair sample of what many roads are showing in their transportation expense we give below the items under this head:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Superintendence | $352,289 | $532,902 | *$180,612 |
| Eng. & rndhsemen | 3,326,550 | 3,050,645 | 275,904 |
| Fuel loco. | 4,620,745 | 4,079,948 | 540,796 |
| Water supply, loco. | 179,209 | 143,996 | 35,213 |
| Oil, tallow & waste | 122,751 | 96,313 | 26,437 |
| Other loco. supplies | 56,904 | 61,555 | *4,650 |
| Train service | 2,406,975 | 2,069,528 | 337,447 |
| Train s'plies & exp | 511,548 | 434,659 | 76,889 |
| Switch, flag and watchmen | 1,382,048 | 1,227,225 | 154,823 |
| Telegraph | 354,520 | 332,132 | 22,387 |
| Station service | 2,511,282 | 2,363,251 | 148,031 |
| Station supplies | 201,658 | 185,785 | 15,872 |
| Switching charges | 244,232 | 131,346 | 112,886 |
| Equipment hire | 188,387 | 141,495 | 46,891 |
| Loss and damage | 335,949 | 263,922 | 72,026 |
| Injuries to persons | 318,861 | 302,600 | 16,260 |
| Clearing wrecks | 52,684 | 42,972 | 9,711 |
| Advertising | 154,036 | 150,645 | 3,390 |
| Outside agencies | 498,404 | 469,180 | 29,223 |
| Stkyds. & elevators | 56,777 | 49,379 | 7,398 |
| Rents, tracks | 331,290 | 317,858 | 13,432 |
| Rents, buildings | 52,423 | 44,194 | 8,228 |
| Stationery & p't'g. | 186,976 | 186,909 | 67 |
| Other expenses | 150,833 | 151,345 | *512 |

*Decrease.

The decrease in the first item of $180,612 is probably due in large part to reclassification, for general expense shows an increase of $119,000.

To sum it up Chicago, Milwaukee & St. Paul has accumulated ample reserves to provide for just such a year as 1904. There is absent the marked tendency to expansion which the generally new character of the country would lead one to expect. No financing has occurred this year. The company has had to curtail, however, and these curtailments have been in maintenances. The problem before the officers is how to reduce the coal bill and how to hold wages in hand. Their purchase of coal lands is to save in the coal bill. They have been vigorously bettering facilities by double tracking long sections and by reducing grades.




Chicago, Milwaukee & St. Paul.

## Atchison, Topeka & Santa Fe.

The Atchison has increased its operated mileage 297 miles, the Southern California, which last year was reported separately, being this year incorporated with the system, so that the total now reaches 8,301 miles. The income account was:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Gross earn'gs. | $68,171,200 | $62,350,397 | $5,810,803 I. |
| Other income. | 1,248,775 | 1,317,993 | 69,218 D. |
| All income. | $69,419,975 | $63,668,390 | $5,751,585 I. |
| Expenses, taxes and rentals. | 44,641,434 | 40,635,576 | 4,005,858 I. |
| | $24,778,541 | $23,032,814 | $1,745,727 I. |
| Charges | 9,418,770 | 9,134,485 | 284,285 I. |
| Surplus | $15,359,771 | $13,898,329 | $1,461,442 I. |

The increase in gross is 9 per cent. and in net 10 per cent. The road earned 5 per cent. on the preferred and 9.4 per cent. on the common stock. The sum of $14,553,780 was spent during the year for the construction and acquisition of additional railroads, for equipment and for other properties and for improvements. The way the expenditure was financed is shown by the table below; $7,500,000 was raised on bonds and $4,600,000 was taken out of current cash.

| | |
|---|---|
| *Debit.* | |
| Increased liabilities— | |
| Funded debt | $7,502,800 |
| Accounts payable | 54,337 |
| Profit and loss | 2,333,344 |
| Decreased assets— | |
| Accounts receivable | 819,218 |
| Cash | 4,597,881 |
| | $15,307,580 |
| *Credit:* | |
| Increased assets— | |
| Road and investments | $10,993,870 |
| Securities on hand | 171,480 |
| Other investments | 989,211 |
| Materials and supplies | 1,611,077 |
| Trust funds, etc. | 183,986 |
| Decreased liabilities— | |
| Special funds | 1,344,112 |
| Accrued interest and taxes | 13,844 |
| | $15,307,580 |

The increase in gross earnings was fairly distributed among passenger, freight, mail and express. But the increase in freight earnings was due to the increase in the aver-

age rate from 9.48 to 10.20 mills per ton per mile. The actual freight handled was very slightly less than last year. The detail of earnings and expenses appears below:

| Earnings: | 1904. | 1903. | Increase. |
|---|---|---|---|
| Passenger | $15,333,773 | $13,369,985 | $1,963,787 |
| Freight | 47,762,653 | 44,022,438 | 3,140,214 |
| Mail and exp. | 3,835,662 | 3,411,697 | 423,964 |
| Miscellaneous. | 1,139,111 | 846,275 | 292,836 |
| Total | $68,171,200 | $62,350,397 | $5,820,802 |
| Operating expenses: | | | |
| Maint. of way | $9,170,234 | $9,304,892 | *$134,658 |
| Maint. of equip | 10,006,135 | 8,510,543 | 1,495,592 |
| Cond transp. | 21,295,960 | 19,023,145 | 2,272,815 |
| Gen'l exp... | 1,749,702 | 1,598,530 | 151,172 |
| Total | $42,222,032 | $38,437,110 | $3,784,922 |
| Net | 25,949,167 | 23,913,286 | 2,035,880 |

*Decrease.

The gross earnings per mile are larger than ever before. The growth in the last seven years is indicated below.

| | Gross earnings, per mile. | | Gross earnings, per mile. |
|---|---|---|---|
| 1897 | $4,752 | 1901 | $6,977 |
| 1898 | 5,653 | 1902 | 7,527 |
| 1899 | 5,760 | 1903 | 7,827 |
| 1900 | 6,297 | 1904 | 8,334 |

The striking thing about gross earnings is the rapid increase of passenger earnings:

| | Freight. | Passenger. |
|---|---|---|
| 1897 | $22,067,686 | $5,574,288 |
| 1898 | 28,588,716 | 7,347,361 |
| 1899 | 29,492,586 | 8,126,141 |
| 1900 | 33,729,332 | 9,334,661 |
| 1901 | 39,052,557 | 11,678,017 |
| 1902 | 41,815,607 | 13,439,384 |
| 1903 | 44,622,438 | 13,469,985 |
| 1904 | 47,762,653 | 15,433,773 |

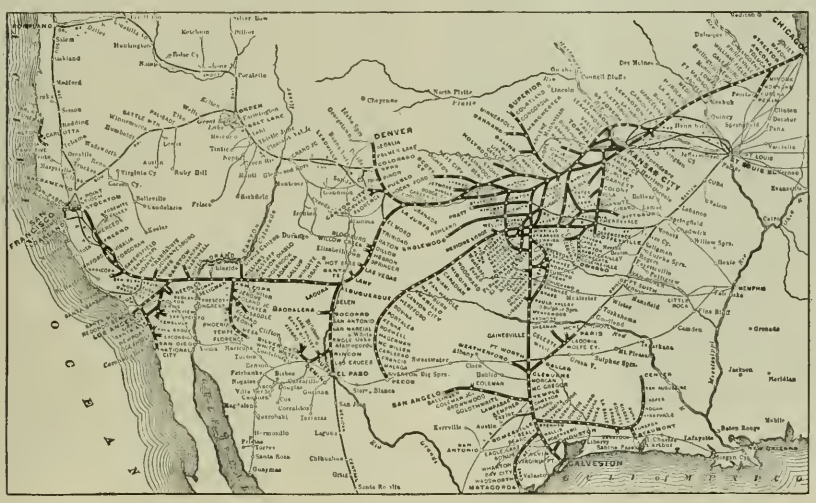
The operations of 1904 were seriously harassed by floods in Kansas. In parts of the State the rivers were out of their banks on three separate occasions. Many bridges were lost and considerable track destroyed. But the Maintenance of Way expense was practically the same as the year before. Maintenance of equipment was about $1,500,000, or nearly 20 per cent., greater than in 1903. Conducting transportation expense increased 12 per cent. In common with all other roads Atchison was unable to hold this expense in hand. Its fuel bill jumped a round million of dollars, or about 25 per cent. But the wages situation appears to have been in fair control. The increase in train service expense was but about $200,000, and for engineers and firemen but about $50,000. In another respect the Atchison shows pretty well—namely, in the expense of wrecks and loss and damage, which, while larger than last year, yet has not so outrun the volume of business as is the case on many roads. During the year the company acquired new equipment as follows:

| | Charged to— Capital. | Operating exp. |
|---|---|---|
| Locomotives | 124 | 27 |
| Freight cars | 1,860 | 1,283 |
| Passenger cars | ... | 68 |

About 11 per cent. therefore of the locomotives, 8 per cent. of the freight, and 8 per cent. of the passenger equipment is less than one year old.

The revenue freight train load fell off from 279 to 269 tons, but the higher ton mile revenue saved the freight train mile revenue and pushed the average up from $2.65 to $2.75.

Atchison's year has not been one of especial achievement, but the road has fairly held its own.



Atchison, Topeka & Santa Fe.

## NEW PUBLICATIONS.

*Tractive Power Chart.* Published by The Derry-Collard Company, New York: 1904. Price 50 cents.

This chart has been prepared to show graphically the theoretical drawbar pull of any locomotive. Three sets of curves, projected from each other are used; full directions are printed on the chart. Cylinder diameters are given for each half-inch from 15 in. to 45 in., and piston strokes for each two inches from 20 in. to 36 in., and these are plotted to give curves of cylinder volumes. In the same way the relation between boiler pressure and wheel diameter is shown in a series of curves and these two sets of curves are projected from the top and side to give a third set showing tractive effort. Boiler pressures are taken from 120 lbs. to 230 lbs. reduced by 15 per cent. to give assumed mean effective pressure and wheel diameters are taken from 20 in. to 90 in.

*The New York Subway*: Its Construction and Equipment. New York: The Interborough Rapid Transit Company, 1904.

This souvenir of one of the greatest pieces of municipal engineering in the world has been compiled by the Interborough Rapid Transit Company to commemorate the opening of the subway on October 27. It contains an introductory history of the conception of the project, a general description of the line and the stations, a description of the types and methods of construction of the tunnel, a description of the power house equipment, system of electrical supply, signals, rolling stock, shops, and miscellaneous features. A list is given in the back of the book of all of the contractors who did work on the subway. Many handsome photographs illustrate the descriptions throughout the book and no pains nor expense has been spared to make this souvenir artistic and attractive. The McGraw Publishing Company had charge of the publication of the book.

*Proceedings of the Thirty-eighth Annual Convention of the Master Car Builders' Association.* 1904. J. W. Taylor, Chicago (The Rookery). Secretary.

Although this year's volume of the Proceedings is not quite so large as that of last year it contains quite as much information of value and of interest in the papers and discussions read before the last convention at Saratoga. The changes in standards as voted up by letter ballot have been made on the plates in the back of the book. The chief value of the book is that it is the only accurate and authentic compilation of the standards and recommended practice of the association, and is therefore an almost indispensable reference book for those who have to do with any branch of car building.

*Proceedings of the Thirty-seventh Annual Convention of the American Railway Master Mechanics' Association.* 1904. J. W. Taylor, Chicago (The Rookery), Secretary.

A comparison of the size of the volumes of these Proceedings from year to year is a fairly good indication of the importance and amount of the work which this association has accomplished since its organization. This year's volume contains 552 pages of text and is the largest yet published. Our readers are so familiar with the contents of these volumes from year to year that any review of them would be superfluous. In every way this year's volume is uniform with those of previous years.

## TRADE CATALOGUES.

*The Union Pacific* has been distributing a passenger advertisement in the shape of a small magazine containing the platforms of the four principal political parties—Republican, Democratic, Prohibition and Peoples, and the letters of acceptance of the Presidential candidates. Accompanying the magazine is the road's Agricultural Bulletin No. 32, which concerns the potato crop of Nebraska for 1904. It gives by counties the acreage planted to potatoes, the yield per acre and the total yield. The latter amounts to 8,774,245 bushels from 74,552 acres.

*The Sullivan Machinery Company*, Chicago, sends its October bulletin number 48-B, in which is given a detailed description and illustrations of the Sullivan chain mining machine. This machine is used for undercutting coal in both room and pillar mines. Some figures as to the time and cost of the mechanical undermining of coal are also given.

*The Wile Power Gas Company*, Rochester, N. Y., maker of gas producers for power and fuel, sends its catalogue A. This describes producer gas, its uses and costs, and compares it to other forms of power, such as steam engines, etc. It also shows the efficiency of producer gas as a fuel compared with coal fires, illuminating gas and natural gas.

*The McMyler Manufacturing Company*, Cleveland, Ohio, has issued a new catalogue. The company designs and builds hoisting and conveying machinery, and the catalogue illustrates and describes revolving cranes, coal conveyors, ore conveyors, coal storage plants, car dumping machines, clam-shell buckets, including special designs for ore; orange-peel buckets, hoisting engines, electric conveyors, and all kinds of buck-

ets. The attention of railroad men is directed to an arrangement for coaling locomotives and taking out ashes at small towns, that is claimed to be economical and convenient.

*Chas. E. Hatt Company.* Grand Rapids. Mich., issues a catalogue of Hatt's furniture and miscellaneous varnishes, and of polishes, colors, stains and varnish and paint remover.

## CONTRIBUTIONS

### Train Registers and Other Things.

Buffalo, N. Y., Oct. 31, 1904.

To the Editor of the Railroad Gazette:

The contribution of Mr. H. W. Forman in your issue of Oct. 28 on defective train rules, and particularly his elucidation of practice under Rule 96, makes an illuminating chapter; every trainman, operator and despatcher ought to read it. But will not the reader rise from the perusal of this letter with the feeling that it is only a beginning? Any number of suggestions arise in one's mind as he reflects on the exigencies of train work here touched upon. Any one who reads Mr. Forman's book will find still other suggestions.

For example, what a nest of unpleasant features one finds in connection with train registers. Speaking to almost any superintendent or trainmaster you may pertinently ask:

Are the page forms of your registers simple and clear? Are trains going in one direction entered on one page and those in the opposite direction on the other? Is a page set apart for each day's business? Are trains entered correctly and is the arriving or leaving time always plainly shown? Do men who receive orders to meet trains at such points always carefully consider the time that a train is registered in connection with the time their order is completed, to make sure that the train is not making a second trip and has not arrived on the trip which their orders indicate it shall be met or waited for? Do men use all the time necessary to check up registers, or do they hurry through the duty perfunctorily? Are trains always registered on the proper page?

Are all orders delivered to enginemen personally by the conductor or operator, or does the conductor sometimes send an order by his brakemen? Who on a train read train orders? When it is discovered that men are careless about their duties in safely handling their train, what corrective measures are applied? Are men disciplined for failure to properly care for their train even though an accident does not result from such neglect?

How much territory are despatchers handling? Assuming that 40 orders is a safe day's work, are they required to give 60 or 75? How many hours do they work each day? What is the age and experience of operators? Who examines them? What do they know about the rights of trains? How are they keeping the records at stations? What kind of signals are they required to keep at hand, and are these kept in their proper place at the station? What are the personal habits of employees when off duty? Are there any men employed who are over 70 years old? Any 15-year-old boys? Any men who are notoriously sleepy, or reckless and indifferent as to their work?

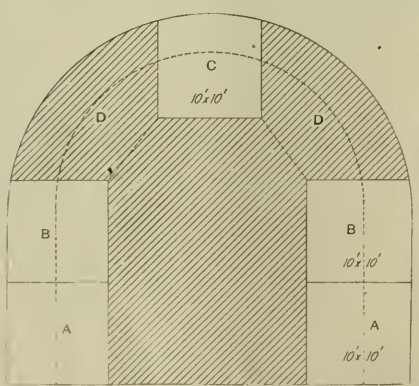
Are there any train-order signals so located that they cannot be seen until a train is nearly upon them? When men find switch or other fixed signals not burning at night, what do they do? Is there a record of all such imperfect signals at headquarters? In cases where a train is directed to display signals for a following section, when are they put up; before the train starts from such station, or after running a few miles? If indicators are used, are they taken in upon arrival at terminals, or allowed to remain in place in the caboose until the men come around to go out on another trip? Do enginemen give whistle signals invariably, and are they always answered by two short blasts? If not answered, what does the engineman do to prevent the other train from moving against the following sections? Do they invariably report their brother enginemen who fail to answer such signals, or do they cover the circumstance up? When double-headers are run is the second engineman required to watch such things also? Are train orders checked up to see if they are in proper form and that no orders are given that might mislead train and enginemen? And so on *ad finem*.

The mistakes prevented by trifling accidents, and by reminders in the most unusual way, would be appalling if they were to become known. It may be a brakeman, or the conversation of a passenger on a train that reminds a conductor or engineman. Hence the necessity for surrounding train movements with every possible safeguard, even to carrying the matter so far that it may at times prove burdensome. A large book could be written on the one word "habit."

An operator once told this incident: Before repeating an order he was of course required to state that his order signal was displayed at "stop." On the night in question he so stated, but forgot to so display the signal. A passenger applied for a ticket to go on this train, remarking that he was aware that the train was not scheduled to stop at that point, but as it was an urgent case he thought the operator might get permission to stop it. The operator informed him that this was unnecessary, as he held an order for the train, and that it would have to stop to get it. The passenger inquired as to how the train would know that there were orders and was told that the order signal showing red would indicate this. The collision was prevented by this passenger calling attention to the fact that the signal was showing a white light. J. B. C.

### Great Northern Tunnel at Seattle.

Last week we published a description of the terminal improvements which the Great Northern and the Northern Pacific are jointly carrying out in Seattle, Wash. Only brief mention was made of the tunnel being driven under the business section of the city, which

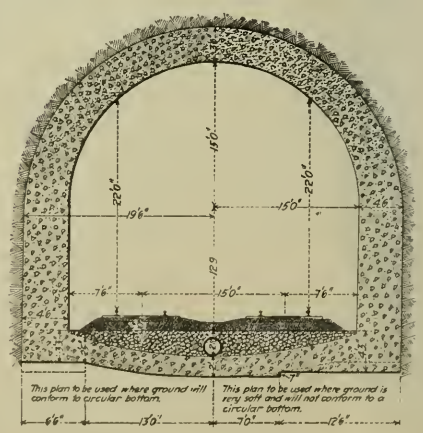



Method of Driving Drifts in Seattle Tunnel.

is nearly a mile long and which is perhaps the most difficult part of the work, involving the expenditure of the most skill and money. We are now enabled to give a more complete description of this part of the work and to show the accompanying illustrations from photographs taken during the progress of the construction.

The tunnel is being built to relieve the congestion along the water front. All of the terminal tracks and yards of both roads run along the edge of the bay, and the interference of traffic in the yards and on the main line is now so great that some steps for the relief of the congestion were imperative. Although up to the present time the progress of this work has attracted but little attention, this tunnel is one of the most important engineering projects which has ever been attempted on the Pacific Coast. Preliminary surveys were made in the early part of 1903 and the work was begun at the north end of the tunnel in May of that year. In July work was begun at the south end. The exact length of the tunnel is 5,130 ft. It is 30 ft. wide between the side walls and 28 ft. high from the top of rail to the crown of the arch. The accompanying illustration, which is reproduced from the article in last week's issue, shows the dimensions of the cross section and the concrete lining of the tunnel.

The peculiar nature of the soil underlying Seattle made the work dangerous and difficult at times. A stratum of blue clay containing large amounts of water underlies the surface soil to a depth of 150 ft. or more, and as the tunnel was driven through this clay the water draining down through the soil caused some dangerous settlements at the surface above. There was little danger of caving or collapse in the heading and no necessity for using a shield or compressed air, but there was no method by which this seepage could be prevented. Facing on the streets above the tunnel are a number of the largest buildings in the city, many of which are of recent construction, and although every precaution was taken to prevent serious settlements under these buildings, some settlements did occur. The Stander Hotel, which was in process of building, settled so that cracks two inches wide appeared in the walls when the tunnel bore was advanced under it. This building was shored up by the railroad companies and the necessary repairs made so that the building could be completed. The tunnel at this point is 132 ft. below the surface of the ground. Another building, the Hotel York, which stands only a little distance from the entrance to the tunnel and where the depth is not great, settled so that the building was condemned. This building and the ground on which it stood were bought by the railroad companies and the building is now being torn down. Aside from these two cases the damage has been comparatively slight and the engineers in charge anticipate no further trouble. The soil has settled as much as it is likely to do, since the water




Section of Seattle Tunnel.

Timber Forms for Concrete Arch Ring.

which drained into the tunnel and caused the porous earth to compact is now practically exhausted.

The method of driving the tunnel was rather an unusual one. The accompanying diagram shows the five drifts which were carried forward as the work progressed. Each of these drifts are 10 ft. by 10 ft., and the work was carried on in the same manner simultaneously at both the north and south ends of the tunnel. Drifts A along the sides of the invert were started first, and up to within the last few hundred feet were always kept from 10 ft. to 20 ft. in advance of drifts B. Drift C was advanced at the same rate as drifts B. As the work on the drifts progressed, 12 in. x 12 in. timbers were used to shore up the roof, and the permanent timber lining for the sides of the tunnel was put in place. After the side and top drifts had been advanced about 100 ft. the triangular cores between drifts B and C were removed and the roof shored up to the crown of the arch as this work progressed. The concrete lining in the side walls was put in close up to the headings of the side drifts. Following 100 ft. in the rear of the gangs employed on this work were other gangs employed in stoping out the main core. The excavation in the drifts has been done almost entirely with pick and shovel, the soil being carried out in wheelbarrows and on traveling belts. At one or two points some small quantities of rock were encountered, but no blasting was done in the tunnel. After the tunnel had been advanced some little distance from the portals, temporary tracks were laid and the dirt hauled to the portal of the tunnel in contractors cars with small steam locomotives.

About 1,000 men have been employed on the work since August, 1903. These were divided into three eight-hour shifts and men were at work in the headings continuously. Most of the men employed were experienced miners who were familiar with underground work and very expert in shoring and timbering and in doing clean and rapid work of this kind. Throughout the construction of the tunnel there has been keen rivalry between the gangs working on the north and south ends, and it was this rivalry which caused the foreman on the south end to have installed a traveling belt so that his gangs could work the faster. This conveyor was found to work satisfactorily and to greatly facilitate the removal of the excavated material from the drifts.

In order to obtain sufficient depth under the business section of the city it was found

Removing Main Core after Timber Arch and Concrete Side Walls Were Completed.

necessary in making the surveys to put in two 4-deg. curves. It was a delicate surveying feat to keep both ends of the tunnel advancing along the assumed lines with absolute accuracy, but when the gangs met in the center, the calculated length of the tunnel and the actual length were found to differ but 1 in., and only ¼ in. deviation in the running lines and ⅛ in. in the levels of the two ends occurred. This is really a remarkable feat in view of the circumstances.

At one point in the tunnel about 130 ft. below the surface the remains of a prehistoric forest were encountered in the headings. One tree 3 ft. in diameter was unearthed in a perfect state of preservation. It was embedded in the clay and was saturated with water. On being brought into the dry, open air it rapidly crumbled and disintegrated into a little heap of mould. The hilly formation of Seattle is supposed to be due to the action of a big glacier from Mount Rainier, which moved into the sea about 2,000 years ago, and the remains of this forest found under the ground are probably that old.

The exact progress of the tunnel on November 1 was as follows: Drifts C at the north and south ends had met. The ceiling

View of Completed Tunnel about 1,000 Feet from South Portal.

had been shored up and the concrete in the crown was expected to be completed within a week. Drifts A and B were still separated by a distance of 180 ft. between the two ends and 450 ft. of the main core remained to be excavated. The meeting point of drifts C is 2,730 ft. from the south end and 2,400 ft. from the north end. It is expected that within two months the tunnel will be entirely completed and tracks laid, but it will not be put into use for about a year, since the other terminal improvements, including the new passenger and freight depots, have not yet been completed. It is estimated that the cost of the tunnel alone will be more than 1½ million dollars.

Mr. A. H. Hogeland, Chief Engineer, Great Northern, and Mr. Alexander Stewart, the Resident Engineer on the work, had entire charge of this work and the other terminal improvements, and we are indebted to them for information furnished.

## The Railroad Cross-Tie Problem.

BY S. WHINERY, CIVIL ENGINEER.

(*Concluded from page* 528.)

3. Reinforced concrete is just now receiving a good deal of attention as a possible substitute for railroad cross-ties. Admirable as concrete is for a large number of structural purposes, the inherent qualities of this material are such as to prejudice the conservative railroad man against its use for cross-ties, even when steel-reinforced in the best manner, subjected as it is must be to the incessant and very severe shocks of passing railroad rolling stock. If it could be used as a track support in such a way that it would be subjected to compression only, and then through the distributing intervention of steel or wooden beams, the prospect would be more prepossessing.

In Fig. 4 I have attempted to design a reinforced concrete cross-tie in accordance with our best lights on the subject at this time. Its dimensions and construction will be evident from the sketch. This is clearly a case where we cannot neglect the consideration that a cross-tie acts as a continuous girder. At the middle of the tie the reinforcing steel must be at the top, while under the rails it must be at the bottom of the tie. Some designs have attempted to meet this condition by bending the steel rods and so building them into the concrete tie that they shall be properly disposed to take care of the strains. I have adopted the simpler arrangement of using two sets of rods, one in the top and the other in the bottom, overlapping each other at the point of flexure in the tie. The moment of resistance of this reinforced beam, both at its middle and under the rails, figured by well known formulæ, allowing a fiber stress of 12,500 lbs. per square inch of steel, seems to be about the same as that given above for the standard wooden tie. Unless, therefore, it should succumb to the repeated impact shocks of modern railroad service, it may be considered equivalent in strength to the wooden tie. As shown, its construction requires 3.54 cu. ft. = 0.131 cubic yard of concrete and 51 pounds of steel (including tie plates, anchor plates and anchor bolts). Its weight would be not less than 500 pounds. Its cost can only be roughly estimated, since it involves some elements upon which we have little data. Among these may be noted the cost of molding concrete into such small forms, the danger of injury and breakage in removing the ties from the forms and storing them (unless they were allowed to remain in the forms longer than economy of manufacture would probably permit); and the important fact that the ties must be stored, watered and otherwise cared for for at least six months before they become sufficiently "set" to put on the market. Those most familiar with such work would hardly place the cost of the concrete below $7 per cubic yard, and if we call the cost of the steel 2¼ cents per pound (both including a reasonable profit to the manufacturer), the cost of the tie, ready to ship, would be about $2. But to this must be added the cost of loading, transportation to the point of delivery, and unloading the ties. Considering that four of them weigh over a ton, 30 cents per tie would probably be a low allowance for these items, and the delivered cost would therefore be about $2.30 each. In view of the printed reports that concrete ties are made for less than $1 each, this estimate seems high; but I believe that a careful study of the matter, and, later, experience, will convince the competent engineer or manufacturer that the market price would be above rather than below the figure I have estimated.

The problem of a suitable fastening between such a tie and the rail is a troublesome one. Anchor bolts built into the tie with anchor plates at the bottom and rail plates at the top, would seem to promise the best results, but experience is required to determine the stability and adhesion of such bolts in the concrete when subjected to the incessant shocks of passing trains, and they would weaken the section of the tie directly under the rail to a greater degree than the spikes in the wooden, or the bolts in the metal tie. Furthermore, these bolts, if broken or disabled, could not be replaced without taking out the tie, which is a very serious objection.

The inertia due to its great weight and the friction between its comparatively rough sides and the ballast should make the concrete tie superior to either the wood or metal tie in lateral stability of track.

The behavior of a concrete tie under the severe conditions of modern trunk-line track must, at this time, be considered purely conjectural, and any estimate of its useful life must be little better than a rude guess. He would, I think, be a bold advocate who would claim a longer life for it than seven or eight years.

4. Quite a number of designs for a cross-tie made by combining concrete with some form of steel-beam have been proposed. To anyone who will go into the matter carefully it will, I think, seem at least doubtful whether any such design can be devised that will give more strength per dollar invested in its construction than the concrete beam reinforced with steel rods. That it may, however, have special advantages, regardless of cost, may readily be conceded. Most of the ties of this class that have appeared, and some of which are undergoing trial in track, are so badly designed that they are foredoomed to failure. Old rails and scrap angle-irons are not good sections to use for the purpose, and even if they were, their supply for making ties on a commercial scale might be questionable. After some study of the matter I am inclined to believe that the most promising design for a tie of this general character will be found in the combination of a steel "I" beam of such section and area that it will, alone, have a moment of resistance equal or nearly equal to the standard wooden tie, with a concrete base that will supply the requisite bearing area on the ballast.

Fig. 5 illustrates what I have in mind. Here the 4½ inch I beam weighing 10½ pounds per foot has a moment of resistance of about 43,000 inch-pounds. It is embedded to about half its depth in a plain concrete beam having a bottom width of 9 inches. The rail fastenings are the same as those used with the all-steel tie. Such a tie should have good holding power in the ballast, and aside from the greatest defect of all concrete for ties—its brittleness—should promise satisfactory service. Even if the concrete should fail before the I beam, the tie could be removed from the track and rebuilt at a small part of its original cost. Making allowance for this possibility of renewing the tie, we might reasonably expect a much longer average life for it than the steel-reinforced concrete tie, or, say, at a rough guess, twelve or fifteen years. Its total weight would be about 450 lbs., and its cost, delivered, would probably be about $3.25 each.

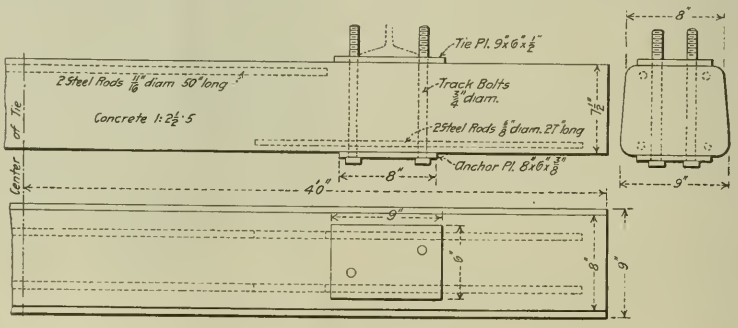



Fig. 4—Reinforced Concrete Tie.

| Quantities: | Pounds. |
|---|---|
| Concrete = 3.54 cu. ft. = 0.131 cu. yd. | 496 |
| Steel: | |
| 8⅛ ft. of steel rod | 10.3 |
| 4½ ft. of steel rod | 4.6 |
| 2 tie plates | 16.3 |
| 2 anchor plates | 13.6 |
| 4 bolts | 6.6 |
| Total, steel | 51.4 |
| Total, tie | 547.4 |

It would be hardly correct to speak of the treated wooden tie as a substitute for the common tie, but in any fair comparison of the merits and economy of different kinds of ties, it must be taken into consideration.

The cost of untreated wooden ties varies greatly in different sections of the United States, ranging from about 30 cents to 60 cents. The average cost of the best quality of ties probably does not exceed 50 cents. The cost of preservative treatment also varies widely with the process and the thoroughness of the work. At present nothing better than creosoting is known. To thoroughly impregnate wood with creosote oil may require, say, twelve pounds of oil to the cubic foot of wood, and the cost of the treatment complete may vary from 75 cents to $1 each

for the standard tie. Calling it 90 cents, and assuming that the untreated tie costs, delivered, 50 cents, the cost of the treated tie will be about $1.40 each. The useful life of such treated ties has not yet been satisfactorily determined. There is good reason to believe they would last twenty years, but we shall be on the safe side in assuming that treated hard-wood ties will render good service for seventeen years.

*Relative Economy of Different Ties.*

The relative economy of different kinds of ties is the question that most keenly interests the railroad manager or engineer. As between ties equal in their safety and utility, the elements that enter into the problem of relative economy are:

1. The first cost of the tie, delivered.
2. The useful life of the tie.
3. The cost of tie renewal and of track maintenance, in so far as it may be affected by the kind of tie used.
4. The cost of interest on investment, and of a sinking fund.
5. The value of the worn out tie when removed from the track.

We have already roughly estimated the cost of the several kinds of ties we have considered and the probable useful life of each.

It is often assumed that the cost of track maintenance would be materially less if metal or concrete ties were substituted for those of wood. Experience in the United States is yet too meagre to supply reliable data on this point. The steel ties that have been tried here were entirely too weak for the service to which they were subjected, and, as might have been expected, track maintenance was much more expensive than with standard wooden ties. Foreign experience has been more favorable to the metal tie, and there are reports based on a considerable experience showing decided economy over wooden ties, in cost of maintenance. But the lighter rolling stock and the less frequency of trains in nearly every case must be taken into consideration. Excluding the cost of renewal, it might reasonably be expected that with ties of equal strength and bearing area, the cost of track maintenance would be practically the same, regardless of the material of which the tie be composed, and in the absence of evidence to the contrary we may assume this to be the fact. The cost of putting a new tie into the track, and of taking it out when worn out, may properly be considered apart from the cost of track maintenance and charged to the cost of the tie. The cost of putting in a new wooden tie seems to be about 10 cents, and the cost of taking it out 2½ to 3 cents. If we charge against the new tie for "renewal" 12 cents, we shall not be far wrong. The heavier steel and cast-iron ties would cost more, say 15 cents; and the concrete ties, owing to their weight, would cost still more, say 18 cents.

Wooden ties have no value when worn out. The worn out steel tie, and the steel in the old concrete I beam tie would have a value as scrap. The cost of recovering the steel from the reinforced concrete tie would probably almost equal the value of the steel recovered, and we may therefore consider it of little value. The market price of such scrap varies, but considering the cost of marketing it, $10 per ton would be a liberal allowance.

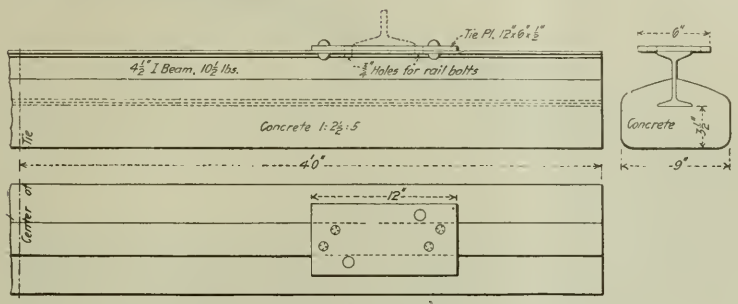



Fig. 5—Concrete I-Beam Cross-Tie.

Quantities:

| | |
|---|---|
| 1 4½-in. I-beam, 8 ft. @ 10½ lbs. | 84 lbs. |
| 2 tie plates, 12-in. x 6-in. x ½-in. | 20.4 " |
| 8 rivets | 2 " |
| Total | 106.4 " |

Concrete = 2.5 cu. ft. = .093 cu. yd.
Total weight of tie, 456 lbs.
M for beam = 43,000 inch-lbs.

In estimating the relative cost or economy of different ties, it is common to divide the first cost of the tie by the number of years' service it may be expected to give, and to call the quotient the annual cost of the tie. This is not correct and may lead to erroneous conclusions. Suppose that the first cost of a tie be $1, that its life be ten years, and that capital to buy the tie be borrowed at 4 per cent. The annual interest charge will be four cents. To repay the sum borrowed we may pay into a sinking fund each year a sum such that the various sums thus set aside, with four per cent. interest (which we assume the money will be able to earn) shall together amount, at the end of ten years, to $1. With the $1 we can then pay off the debt incurred to purchase the tie, and close the transaction, or we can purchase with it a new tie and put it in the place of the old one. This may go on during any number of tie-life periods, and at the end of any one of them we shall have in hand the $1 to pay off the original debt, and close the account.

During any such life-period the *annual* cost of the tie will be:

| | |
|---|---|
| One year's interest on $1.00 at 4% | $0.04 |
| One year's payment to the sinking fund | .0833 |
| And the total annual cost will be | $0.1233 |

| | |
|---|---|
| Whereas the $1.00 divided by ten years (neglecting interest) would equal, annually, only | $0.10 |
| But, if to this 10 cents we add the yearly interest charge, 4 cents, we shall have as the apparent annual cost | .14 |

Which is almost as much in excess of the correctly computed annual cost as the 10 cents is below it.

We have not here made any allowance for the possible value of the worn out tie. If it could be sold for ten cents as scrap, we should obviously have to provide for only 90 cents in our sinking fund to enable us to pay the debt incurred in the original purchase.

The annual cost of a cross-tie arrived at by the method outlined above is the most satisfactory unit by which to measure its economy. But the element of spacing in the track must also be considered. If we divide the cost of the tie by the distance from center to center of ties, we shall have the cost per linear foot of track, and thus reduce our results to *annual cost of ties per linear foot of track*, which is the true basis of comparison.

This annual cost per linear foot of track may be expressed algebraically thus:

Let x = the required annual cost of ties per linear foot of track.
c = the first cost in the track per linear foot of track.
v = the value of the worn out tie per linear foot of track.
L = the useful life of the tie in years.
i = the rate of interest = the interest on $1.00 for one year.
s = an annual payment into a sinking fund which at i rate of interest for L years will amount to one dollar (s can be taken directly from tables such as that on page 16 of Kent's Mechanical Engineers' Pocket Book).

Then $x = ci + (c - v)\,s$.

If $v = 0$, then $x = c\,(i + s)$.

Applying this formula to each of the kinds of ties we have considered, we may, for facility in comparing results, prepare a table like the following:

Table Showing Data and Annual Cost of Railroad Cross-Ties of Different Kinds.

| | Rate of interest, 4% | | | | | |
|---|---|---|---|---|---|---|
| | Wood | | | | Concrete | |
| | Untreated. | Treated. | Steel. | Cast-iron. | Reinforced. | Steel-beam. |
| Life of tie in years | 8 | 17 | 25 | 30 | 8 | 14 |
| Cost of tie delivered | $0.50 | $1.40 | $4.25 | $5.25 | $2.30 | $3.25 |
| Cost of renewal | .12 | .12 | .15 | .15 | .18 | .18 |
| Cost of tie in track | .62 | 1.52 | 4.40 | 5.40 | 2.48 | 3.43 |
| Value of worn-out tie | ... | ... | .85 | .75 | .20 | .53 |
| Spacing of ties, center to center, feet | 1.875 | 1.875 | 2.0 | 2.0 | 2.0 | 2.0 |
| Cost of ties per linear feet of track | 0.33 | 0.81 | 2.20 | 2.70 | 1.24 | 1.76 |
| Value of worn-out ties per linear foot of track | ... | ... | .42 | .37 | .10 | .26 |
| Annual cost of ties per linear foot of track | 0.049 | 0.067 | 0.131 | 0.149 | 0.173 | 0.152 |
| Annual cost for one mile of track | 258.72 | 353.76 | 691.68 | 786.72 | 913.44 | 802.56 |

The last line of this table tells the whole story, and little comment is called for. The lesson it conveys is that *no metal or concrete cross-tie capable of giving the same efficiency of service in track as the wooden tie can hope to compete with the latter at anything like present cost prices of each.*

By substituting different values in the equation given above we may obviously solve various problems relating to cross-tie economy. Thus, if we wish to know what must be the cost of untreated wooden ties to make them equal in annual cost to the steel tie, we may place x = $0.131 (the annual cost of the steel tie) and we shall have c (i + s) = $0.131. Solving this for the value of c we find it to be $0.882, or, in other words, until the cost in the track of untreated oak or yellow pine ties shall exceed $0.88 per linear foot of track, they will be more economical to use than the steel tie. This price is equivalent to $1.65 per tie.

In like manner the following interesting conclusions, based on equal economy in use, seem to be justified:

1.—If the cost of creosoting ties be 90 cents each, it will not pay to resort to creosoting until untreated ties shall cost about 84 cents each.

2. When untreated ties cost 50 cents each and last eight years any treatment that will

just double their life must not cost over 57 cents each.

3.—Under the same conditions, as above, a treatment that will not add over 50 per cent. to the life of the tie must not cost over 36½ cents for each tie.

4.—Where the climatic conditions are such that untreated ties costing 50 cents each in the track, last only six years, any treatment that will double their life will pay if the cost be not over 39 cents per tie.

5.—If ties of inferior woods, costing 40 cents each, can by treatment, costing 90 cents, be made to last 16 years, they will be as economical as oak or yellow pine ties lasting eight years and costing 75 cents each.

6.—To be as economical as untreated wooden ties costing 62 cents in track and lasting eight years, a steel tie good for 25 years service must not cost over $1.85.

7.—Under the same conditions, a concrete tie lasting eight years must not cost over 81 cents, and a concrete-steel-beam tie lasting 14 years must not cost over $1.05.

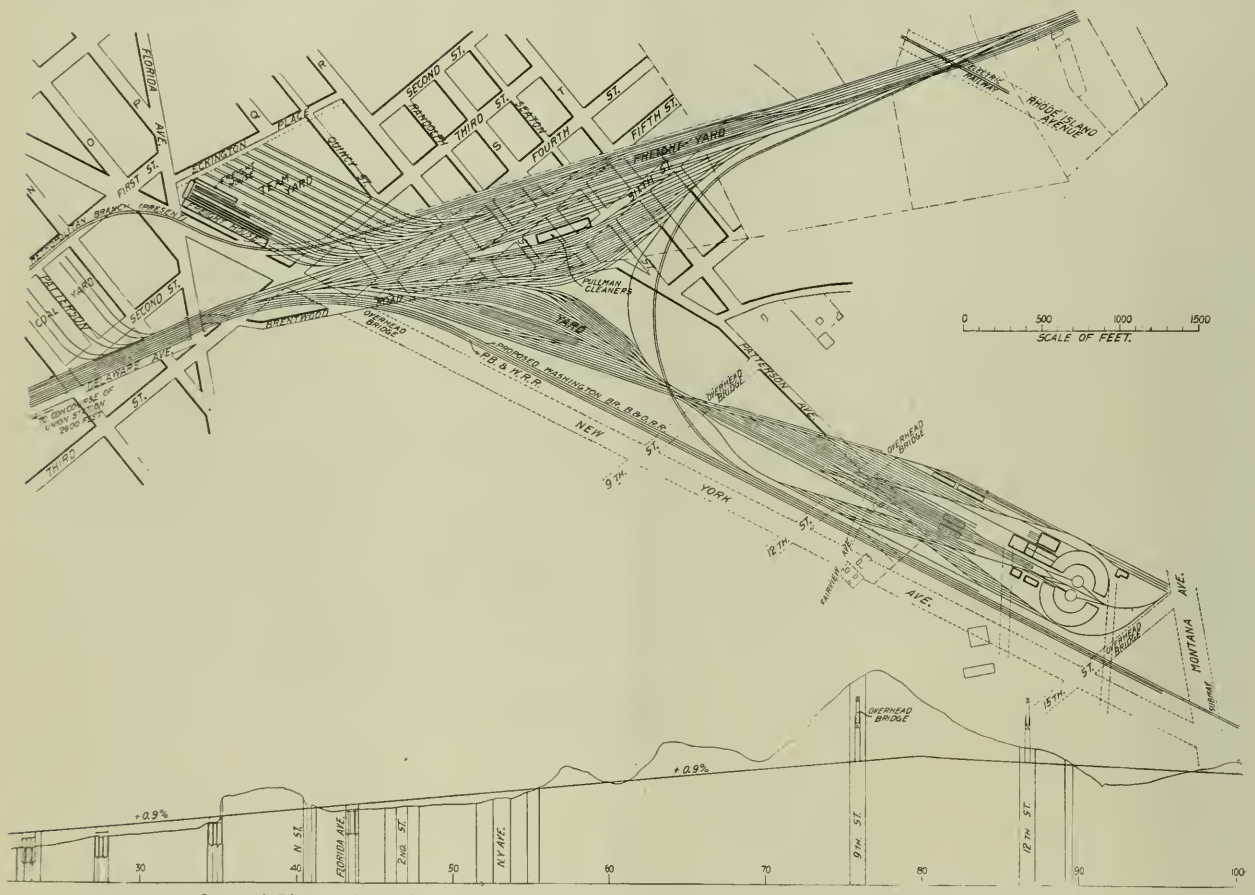
I need not multiply these deductions—any one interested can extend them indefinitely. Those above assume that the data of cost and life of the different kinds of ties are as I have estimated or assumed them to be. Whether they be accepted or not, the method here used to compare different kinds of ties with each other is, I believe, the correct one, and if so, each person can apply it to any data he may have, or any assumptions of cost and life of tie that he may think reasonable.

The Paris Metropolitan carried 80,000,000 passengers between January 1 and September 20, and the receipts were 14,000,000 francs, or $2,800,000; an increase over the same period of 1903 of 6,550,000 passengers carried and 1,200,000 francs in receipts. The length of the two lines operated is 24 kilometers.

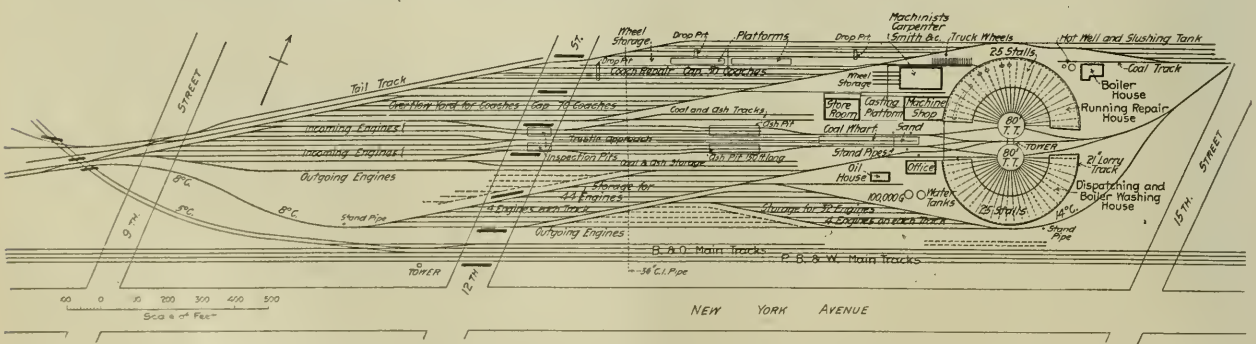
## New Yards and Terminal Approaches at Washington D. C.

BY W. F. STROUSE.*

The new union station at Washington, D. C., has already been fully described in the *Railroad Gazette*, Dec. 4, 1903, and Jan. 15 and June 3 of this year. In addition to the work on the station itself, the changes necessary in all of the yards and approaches of the Baltimore & Ohio and a part of the Pennsylvania's tracks have involved the handling of immense quantities of excavation and the construction of extensive masonry work for the approaches. The construction of this great piece of work has been divided between the Pennsylvania Railroad and the Baltimore & Ohio. Massachusetts avenue was made the dividing line and all work south of that street is being done




General Plan and Profile of Yards and Approaches, Washington Union Station Improvements.




General Layout of Car and Engine Yard Terminal, Washington, D. C.

*Assistant Engineer, Baltimore & Ohio, in charge of construction at Washington.

by the Pennsylvania, and, with the exception of a connection of the Philadelphia, Baltimore & Washington near Winthrop Heights, all of the work north of Massachusetts avenue is being done by the Baltimore & Ohio.

The accompanying general plan shows the arrangement and extent of the new yards and other terminal facilities which are to be provided on the outskirts of the city. The approach tracks to the station are carried on a solid fill supported with masonry retaining walls. All of the streets between H street and Florida avenue have been carried under the tracks by depressing them from 11 ft. to 16 ft. below the former grade line. North of Florida avenue the streets will be treated as follows: Rhode Island avenue will be taken under; New York avenue, Ninth, Twelfth and Fifteenth streets will be taken over, as will also Montana avenue. An average fill of 20 ft will be required over the entire area occupied by the new terminal station, and this will be enclosed by retaining walls on the east and west sides. These walls are continuous from the Plaza in front of the station on out to M street, and range in height from 5 ft. to 35 ft. above the present surface of the ground. The retaining walls are of the ordinary section, being constructed of sandstone facing backed with Portland cement concrete. All of the foundations are of concrete, but the stone work is carried down from 12 to 18 in. below the surface of the ground. The west retaining wall between the station building and the heating plant, a distance of about 1,000 ft., encloses a subway in which the pipes and wires will be carried from one building to the other.

The bridges which carry the tracks over the streets are of somewhat unusual design. The distance between abutments in all cases is 80 ft. at right angles to the axis of the street. This distance is divided into three spans; a center span of 25 ft. and two side spans of 27 ft. 6 in., the tracks crossing the streets on a skew of 15 deg. 42 min. The center span is supported on two rows of columns and the superstructure consists of 24 in. I-beams spaced about 18 in. center to center. These beams are embedded in concrete carried down 2 in. below the bottom flange and surfaced on top flush with the top flange. Over this solid mass of steel and concrete is a layer of petroleum residuum ¾ in. thick, and on top of that is another layer of reinforced concrete about 6 in. thick, on which the ballast is laid. This will give a perfectly dry structure, it is thought, since the waterproofing is continuous over the whole bridge floor and is carried down on the rear face of the abutments.

As the shortest of these subway bridges will carry ten tracks divided into two groups of five each, it was necessary to provide expansion joints at intervals of about 30 ft. The construction of these joints is shown in one of the accompanying drawings. They will be thoroughly waterproofed to insure against dripping to the streets below. Because of the unusual length of these street subways under the tracks, which in one case is 790 ft., it was necessary to provide for lighting in some way, and also to ventilate them. Prismatic lights will be introduced in the roof between tracks, and, at one or two street crossings, openings 10 ft. wide by 80 ft. long have been provided near the center, so as to admit both light and air.

The abutment walls for supporting these street crossing bridges are of the ordinary construction except for special provisions which have been made for drainage. Gutters are constructed in the backs of all abutments with down spouts placed at frequent intervals which will be connected with the street sewers. The backs of the abutments

Temporary Tracks at North End of Baltimore & Ohio Station.

Panoramic View of Terminal Station Site Looking North and Showing East Half of Foundations for Station Building.

Foundations for New Washington Union Station, Looking East.

are covered with a layer of waterproofing ½ in. thick, applied on a thoroughly dry surface at a boiling temperature.

The construction of the long retaining and abutment walls on this work developed some methods not usually employed on average construction work of a similar nature. The work was also complicated by the presence of many railroad tracks and yards located in the center of, and all around, the construction site. Before starting work on the masonry a large cubical concrete mixer was installed near the intersection of the east wall and G street. A pit about 16 ft. wide and 40 ft. long was constructed about 100 ft. away from the mixer. Across this pit were laid two surface tracks which extended for a sufficient distance beyond the pit to provide storage for five or six cars containing material. One track was used for sand and the other for broken stone. Between the two tracks was located the cement house, one end of which extended up to within a few feet of the end of the pit.

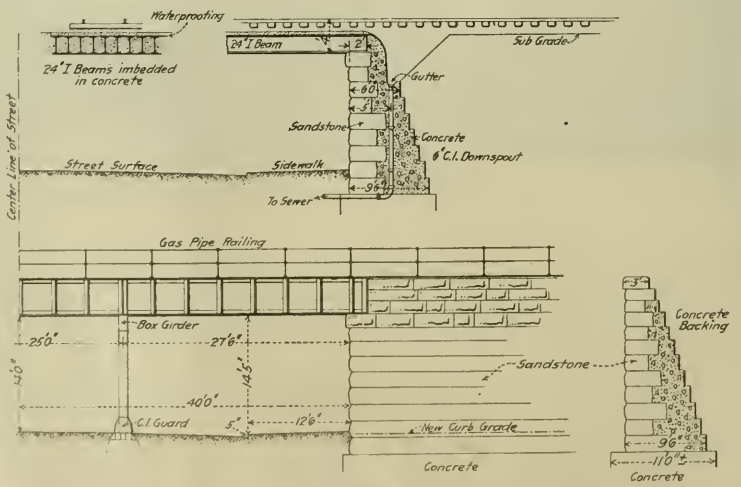
West Retaining Wall between H Street and Terminal Station, Showing Subway.

Steam Shovels Excavating 82-ft. Cut for Coach Yard.

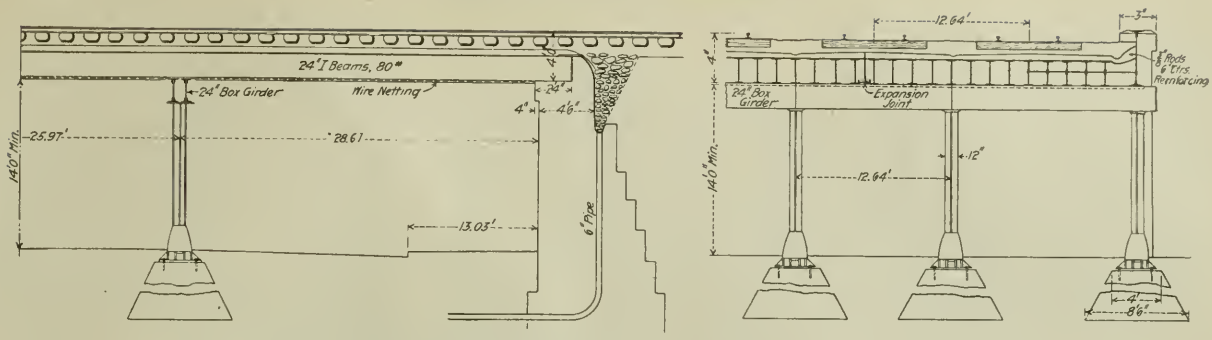
The cars containing the sand and stone were dropped down by gravity over the pit. A truck used for conveying materials to the mixer was first placed under the car containing sand and the proper quantity of sand dumped into it direct from the car. The truck was then moved to a point midway between the material tracks and the cement was added in proper quantity. After this it was moved under the stone car and the necessary amount of stone was dumped into it directly from the car. The truck was then hauled up an incline by a cable and automatically dumped into a large hopper above the mixer. While the car was being returned to the pit the material just deposited in the hopper was fed into the mixer. An automatic device was used for adding water in the mixer, and under ordinary conditions this gave very uniform results. When sufficiently mixed, the concrete was dumped into buckets, carried on small trucks and conveyed by horses or mules to the points where it was to be used. This plan worked satisfactorily as long as the shipments of material and progress of the work were approximately the same. In case of bad weather or any delay on the work which would bring together more material than could be disposed of within the time limit for releasing cars, the contractors, of course, were subjected to demurrage charges; but, owing to the simplicity and cheapness of the method of handling the material, a reasonable amount of demurrage could well be afforded. The greatest difficulty was experienced in midwinter, when for short periods of time masonry could not be laid because of the freezing temperature.

At the other mixer, installed near the intersection of the west wall and G street, the method of handling the material was somewhat different. An elevated double-track line of bins was constructed, one of which was used for sand and the other for crushed stone. Cars containing these two materials were run up on the tracks over the bins and dumped, and the cars were released within a few hours after their arrival. A cement house was erected adjacent to the bins in which the stone was stored, and the cement was unloaded from the cars standing on the track over the stone bins by throwing the bags down a chute through the roof of the house. A subway, about 6 ft. square, was built under each line of bins. The truck, used for conveying material, on returning from the mixer, first passed through the subway under the sand bins, where sufficient sand for a batch was taken from the bins by opening an aperture in the bottom by a simple lever device. The truck was then moved to the outer end of the bins to an automatic transfer table. It was then moved laterally to the track under the stone bins, where the stone was taken in the same manner as the sand above described. At the end of the bin, near the mixer, a hopper was arranged into which cement was placed in batch quantities. As the truck passed this point the cement was added. The truck was then taken up an incline by cable and dumped into a hopper, over the mixer. The quantities of materials were gaged by metal strips riveted to the sides of the trucks.

A Hains' gravity mixer was also installed in L street. The stone and sand used at this mixer were taken direct from drop bottom cars, placed in position on a trestle over L street, which had previously been depressed to the new grade. This material was dumped through the floor of the trestle into buckets, in which it was hoisted to the top platform of the mixer. The cement which was housed nearby was taken to the top of the mixer in the same manner. The method of mixing by this machine is peculiar. The stone and sand are placed in separate hoppers on the top platform. From these hoppers this material is taken in proper proportions by




Detail of Retaining Wall and Typical Overhead Street Crossing.




Detail of Typical Street Crossing Bridge Showing Arrangement of Columns and Drainage.

turning circular discs, having a quarter segment cut out, into four hoppers on the second platform. On this platform the cement and water are added. These hoppers are then all opened simultaneously and the mass is allowed to fall into one large hopper. It is then passed successively through three of the large hoppers into the bucket in which it is conveyed to the work. The principle upon which this machine works is suction; the center of the mass moving first and drawing the sides toward it.

Another of these mixers was located on the site of the station building and was used to mix the concrete used in the foundations. The method of handling the crushed stone in this portion of the work was different from any above described. In this case the stone and sand were dumped from cars into bins under an elevated trestle. The bottoms of these bins were arranged as chutes, which were opened and closed by a form of cut-off, raised and lowered by hand. Certain bins were used for sand, others for stone. These materials were taken from the chutes into buckets which were hoisted to the top of the mixer by derricks. The cement house was so located that the bags were run down a chute, from the cars on the trestle, through the roof of the house.

The floor of the station was fixed at an elevation of 58 ft. above mean tide. This required the construction of foundations which extend from 30 to 38 ft. above the ground, requiring a most elaborate and intricate system of forms for moulding the concrete to the proper shape.

As so much of the masonry work consisted of long stretches of wall, traveling derricks were used in most cases, and, where possible, one rail of the derrick track was used as one rail of the track upon which the masonry material was handled. When the concrete foundations were in, the stone and concrete work were put up. A course of stone facing was laid, after which the concrete backing was rammed in place, in layers about 8 in. thick; each course being completed and allowed to set before another course was started. On work of this kind, this method gave the concrete time to set before the next course was started.

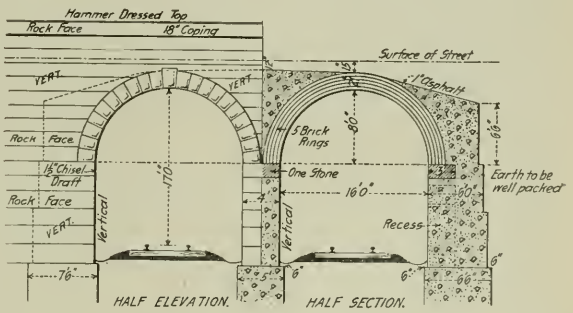
The forms used in putting up the concrete work, were of a very simple design. Small iron rods, having a nut on one end and a hook about 2 in. long on the other end were set in the top of each course, for the purpose of holding the forms for the next course in place. When the concrete was set, these rods were cut off.

As the space used by the Baltimore & Ohio for coal and team yards will be occupied by the terminal depot, it was necessary to provide for these facilities at some other point. The site selected for the new coal yard is located between First and Second, and M and N streets. In this space six lines of trestle, each about 600 ft. long and 18 ft. high, were built, having a capacity, in all, of about 60,000 tons. The driveways are 33 ft. wide, one for each trestle, and are macadamized. The bins cover three-fifths of the total area of the block, while the driveways cover the remaining two-fifths. The trestles are all constructed level, but owing to the grade of First street and of the terminal tracks on Delaware avenue, it was found necessary to construct the yard on a 1 per cent. grade, transversely descending toward M street. A system of tile drains will drain the yard and driveways.

A new freight terminal was constructed at New York and Florida avenues, which is perhaps as complete a layout as can be found for handling a business such as Washington furnishes. About 80 per cent. of the business of this city is inbound. Washington is not a producing city, as factories are discouraged to such an extent that few exist. The rapid growth of the city and the substantial character of most of the construction, makes it a large market for all kinds of building material, which is handled in car-load lots.

In view of these conditions, team or bulk unloading tracks were provided to accommodate about 450 cars, while the house tracks will care for about 200 cars, and a freight storage yard holding about 600 cars has also been provided. The team and house tracks are divided into three groups, each having a switching track, of some length, which will permit several yard engines to work the groups without interference. The storage yard is divided into three sections, so arranged that the switching can be done with the least interference.

East of the freight terminal are located the joint passenger coach yard, roundhouse, shops, engine yards and repair tracks. Two tracks, between the terminal yard and the roundhouse, are set aside for handling engines and cars between the station and the coach yard, and roundhouse, without interfering with the movement of trains over the main passenger tracks. They are located between the Washington and Metropolitan Branches, and pass under the "Y" connection of these two lines.

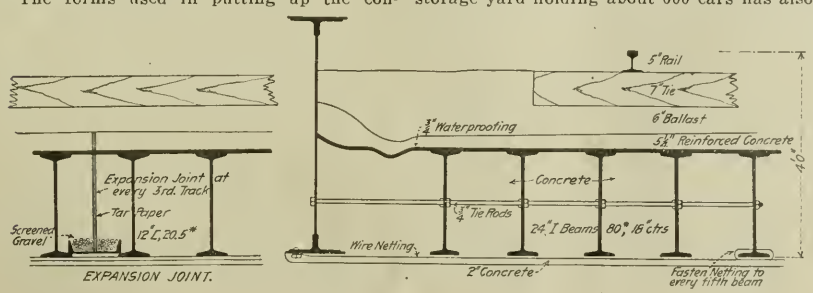



Portal and Half Cross-Section of Pennsylvania Tunnel under Capitol Hill.

At Florida avenue all tracks are at the same elevation. From this point north and eastward the grades of the groups of tracks are as follows: The Washington Branch connection of the Baltimore & Ohio and the Magruder connection of the Pennsylvania ascend at the rate of 0.9 per cent., the coach yard tracks at 0.5 per cent., and the Metropolitan Branch connection of the Baltimore & Ohio at 0.7 per cent. These differences in grades are due largely to the natural contour of the ground and served to permit an easy overhead crossing of the "Y" connection between the Metropolitan and Washington Branches over the equipment tracks, which are constructed on the same grade as the coach yard, southwest of the "Y," but which have heavier grades north of it.

From a construction standpoint heavier grades would have been preferable on all the different groups of tracks, as about 2,250,000 cubic yards of earth will have to be removed to bring the space assigned as a passenger coach storage yard to the proper grade.

A better idea of the magnitude of this work may be had, when it is stated that the material, over a considerable area, has to be removed to a depth of 82 ft., and that




Detail of Bridge Floor and Expansion Joint.

about 75 acres of ground will be occupied by these yards. Six large steam shovels, each having a capacity of about 30,000 cubic yards per month, are engaged on the work, and to date, have moved about a million cubic yards of material, practically all of which has been wasted. Quite a large percentage of this material was hauled nearly two miles from the point where it was excavated. Practically all of the remaining material will be used to fill in the terminal space and the plaza. Should there be any material left after this work is done it will be used to fill property now owned by the railroad company around the plaza, which will be 30 to 35 ft. above the present ground level.

As designed, the coach yard will have a capacity of at least 600 cars. The roundhouse and shop layout has been carefully designed, and the arrangement will be quite convenient and complete. The engine house, it will be noted, will be constructed in two sections of 25 stalls each, both sections having a turn-table. The coaling plant will consist of storage bins with measuring devices, and is located between the ash pits and the roundhouse; the approach to the storage bins will be by the ordinary trestle incline. The coal will be delivered in the bins direct from drop bottom cars, the cost of handling being very small. This style of coal wharf requires more room than a mechanical device, but is cheaper both in first cost and operation. The general construction of the ash pits will be very similar to ordinary practice, but the ash track will be depressed enough to permit loading the cars by shoveling the ashes over an adjustable apron, the top of the car being below the bottom of the engine pit. Inspection pits are also provided and are reached just before going on the ash pit, where the engines can be examined before turning them into the house.

The track arrangement will be such that access to both tables can be had from both sides of the coal wharf and from both tables to the storage yard. A tail track is provided for moving engines to the storage yard without fouling inbound tracks. Shop facilities will be provided for making light repairs to cars and engines, and the necessary tracks, platforms, etc., will be installed.

The contract for grading the site of the new coal yard and the new bulk freight yard estimated at 100,000 cu. yds. and 50,000 cu. yds. respectively was let to Stewart & Wilmoth. The grading and masonry contract for the northern approach was let to McMullen & McDermott and to the Hoffman Engineering & Construction Company. In this contract the estimated quantities were 2,600,000 cu. yds. of excavation and 100,000 cu. yds. of masonry. The Thompson-Starrett Company, of New York, obtained the contract for the foundations and superstructure of the new Terminal Station building with the exception of the steelwork and interior decorating. The New York Continental-Jewell Filtration Company is building the tunnel under Capitol Hill which will connect the Pennsylvania with the new station.

In the preparation of this article the author is indebted to D. H. Burnham & Company, Architects, Chicago, for information in regard to the station building; to Mr. Robt. Farnham, Jr., Assistant Engineer, P., B. & W. R. R., and to the members of his staff for photographs of the works.

The Wurtemberg State Railroads have had a surgeon's car built and equipped with all necessary appliances for the care of victims of railroad accidents, held ready to go anywhere on receipt of a telegram.

## Tests of Locomotives on the French State Railway.*

(*Continued from page 486.*)

In the original series of articles, the figures obtained from the tests are given in considerable detail and the results for each engine are examined individually, the operation of the steam being followed carefully from its passage through the throttle to its exhaust to the stack. Analyses are given of the wire-drawing of the steam in the steam pipes and during admission, of the expansion of the steam and of the coal and water consumption. In conclusion a summary of the results of these analyses is given for the purpose of comparing the performances of the different types of engines. The following is an abbreviated translation of the summary.†

*Summary of Results.*—The tests were made on the following locomotives:

1. No. 2,617. Single expansion 2-4-2 type with Bonnefond trip valve motion, having the exhaust independent of the admission, and a constant compression of about 10 per cent. Boiler pressure 185 pounds. Driving wheels 79½ in. diameter.

2. No. 2,754. Single expansion 4-4-0 type, with Ricour piston valves. Boiler pressure 200 pounds. Driving wheels 79½ in. in diameter.

3. No. 2,901. American single expansion 4-4-2 type, with piston valves. Boiler pressure 213 pounds. Driving wheels 84 in.

4. No. 2,802. American Vauclain compound 4-4-0 type. Boiler pressure 213 pounds. Driving wheels 84 in. in diameter.

5. No. 3,729. De Glehn four-cylinder compound 4-6-0 type. Boiler pressure 213 pounds. Driving wheels 69 in. in diameter.

The French locomotives have throttles of the double slide valve type while the American engines are fitted with double seated balanced poppet valves, which have the advantage of being very easy to operate, and giving an easy control of the amount of the opening. The poppet valve may, however, be criticised as being less steam tight than the slide valve, and more difficult to fit. Engines 2,754 and 2,901 are fitted with the single valve link motion and consequently, the control when working must be chiefly dependent on the throttle. Hence under ordinary working conditions the engine is run with the throttle not fully opened, and the steam chest pressure under these conditions is several pounds less than the boiler pressure. The tests show that the efficiency rises with the steam chest pressure and that when the pressure is down to 60 or 70 lbs. the steam consumption per horse-power hour is about 40 per cent. greater than when 140 to 160 lbs. pressure is carried. With a special valve motion as on engine No. 2,617, or better still, with compound cylinders, the engine can be run with the steam chest pressure in the neighborhood of the boiler pressure, thus securing a higher efficiency.

The steam chest pressure shows but slight variations during the stroke, except on the de Glehn engine No. 3,729. The variation of pressure on this engine is due to the small volume of the steam pipes, which is only 3.4 times the volume of the cylinder, while on the other engines the volume between the throttle and the high-pressure cylinder is from 4.4 to 5.4 times the cylinder volume.

Table 2 gives figures showing the wire-drawing during admission. In column two are the maximum port-openings for ordinary cut-offs and in column three the "factor of wire drawing," or the ratio of the fall of pressure during admission to the original steam chest pressure. The average port opening during admission is approximately two-thirds of the maximum port opening. It will be seen from the table that there is considerable wire-drawing in engine No. 3,729 (de Glehn), and even more in No. 2,754 (Ricour piston valve), as compared with the Bonnefond and the two American locomotives.

In its path from the boiler to the exhaust the steam encounters many obstacles, and consequently as the speed of the engine increases the tractive effort falls off. Table 3 shows the tractive efforts of the five engines calculated for a boiler pressure of 170 lbs. per sq. in., at speeds of 30 and 60 miles an hour. Column five gives the percentage of fall in the tractive effort when the speed is increased from 30 to 60 miles an hour. Engine No. 2,617 (Bonnefond trip motion) shows the most rapid fall of power. This is due to the defective action of the trip motion at speeds exceeding 50 miles an hour. Then comes the de Glehn compound No. 3,729, but it must be remembered that this engine has driving wheels only 69 in. in diameter. Next is the single expansion, No. 2,754, with Ricour piston valves, and the two American engines, which owe their superiority to their large ports.

The highest back-pressure is shown by engine No. 2,754, on which the piston valves are too small in diameter. The back-pressure is a little lower on No. 2,617 (Bonnefond trip motion) and on the two American engines, which do not have variable exhausts. The de Glehn engine, No. 3,729, is superior to all of the others in this respect, the back pressure being at least one-third less. It should be mentioned that this engine can maintain steam with the variable exhaust full open.

The fall of pressure in the intermediate receiver, that is to say the average distance between the high-pressure exhaust line and the low-pressure admission line, is about the same in the Vauclain and the de Glehn compounds. This fall of pressure which at high speeds amounts to 10 or 15 pounds, represents a considerable loss of work.

The steam consumption per horse-power hour as calculated from the indicator diagrams, is dependent on the pressure at admission and on the amount of the expansion. This is illustrated by the figures in table 4. All of the trains are passenger trains of about the same speed, with the exception of No. 1,428, which is a fast freight. The figures given for the indicated steam consumption are obtained by averaging the figures from the individual diagrams, which is a method sufficiently accurate for the present purposes of comparison. The number of expansions is obtained by dividing the final volume of a single cylinder by the initial volume occupied by the steam when admission ceases. For the compounds, the final volume is that of the low-pressure cylinder, and the initial volume is that of the steam admitted to the high-pressure cylinder.

The two compound locomotives show the lowest indicated steam consumption, which varies according to the working pressure from 15.5 to 18 pounds of steam per horse-power hour. Engine No. 2,617, with the trip valve gear, comes next to the compounds with slightly over 18 pounds per horse-power. On engine 2,901 leakage of the piston valves after cut-off increases the steam consumption; with steam tight valves this engine would show about the same consumption as No. 2,754, that is to say, a little less than 20 pounds of steam per horse-power hour.

The weight of steam lost by cylinder con-

*Abstract of articles by Mr. Joseph Nadal, Chief Assistant Engineer of Motive Power and Equipment, French State Railway, appearing in the Revue Generale des Chemins de Fer for May, 1903, and March and September, 1904. Translated by Lawford H. Fry.

†Throughout the present article all opinions expressed and all conclusions arrived at are those given by Mr. Nadal in the original articles.

*Table I.*

Dimensions and Types of Locomotives Under Test.

| | | | | | |
|---|---|---|---|---|---|
| Number | 2617 | 2754 | 2,901 | 2802 | 3729 |
| Nationality | French. | French. | American. | American. | French. |
| Type | 2-4-2 | 4-4-0 | 4-4-2 | 4-4-0 | 4-6-0 |
| Expansion | Single. | Single. | Single. | Compound. | Compound. |
| Valve | Corliss. | Piston. | Piston. | Piston. | Slide. |
| H.-p. cylinders, diameter, inches | 17⅜ | 16½ | 17 | 13 | 13¾ |
| L.-p. cylinders, diameter, inches | .. | .. | .. | 22 | 21⅝ |
| Stroke, inches | 25¼ | 25½ | 26 | 26 | 25¼ |
| Driving wheels, diameter, inches | 79½ | 79½ | 84 | 84 | 69 |
| Boiler pressure, lbs. per. sq. in. | 185 | 200 | 213 | 213 | 213 |
| Flue heating surface, sq. ft. | 1,205 | 119 | 171 | 129 | 130 |
| Fire-box, heating surface, sq. ft. | 103 | 1,582 | 1,721 | 1,571 | 1,697 |
| Total heating surface, sq. ft. | 1,308 | 1,701 | 1,892 | 1,700 | 1,827 |
| Grate area, sq. ft. | 20.5 | 21.5 | 35.0 | 25.6 | 25.6 |
| Weight on drivers, pounds | 63,000 | 64,800 | 75,000 | 72,300 | 95,000 |
| Weight, engine, pounds | 106,700 | 110,000 | 143,300 | 120,800 | 131,000 |
| Weight, engine and tender, pounds | 154,000 | 203,000 | 216,000 | 176,000 | 203,000 |

Note: The heating surface is measured on the inside of fire-swept side of fire-box and flues. Engines 2754 and 3729 have Serve ribbed flues.

*Table II.*

| Engine No. | Maximum port opening in sq. ins. under ordinary conditions of cut-off. | Wire-drawing factor for a speed of 50 miles an hour and average cut-off. |
|---|---|---|
| 2617 | 9.2 to 12.5 | 0.20 |
| 2754 | 3.0 " 5.3 | 0.38 |
| 2901 | 7.5 " 8.7 | 0.25 |
| 2802 | 11.5 " 18.2 | 0.20 |
| 3729 | 3.7 " 6.5 | 0.33 |

Note: The "wire-drawing factor" is the fraction of the steam chest pressure which is lost by wire-drawing during admission.

*Table III.*

| Engine No. | Average cut-off in per cent. of the stroke. | Indicated tractive effort in pounds: At 30 miles per hour. | Indicated tractive effort in pounds: At 60 miles per hour. | Percentage of reduction in the tractive effort when the speed is increased from 30 to 60 m. p. hr. |
|---|---|---|---|---|
| 2617 | 20 | 6,500 | 3,200 | 50.8 |
| 2754 | 25 | 5,730 | 4,200 | 27 |
| 2901 | 25 | 6,830 | 5,400 | 21 |
| 2802 | 50 | 7,160 | 5,620 | 21.5 |
| 3729 | 40 | 7,060 | 3,640 | 48.4 |

Note: The last column shows the reduction in the tractive effort when the speed is increased from 30 to 60 miles an hour.

*Table IV.*

Indicated steam consumption per horse-power hour, showing its connection with the steam chest pressure and the ratio of expansion.

| Engine No. | Train number and date. | Average: Steam chest pressure, lbs. per sq. in. | Average: Cut-off in per cent. of the stroke. | Average: No. of expansions. | Average indicated steam consumption per h. p. hour |
|---|---|---|---|---|---|
| 2617 | 86 June 5, '02 | 163 | 22 | 3.8 | 18.52 |
| | 86 June 6, '02 | 174 | 22 | 3.8 | 18.41 |
| 2754 | 86 Oct. 24, '02 | 157 | 28.5 | 2.86 | 19.10 |
| | 98 July 1, '02 | 152 | 29 | 2.82 | 20.65 |
| 2901 | 86 Oct. 29, '02 | 160 | 27 | 3.0 | 20.77 |
| | 86 Oct. 30, '02 | 137 | 26 | 3.1 | 21.45 |
| 2802 | 86 May 9, '02 | 146 | 55 h. p. | 4.45 | 18.05 |
| | 86 May 14, '02 | 203 | 40 h. p. | 5.50 | 15.51 |
| 3729 | 98 May 12, '03 | 174 | 40 h. p. | 4.8 | 16.10 |
| | 86 May 22, '03 | 185 | 45 h. p. | 4.4 | 17.60 |
| | 1428 June 3, '03 | 198 | 45 h. p. | 4.4 | 16.00 |

*Table V.*

Amount of cylinder condensation.

| Engine No. | Area of clearance space in square inches. | Train number and date. | Change in temperature of the steam in degrees Fahrenheit. | Weight in pounds of steam condensed per h. p. hour. | Total weight in lbs. of steam condensed per hour. |
|---|---|---|---|---|---|
| 2617 | 874 | 86 June 5, 1902. | 134 | 6.17 | 3,530 |
| | | 86 June 6, 1902. | 132 | 5.66 | 3,280 |
| 2754 | 929 | 86 Oct. 24, 1902. | 128 | 8.86 | 4,030 |
| | | 98 July 1, 1903. | 125 | 7.56 | 4,090 |
| 2901 | 1,120 | 86 Oct. 29, 1902. | 134 | 7.28 | 4,470 |
| | | 86 Oct. 30, 1902. | 126 | 6.63 | 3,620 |
| 2802 | 1,070 | 86 May 9, 1902. | 68.5 | 4.20 | 3,360 |
| | | 86 May 14, 1902 | 76.5 | 4.65 | 3,370 |
| 3729 | 960 | 98 May 12, 1903 | 93 | 5.97 | 3,030 |
| | | 86 May 22, 1903 | 96 | 5.47 | 3,950 |

*Table VI.*

Comparison of steam consumption as shown by the indicator and as actually measured.

| Engine No. | Actual weight of water used per horse-power hour. | Calculated weight of dry steam used per horse-power hour. | Percentage of difference between the actual and the calculated steam consumption. |
|---|---|---|---|
| 2617 | 26.45 lbs. | 25.44 lbs. | 4.6 |
| 2754 | 29.80 " | 27.50 " | 7.7 |
| 2901 | 29.63 " | 28.37 " | 4.4 |
| 2802 | 26.67 " | 22.33 " | 16.2 |
| 3729 | 23.59 " | 22.58 " | 4.3 |

*Table VII.*

Evaporative Duty of the Locomotives.

| No. of engine. | Pounds of water evaporated per lb. of coal. | No. of engine. | Pounds of water evaporated per lb. of coal. |
|---|---|---|---|
| 2617 | 7.16 | 2802 | 8.00 |
| 2754 | 6.78 | 3729 | 7.27 |
| 2901 | 6.66 | | |

*Table VIII.*

Resistance of locomotives and tenders, in relation to Speed.

| Engine No. | Average weight in tons of 2,000 lbs.: Engine. | Tender. | Total. | Formula for resistance. | Resistance in pounds per ton of loco. and tender at 50 miles per hr. | Tractive effort required by loco. and ten. at 50 miles per hr. |
|---|---|---|---|---|---|---|
| 2617 | 53 | 24 | 77 | $R = 7.6 + 0.157\ V + 0.00362\ V^2$ | 23.9 lbs. | 1,840 lbs. |
| 2754 | 55 | 46 | 101 | $R = 7.6 + 0.085\ V + 0.00342\ V^2$ | 20.4 " | 2,060 " |
| 2901 | 72 | 36 | 108 | $R = 7.6 + 0.085\ V + 0.00342\ V^2$ | 20.4 " | 2,200 " |
| 2802 | 60 | 28 | 88 | $R = 8 + 0.097\ V + 0.00517\ V^2$ | 25.8 " | 2,270 " |
| 3729 | 65 | 36 | 101 | $R = 8 + 0.097\ V + 0.00517\ V^2$ | 25.8 " | 2,600 " |

Note: R = resistance of locomotive and tender in pounds per ton.
V = speed in miles per hour.

densation was calculated for each engine by the formula previously given. The amount of cylinder condensation in a locomotive depends on the area of the metallic surface in contact with the live steam, and on the difference between the admission and the exhaust temperatures. Table 5 shows these factors for the engines tested and summarizes the results obtained by the application of the formula. There is not much difference between the clearance surfaces in the different engines, but it is less for the compounds than for the single expansion engines, as the diameter of the high-pressure cylinder is less than the diameter of the equivalent single expansion cylinder. The temperature range is less in the compounds but is not quite reduced by one-half, as the working pressure is not the same and the fall of temperature is not divided equally between the high and the low-pressure cylinder. The cylinder condensation losses, with trains of the same speed, varies but slightly with the amount of power developed, and consequently the loss per horse-power hour is least when the engine is developing the greatest power. In table 5 engine No. 2,802 (Vauclain compound) makes a slightly better showing than No. 3,729 (de Glehn compound) because the fall of temperature is more evenly divided between the two cylinders. Engine No. 2,617 (Bonnefond trip motion), which has the smallest clearance surface, gives only slightly more cylinder condensation than the compounds.

The formula for the loss by cylinder condensation can be checked by comparing the calculated steam consumption with the actually measured water consumption. The measured water consumption includes the steam required for the air pump as well as that used by the cylinders, while the calculations only give the steam used by the cylinders. There should therefore be a difference of about 3 per cent. between the calculated and the measured figures, and any greater difference must be due to moisture in the steam or an error in the calculation of the cylinder condensation. Table 6 shows the steam consumption figures for the locomotives under test. It will be seen that the calculated figures agree closely with those obtained by direct measurement except in the case of engine 2,802. The want of agreement in this case can be explained by an examination of the figures given in table 7 for the evaporated power of the coal. In engine 2,802 one pound of coal evaporated a little over eight pounds of water, while in the other engines the evaporation of a pound of coal was in the neighborhood of seven pounds of water. It is hardly likely that the evaporative power of the coal should be so much greater in one case than in the others, and the natural conclusion is, that engine 2.802 primed excessively and that the figure given for evaporation really represents an evaporation of 7 pounds of dry steam, which carries with it 1 pound of water. This would give 12.5 per cent. of moisture in the steam which with 3 per cent. added for the air-pump losses, is very nearly the figure shown.

Table 6 shows that if the formula for cyl-

*Table IX.*

Characteristic factors of the locomotives.

| Class. | Engine No. | Factor 1.: Weight on driving wheels. | Factor 1.: Maximum tractive effort. | Factor 1.: Factor of adhesion. | Factor 2.: Normal weight of steam produced per hr. | Factor 2.: Ratio of weight of locomotive to weight of steam produced per hr. | Factor 2.: Normal weight of coal burnt per sq. ft. of grate pr. hr. | Factor 3.: Steam used per horse-power hour. | Factor 3.: Normal horse-power. | Factor 3.: Weight of engine without tender per horse-power. | Factor 3.: Normal indicated tractive effort at 50 miles per hr. | Factor 4.: Coefficient of efficiency at 50 miles per hour. | Factor 4.: Steam used per hr. per lb. of tractive effort per hour. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single expans.. | 2,617 | 65,000 | 15,700 | 4.28 | 16,200 | 6.58 | 1,200 | 25.44 | 640 | 166.5 | 4,760 | 0.605 | 42.03 |
| Single expans.. | 2,754 | 64,800 | 14,800 | 4.37 | 18,600 | 5.92 | 1,300 | 27.55 | 675 | 163.0 | 5,030 | 0.591 | 46.56 |
| Single expans.. | 2,901 | 75,000 | 16,900 | 4.44 | 24,400 | 5.53 | 1,150 | 28.40 | 915 | 156.5 | 6,810 | 0.678 | 41.84 |
| Compound .... | 2,802 | 72,300 | 14,800 | 4.90 | 20,500 | 5.90 | 1,230 | 22.33 | 910 | 133.0 | 6,780 | 0.666 | 33.49 |
| Compound .... | 3,927 | 95,000 | 18,100 | 5.24 | 21,000 | 6.22 | 1,270 | 22.58 | 930 | 140.5 | 6,930 | 0.625 | 36.11 |

inder condensation is correct there cannot (except in the one case) be much moisture in the steam, and on the other hand if the steam can be shown to be free from moisture the figures obtained from the tests prove that the cylinder condensation formula gives correct results.*

American locomotives have the reputation of being less economical than those of Europe, and this reputation appears to be justified by the results given by those on the French State Ry., at least when they were first put into service. The following conclusions apply, of course, only to those American locomotives of which we have been able to follow the operation, and it would be dangerous to generalize from our conclusions. The causes of low efficiency in a locomotive may be grouped under the following headings:

1. Low boiler efficiency whether due to poor combustion or evaporation; priming.
2. Boiler leaks.
3. Defective utilization of the steam in the cylinders.
4. Leakage at the slide valves.
5. Interior resistance of the machine.

1. The American locomotive No. 2,901 shows the lowest rate of evaporation per pound of coal, in table 7, while on the other hand the American engine No. 2,802 shows the highest evaporation. It has, however, been explained previously that this apparently high figure is really due to priming. In reality the efficiency of the American boilers is less than that of the French boilers, this being chiefly due to the arrangement of the exhaust which has a double nozzle and is not variable. The American engines often prime considerably on account of the small surface of the water in the boiler and of the restricted volume for steam above the water. These drawbacks are due to the elevated position of the boiler.

2. The boiler is constructed of material of excellent quality; but its construction, doubtless owing to the high cost of American labor, is not very careful. Leakages at seams, staybolts and tubes are very frequent.

3. The operation of the steam in the cylinders would be as economical as in European engines if the running conditions would allow of steam chest pressures of 130 or 140 pounds per sq. in., which would mean a cut-off at 20 or 30 per cent. of the stroke. It appears that in America it is usual to cut-off at 40 or 50 per cent. This does not give sufficient expansion and consequently the steam consumption is high.

4. All of the American slide valves whether of the D or piston type are balanced. This is advantageous on account of the reduction in friction, and with the modern increase in steam pressures balancing appears to be becoming more and more necessary. Unfortunately balanced slide valves are rarely steam tight. In particular the piston valves of the American engines Nos. 2,802 and 2,901 soon become leaky, as they are only provided with the ordinary cast-iron piston packing rings. The openings in the rings increase in size, and if the valve head does not fit the steam chest exactly, leakage direct to the exhaust is permitted. The steam-chest bushings wear rapidly near the edges of the ports and the admission of the steam is not entirely intercepted at the point of theoretical cut-off, but goes on during the expansion or even later, according to the amount of wear. The Vauclain compound No. 2,802 has for the co-ordinated high and low-pressure cylinder only one valve, which is composed of four cylindrical slide valves mounted on one stem. This arrangement is simple, but of a nature to permit leakage. The steam chest bushing is perforated with many openings, and it is difficult to adjust it so as to bear at all points. Consequently there are often leakages of steam behind the bushing which are difficult to discover.

5. We have remarked in regard to the boiler that the American workmanship is not particularly careful. This may be said of the whole engine. Now if the various parts and particularly the valve motion, are not properly fitted, the interior resistance of the engine will be increased and the efficiency at the drawbar reduced.

The average resistance per ton weight of engine and tender varies considerably with the type of engine. The tests made enabled the resistance of the different engines to be determined, and formulæ were developed which give the average resistance per ton of engine and tender in relation to the speed. These formulæ are collected in table 8, together with the weight of the engine and tender, and the tractive power required to move the engine at a speed of 50 miles an hour.

The character of a locomotive may be judged from the factors which are given below.

1. *Factor of Adhesion.*—This is the weight on the driving wheels divided by the maximum tractive effort. The maximum tractive effort, which is usually only developed on starting, may be calculated for the formula

$$\frac{0.85\ P\ d^2\ s}{D}$$

where P is the maximum difference of pressure on the two sides of the piston (in a single expansion engine this is the boiler pressure).
d is the cylinder diameter.
s is the stroke.
D is the driving wheel diameter.

Indicator diagrams taken during the tests show that the coefficient 0.85 is correct.

2. *Factor of Evaporation.*—This is calculated by the formula $Q = 201 \sqrt{G\ (F + \frac{1}{6} T)}$ where

Q is the weight of water evaporated in an hour in pounds.
G is the grate area in square feet.
F is the fire-box heating surface in sq. ft.
T is the inside tube heating surface in sq. ft.

Under favorable conditions the evaporation can be forced for a short time to about 20 per cent. above the figure given by this formula.

3. *Factor of Steam Consumption.*—This is the indicated steam consumption per horse-power hour calculated at the normal speed, which is the case on the engines under consideration is about 50 miles an hour. From factors 2 and 3 can be calculated the horse-power which can be developed under ordinary running conditions.

4. *Factor of Drawbar Efficiency.*—This factor is calculated for the normal horse-power and also for conditions of lighter service. If the steam consumption is divided by the factor of efficiency, the result gives the steam consumption per horse-power hour effective at the drawbar. These factors and their derivatives are collected in table 9.

*Mr. Nadal quotes a number of authorities as to the quality of the steam produced in a locomotive boiler and bases a considerable calculation on the results obtained with superheated steam, to show that under ordinary conditions the steam is practically dry and that consequently the results of the present tests establish the accuracy of the cylinder condensation formula.

## Long Cars in English Freight Houses.

Necessity is the mother of invention, and those English railroads which in the past few years have been introducing long freight cars have ingeniously solved what seemed a rather difficult problem—that of moving these cars into and out of freight houses and small freight yards, (designed in every part to accommodate only short cars) where the house tracks are at right angles to the main leads. As is well known, the ordinary short car is run from one of these tracks to the other by means of a turntable about 13 ft. in diameter, often worked by hydraulic power. In a situation like this, the feelings of the ordinary long freight car must be highly embarrassing, assuming that it has feelings. On the Lancashire & Yorkshire, however, the problem appears to have been settled very simply, as is shown by the accompanying illustration. The front truck of the car has been turned and started a few feet toward the interior of the shed, and the rear truck is being run on to the table. The running of long cars into a house, in this way, implies that those other obstacles, structures very close to tracks on sharp curves, do not exist in this particular case.

Turning a Long Car in an English Freight House Yard.

The car shown is one of a number which the Lancashire & Yorkshire has recently put into service. It has a capacity of 30 tons and is 35 ft. long, 8 ft. wide over all, and 7 ft. 10½ in. high inside, with a cubic capacity of 1,960 cu. ft. The underframe is steel but the body framing is wood, sheathed on the inside as well as the outside to prevent damage to lading by projections on the framing. Two double-hinged doors, 6 ft. 6¼ in. high x 5 ft. 1 in. wide are provided on each side, and the section of the roof immediately over the doors is formed by a removable tarpaulin so that the car can be loaded or unloaded with a crane. The cars are mounted on diamond arch-bar trucks of the usual form, and are fitted with circle plates, so arranged that they can be turned completely around. With

this arrangement the car can be turned on an ordinary small turn-table in two operations by giving each truck a quarter turn. The car is fitted with both hand and vacuum brakes, but the brake rods instead of being attached to the truck levers in the usual way are carried in to the center of the truck and then down so that the brakes can be applied when the trucks are in any position. The tare weight of these cars is 33,300 lbs.

## Mr. Platt's Review of Automatic Block Signaling.

The Bulletin of the International Railway Congress for September contains a report by Mr. C. H. Platt, former General Superintendent of the Western District of the New York, New Haven & Hartford, on automatic block signals, prepared for the seventh session of the congress; and his theme is "recent improvements in apparatus and progress in the introduction" of such signals. The report covers America alone.

Mr. Platt briefly reviews the discussions of this subject at former meetings of the congress, and then gives detailed descriptions of those improvements in signal mechanisms and signal circuits which appeared in the four years up to September, 1903. These include the Hall electric motor signal, style D, the electro-gas signal, style E, and the Hall normal-danger "wireless" circuit, devised by Mr. Bezer; the Union electric motor signal, style B; the "wireless" polarized relay circuit, and the alternating current circuit for electric railroads; the Pneumatic Signal Company's alternating current circuit for electric railroads and the Miller cab-signal.

Then follow some tables, shown, abridged, herewith. These are dated Sept. 1, 1903.

*Table 1.*
Number of Block Signals in Use.

| No. of roads. | Signals. | Signals—Home. | Signals—Distant. | Signals—Total. | Miles of continuous blocking—Single track. | Miles of continuous blocking—Two or more tracks. | Miles of continuous blocking—Total miles of track. |
|---|---|---|---|---|---|---|---|
| 9 | Electro-pneumatic semaphore | 1,649 | 1,451 | 3,100 | ..... | 282.7 | 917.5 |
| 20 | Electric semaphore ..... | 2,466 | 1,484 | 3,950 | 495.08 | 1,021.81 | 2,654.2 |
| 9 | Electro-gas semaphore ..... | 254 | 236 | 490 | 10.4 | 96.0 | 226.4 |
| 30 | Enclosed disk..... | 2,894 | 1,418 | 4,312 | 151.48 | 1,192.0 | 2,724.86 |
| 7 | Clockwork disk ..... | 942 | 10 | 452 | 206.81 | 286.25 | 779.31 |
| | Total ..... | 8,205 | 4,599 | 12,804 | 863.77 | 2,878.76 | 7,302.27 |

*Table 2.*
Number of Signal Movements.

| No. of roads. | Signals. | Average per day. 24 hrs. | Total for year. |
|---|---|---|---|
| 7 | Electro-pneumatic sem.. | 101,540 | 37,062,432 |
| 15 | Electric semaphore .... | 89,895 | 32,811,810 |
| 4 | Electro-gas semaphore .. | 6,471 | 2,361,884 |
| 23 | Enclosed disk ..... | 221,131 | 80,712,822 |
| 6 | Clockwork disk ..... | 35,964 | 13,127,255 |
| | Total ..... | 455,001 | 166,076,113 |

*Table 3.—Failures.*
Number of Signal Failures Per Year.

| No. of roads. | Signals. | Failures per yr. | Signal movements—Per year. | Signal movements—Avg. per failure. |
|---|---|---|---|---|
| 4 | Elec.-p. sem.... | 1,459 | 23,561,175 | 16,060 |
| 13 | Electric sem.... | 5,066 | 25,917,614 | 5,116 |
| 4 | Elec.-gas sem... | 135 | 2,361,884 | 17,495 |
| 16 | Enclosed disk .. | 4,446 | 80,220,899 | 18,013 |
| 5 | Clockwork disk . | 3,329 | 13,097,325 | 3,934 |
| | Total ..... | 14,435 | 145,158,897 | 10,056 |

Note.—Roads reporting 20,917,216 signal movements per year, included in Table 2, having kept no record of signal failures, are necessarily omitted from Table 3.

In connection with table No. 3 some of the roads, but not all of them, reported the number of false clear indications. In consequence of the incompleteness of the statement comparison with the non-dangerous failures cannot be made, but we give the figures for what they are worth, as follows: Electro-pneumatic, 4 roads, 35 failures; electric motor, 11 roads, 184 failures; electro-gas, 1 road, 1 failure; enclosed disk, 9 roads, 35 failures; clock work, 2 roads, 13 failures; total failures, 268.

The causes of these failures are given as follows:

FALSE STOP INDICATIONS.

| | |
|---|---|
| *Electro-pneumatic Semaphore—* | |
| Broken air pipe | 6 |
| Broken wires | 45 |
| Frost | 126 |
| Lightning | 53 |
| Malicious disturbance | 10 |
| Short circuit | 32 |
| Storm | 34 |
| Unclassified or unknown | 37 |
| | 343 |
| *Electric Semaphore—* | |
| Broken blades | 4 |
| Broken bond wire | 146 |
| Broken line wire | 134 |
| Broken mechanism | 54 |
| Foreign current, including lighting | 85 |
| Frost | 9 |
| Malicious disturbance | 87 |
| Storm | 910 |
| Unclassified or unknown | 651 |
| | 2,080 |
| *Electro-Gas Semaphore—* | |
| Lightning | 8 |
| Malicious disturbance | 1 |
| Unclassified or unknown | 85 |
| | 94 |
| *Enclosed Disk—* | |
| Broken bond wire | 437 |
| Broken line and other wires | 215 |
| Broken switch instrument | 4 |
| Foreign current, including lightning | 124 |
| Malicious disturbance | 128 |
| Short-circuit | 16 |
| Storm | 522 |
| Unclassified or unknown | 295 |
| | 1,741 |
| *Clockwork Disk—* | |
| Broken line wires | 15 |
| Foreign current, including lightning | 130 |
| Heat | 2 |
| Malicious disturbance | 98 |
| Storm | 2 |
| Unclassified or unknown | 609 |
| | 856 |

FALSE CLEAR INDICATIONS.

| | |
|---|---|
| *Electro-pneumatic Semaphore—* | |
| Armature stuck | 1 |
| Circuit-breaker failed | 2 |
| Errors or neglect of batterymen and linemen | 14 |
| Lightning | 7 |
| Storms and frost | 11 |
| | 35 |
| *Electric Semaphore—* | |
| Broken pawls and pins | 6 |
| Circuits grounded | 8 |
| Errors or neglect of batterymen and linemen | 31 |
| Frost and storm | 18 |
| Foreign current | 4 |
| Malicious disturbance | 3 |
| Unclassified or unknown | 114 |
| | 184 |
| *Electro-Gas Semaphore—* | |
| Leaky track circuit | 1 |
| *Enclosed disk—* | |
| Crossed wires | 3 |
| Foreign current, including lightning | 13 |
| Grounded signal current | 2 |
| Red glass broken | 1 |
| Unclassified or unknown | 14 |
| | 35 |
| *Clockwork Disk—* | |
| Cross in lightning arrester | 1 |
| Lightning | 12 |
| | 13 |

In table 5, entitled cost, the noticeable feature is the low cost of the electro-pneumatic signal. The interest on the cost of installation is given as lower than that of any other automatic signal. This is somewhat surprising since it is well known that the first cost of the electro-pneumatic signal is higher than that of any other automatic signal. The fact that many of the other signals are in isolated locations and the electro-pneumatic is used only in a continuous system and comparatively short blocks is not enough to account for this discrepancy. Mr. Platt seems to have been struck with this peculiarity in his returns, for he takes occasion to mention that these average costs do not show which is the most economical or most costly signal under specific conditions.

*Table 5.—Cost.*
Average Cost per Signal per Year.

| No. of roads. | Signals. | Interest on cost of installation. | Depreciation and renewals. | Inspection and repairs.—Labor. | Inspection and repairs.—Material and supplies. | Total. |
|---|---|---|---|---|---|---|
| 2 | Electro-pneumatic semaphore ..... | $22.56 | $21.60 | $35.05 | $40.70 | $119.91 |
| 10 | Electric semaphore ..... | 34.23 | 41.21 | 53.94 | 49.63 | 179.01 |
| 2 | Electro-gas semaphore..... | 31.99 | 38.43 | 37.23 | 22.90 | 129.55 |
| 14 | Enclosed disk..... | 27.79 | 26.07 | 35.24 | 31.16 | 120.26 |
| 6 | Clockwork disk ..... | 24.04 | 20.58 | 53.45 | 25.74 | 123.81 |

Mr. Platt expects that by the time the congress assembles in Washington, the number of automatic signals in use in America will be 16,000, and the total number of miles of track protected by such signals approximately 10,000.

Referring to the action taken by the Paris Congress in 1900, he says that the experience of many years has demonstrated that track circuits and the necessary insulations and bonding therefor, are entirely practicable in construction, and have no appreciable effect on the maintenance of the permanent way.

The statistics given above demonstrate the utility and reliability of automatic signals, already covering more than 13,000 signals, protecting more than 7,000 miles of track, by more than 450,000 movements daily. Therefore, he recommends the adoption of the following conclusions:

"1. That automatic signaling, properly designed and installed, be recogized as a suitable means of protection for train and switching movements.

"2. That any automatic signal system, effectually providing that the signals for any block cannot indicate safety before the last vehicle of the train which may have been permitted to enter the block has cleared the same, be approved."

*Table. 4.—Failures.*
Number of Signal Failures. Per Year.

| No. of roads. | Signals. | Batteries (broken jars,etc.). | Faulty maintenance or inspection—Signal Dept. | Faulty maintenance or inspection—Roadway Dept. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|
| 4 | Electro-pneumatic semaphore ..... | 97 | 677 | 342 | 343 | 1,459 |
| 14 | Electric semaphore ..... | 771 | 1,621 | 594 | 2,080 | 5,066 |
| 5 | Electro-gas semaphore. ..... | 11 | 21 | 9 | 94 | 135 |
| 16 | Enclosed disk ..... | 876 | 1,318 | 511 | 1,741 | 4,446 |
| 5 | Clockwork disk ..... | 322 | 1,715 | 436 | 856 | 3,329 |
| | Total ..... | 2,077 | 5,352 | 1,892 | 5,114 | 14,435 |

## G. Bouscaren.

Mr. Gustave Bouscaren, one of the ablest civil engineers of this country, died at his home in Cincinnati, Ohio, on Sunday last, at the age of 64. He had been in precarious health for more than a year and had been confined to his home for many months.

Louis Frederic Gustave Bouscaren was born August 25, 1840, at Pointe-a-Pitre, Island of Guadaloupe, French West Indies, of French parentage, his father having been an officer in the service of the first Napoleon. His family removed to the United States during the boyhood of Gustave. He studied in St. Xavier College, Cincinnati, and in Georgetown College, Ky. In 1853 he entered the Lysée St. Louis, Paris, France, graduating in 1859, and afterward took the course in mechanical and civil engineering in the Ecole Centrale des Arts et Manufactures. Returning to the United States he began his professional work, in 1862, as a mechanical and architectural draftsman in Cincinnati. He entered upon his railroad career in 1865 as an assistant engineer on the Ohio & Mississippi. Later he was in charge of construction, successively on the Vandalia, the Cairo & Vincennes, and the St. Louis & Southeastern.

In 1873 he was called to the construction of the Cincinnati Southern as first assistant to the chief engineer, Mr. Thomas D. Lovett, and upon Mr. Lovett's retirement in 1876 he became the chief engineer of that important work, continuing in the position until the completion and opening of the road, and afterward as chief engineer of the operating company, the Cincinnati, New Orleans & Texas Pacific. During this latter period the New Orleans & North Eastern and the Vicksburg, Shreveport & Pacific, were built by interests under the control of the C., N. O. & T. P., with Mr. Bouscaren as chief engineer. Resigning in 1884 he opened an office in Cincinnati for practice as consulting engineer.

Among the notable works of which he had charge after that date were the construction of the Covington (Ky.) water works and the new system of water supply for Cincinnati, of which he was chief engineer from its inception until his death. He also designed and had charge of the reconstruction of the Covington & Cincinnati suspension bridge, originally built by Roebling, and of designs for the Chesapeake & Ohio bridge over the Ohio river at Cincinnati. He served on many engineering commissions and committees of the American Society of Civil Engineers, among which may be named the commission appointed by President Cleveland to report upon the feasibility of and the longest practicable span for a bridge over the North River at New York; and (as chairman) on the committee of the Am. Soc. C. E., to report upon a standard rail section. This memorable report revolutionized and standardized rail sections for American railroads to such an extent that more than three-fourths of all the rails now produced in this country conform to the section recommended by the committee.

About the time of the construction of the Cincinnati Southern the science and art of bridge building made very notable advances, and in these Mr. Bouscaren took a conspicuous part. His specifications for the bridges on that road introduced radical innovations, since very generally adopted, in the design and construction of railroad bridges. It may fairly be said that he was the pioneer in not a few features of modern railroad bridge design, and he did not escape the common penalty of the advanced thinker in every field of human effort, though he had the good fortune to live to see his work vindicated. He introduced the use of train diagrams in figuring live load, and his specifications were the first to require the testing to destruction of full sized compression members. He also introduced many improvements in bridge details. Under his specifications the two most notable bridges of the period were constructed—the Ohio river bridge at Cincinnati with its then unequalled truss channel-span of 519 ft., and the remarkable bridge over the Kentucky river, the first important cantilever bridge built in this country.

At the time of his death Mr. Bouscaren was a vice-president of the American Society of Civil Engineers, and chairman of the special committee of the society to further consider and report upon railroad rail sections. Mr. Bouscaren was peculiarly well equipped intellectually for his profession. His highly cultured mind was vigorous, analytical, persistent and bold; few men had to a greater degree the courage to follow their convictions. His work was broadly planned and worked out with painstaking attention to the minutest details. His conception of engineering work seemed to be that the best was never too good, and that anything which fell short of that high standard was to be tolerated only when conditions made it unavoidable. It followed naturally that he expected and insisted upon a high standard of performance on the part not only of his professional assistants, but of contractors engaged upon work under his supervision. If sometimes considered rather exacting by the latter class, his motives were understood and respected by them, and his conscientious probity and honor were unquestioned. In his personal and social relations he was a Christian gentleman—what more need be said?

His death is a serious loss to the profession which he adorned and honored, and will be felt keenly not only by hosts of warm friends, but by the large number of engineers who as young men, were members of his professional family, and owe not a little of their success to his kindly help and thorough training.

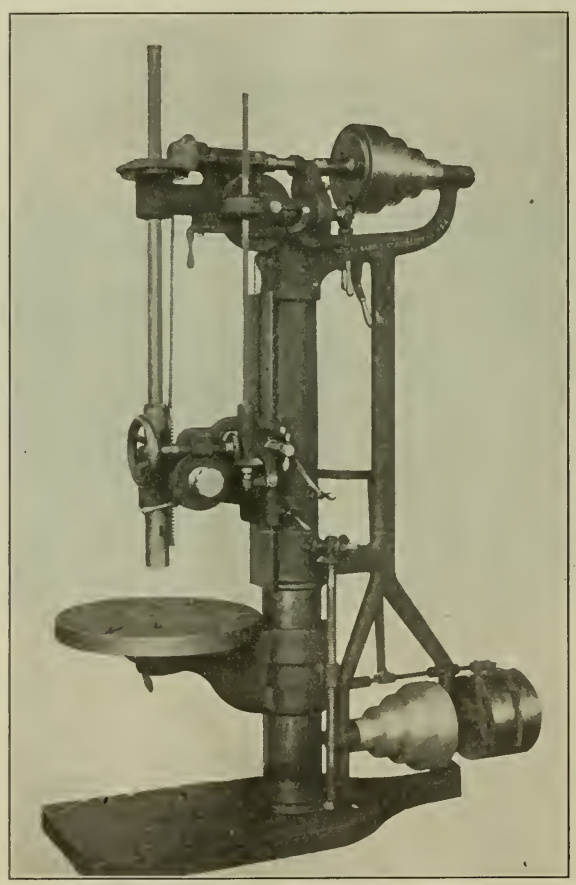


Fig. 1—Upright Drill, W. F. & John Barnes Company.

## Railroad Shop Tools.

*(Continued.)*

### UPRIGHT DRILLS.

The drill shown in Fig. 1 is made by W. F. & John Barnes Company, Rockford, Ill. This tool is known as the No. 3 upright drill and it has a 34-in. swing. It is 8 ft. 2 in. high and the distance from the spindle to the base is 57 in. The diameter of the column is 9¼ in. and the spindle is $1^{15}/_{16}$ in. in diameter and has a No. 4 Morse taper hole. The spindle has roller thrust bearings, self-feed, automatic stop, and quick return motion. The maximum distance from the spindle to the table is 39¾ in. The table is 30 in. in diameter and has a vertical hand adjustment which is operated by means of the miter gears and screw shown in the illustration. The sliding head has a vertical adjustment of 29 in. and the spindle has a travel of 16½ in. There are eight changes of positive gear-driven feed ranging from .006 to .064 in. per revolution of the spindle and the back gear ratio is 6 to 1. The weight of the machine is 2,600 lbs. and the floor space required is 76 in. x 26½ in. The countershaft should run at 175 r.p.m.

The illustration, Fig. 2, shows a machine made by A. D. Quint, Hartford, Conn. It is known as the Quint No. 4 turret machine and is designed for boring, drilling, reaming and tapping holes with but one setting of the work. It practically holds the same relation to the common drill press that the turret lathe holds to the common lathe on work that can be rotated. For certain classes of work this drill is better than the multiple spindle drill, for when using the latter, work must be moved, in turn, after each operation from one spindle to another. With the turret drill, the drills, reamers, taps, etc., are placed in their respective spindles, each of which has an independent stop which can be adjusted for different depths of holes. These different tools, as in the turret lathe, can all be brought to the center and in position for use without stopping the machine. All of the tools in the head that are not in use do not rotate and are out of the way and do not interfere with the work. The illustration shows a 4-spindle, 32-in. machine fitted with a reversing tap holder suitable for drilling or tapping up to 2 in. in solid iron. The base, column, stand and table are the usual type used on upright drills. The sliding head on the column is balanced by a weight, and carries the feed mechanism, the locking

device and the steel spur gearing for the transmission of motion from the vertical shaft to the revolving tool spindle. On the sliding head is mounted a rotary turret head. All the spindles in the turret are indexed to the same point when the spindle is in position for work. Any spindle wanted may be swung into position without stopping the machine by means of a lever shown on the front of turret, which when moved to the right will release the index pin. When the turret is revolved to the spindle wanted, the lever will automatically lock the turret head with the spindle running in position for work. The hand feed is operated by a hand-wheel in front of the turret. The power feed is operated by the belt and cone pulleys on the sliding head. The feed is started and stopped by the knock-off in front of the hand wheel, or it can be set to stop automatically for any depth up to 28 in. by means of the stop shown on the face of the column. The quick return of the head is obtained by means of the pilot wheel on the left-hand side of the head. The clutch for connecting the back gears may be thrown in or out while the tool is running. These Quint turret machines are made in four sizes with from four to 12 spindles.

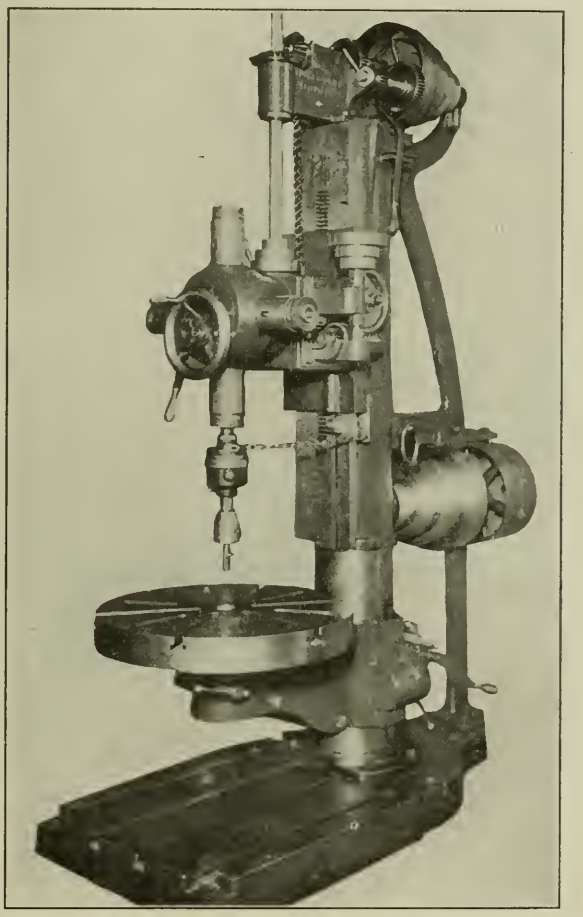


Fig. 2—The A. D. Quint Upright Turret Machine.

Fig. 3 shows a 40-in. swing, back-geared drill made by the New Haven Manufacturing Company, New Haven, Conn. The spindle of this machine is balanced and has a feed of 12 in. operated either by hand or power, has an automatic stop, a quick return motion and an index for measuring the depth of the hole drilled. The shipper is fitted with a brake for stopping the spindle quickly. The head is adjusted by means of a screw operated by miter gears. The adjustable arm which carries the table can be swung aside so that the base plate can be used for drilling. The back gearing is operated by a lever which is within easy reach of the operator. The spindle is 2½ in. in diameter and is of hammered crucible steel fitted with a solid forged collar, and is reamed to fit a No. 5 Morse taper and will hold drills from $2^{1}/_{16}$ in. to 3 in. inclusive. The wear between the quill and the spindles is taken care of by a loose, hardened tool steel collar which is cupped to hold oil. The quill has a threaded collar for taking up wear. All gears are cut from solid blanks. The countershaft is at the base of the machine, and the driving shaft and spindles run in cap boxes. The distance from the face of the post to the center of the table is 20 in., the maximum distance from the spindle to the base plate is 53 in., and the greatest distance from the spindle to the table is 34 in. The vertical traverse of the table is 15 in. and the vertical traverse of the adjustable head is 14 in. The planed surface of the base plate measures 35 in. x 32 in., and the diameter of the adjustable table is 36 in. The machine is 9 ft. high and weighs about 4,200 lbs. The driving pulleys are 16 in. in diameter and have a 3¼ in. face. The largest cone pulley is 14 in. in diameter and it takes a 3-in. belt. The countershaft should run at 225 r.p.m. These drills can be arranged for tapping by adding a pair of friction pulleys which are supported in a bracket attached to the rear of the base of the machine. A device for automatically reversing the machine and running back the tap by power is also supplied when desired. *(To be continued.)*

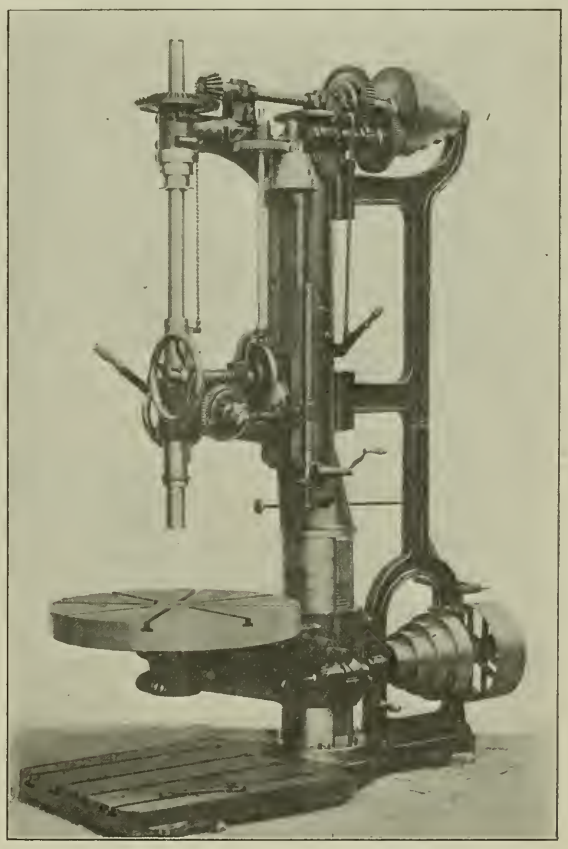


Fig. 3—Upright Drill, New Haven Manufacturing Company.

## The Block System in Iowa.

At the meeting of the Iowa Railway Club which was held at Des Moines on September 12, there was an animated discussion on the question whether or not the block system can be used on the railroads of the west and, if it can be used, whether it is worth having. At a previous meeting a paper had been read by Mr. P. G. Campbell, Chief Train Despatcher of the Chicago & North Western, at Boone, speaking favorably of the block system, and at this September meeting Mr. A. T. Woodruff, Examiner on the Chicago Great Western, read a paper sustaining the opposite side of the question; and the subject was discussed by Messrs. Hammill, Shipley and others.

Mr. Woodruff says that the increase in operating expenses resulting from the use of the block system on the average western railroad will amount to about $1,000 a month for each 100 miles; which means, we suppose, that usually it is found necessary to put on about 20 additional operators or signalmen in a road of that length. From this he goes on to argue that unless the cost of collisions is reduced at least $12,000 a year the block system is too expensive. As he has not found any hundred miles in Iowa where the collision losses have amounted to this sum, he is satisfied that the block system is not worth having. He holds that the delays due to block signaling and their cost are a dead loss. He believes that every attempt to work the absolute block system on lines of heavy traffic in the west have failed; permissive blocking had to be substituted. Permissive blocking is dangerous; no railroad man can be made to believe that the rule, to run under control when a permissive signal is given, will be lived up to. The under-control rule

is not made any safer by having the initials of the despatcher on the caution card. Mr. Woodruff went on to detail some of the bad practices which he finds where the block system is ostensibly in use.

An operator is liable to signal a clear block when it is not clear. This may result from the mechanical oversight of a sleepy operator or from a misunderstanding. An incompetent operator misinterprets the telegraphic code. A "get there" operator clears the block when a train is "coming" to release a following train, which may otherwise be seriously delayed for an opposing train. The nervous operator loses his head. A stupid operator don't know why he did it.

A conductor will perhaps occupy the main track at a station doing work, figuring that the operator is protecting him. The operator does not understand it that way and the train is unprotected.

A favorite trick of a certain class of night operators is to find out "what is coming," then change the position of the signal to "proceed" and go to sleep, depending on the first passing train to awaken them.

The custom of using the train order signal for a block signal is a dangerous practice peculiar to the block system. The normal position of the signal is at "Stop." There is nothing to remind the operator that he has orders for a train and nothing to indicate to the engineer that orders are awaiting him. It all depends on the operator's memory, which if defective will result in his failing to deliver the orders.

Another thing which must not be overlooked, responsibility has been removed from train and engine-men, who as a class are men of experience and mature judgment, and increased responsibility imposed upon operators, who as a class are young, frequently inexperienced and sometimes, perhaps, incompetent.

As a preventive of butting collisions the manual block system affords additional security, but Mr. Woodruff, while admitting this, declares that displaying the stop signal at meeting points is simpler and less expensive.

Mr. Campbell, whose paper had been criticized, was the first speaker in response to Mr. Woodruff. He spoke of a recent case where

"A heavy freight train broke an air hose, and hurt the conductor and rear brakeman, and there was nobody there to protect the train until the men at the head end of the train got back and saw the condition of affairs, and they flagged back."

As to butting collisions, the order at the meeting point is all right if there be an order, but many of the collisions are between trains which should meet according to the time-table and rules, no orders being issued. In two years on his (block signaled) division he could recollect no collision of either kind.

Mr. Hammill (C. & N. W.) with ten years' experience as despatcher and trainmaster on a road using the block system combated the claim that the block system caused delays. On one division he had moved 28 stock trains, six passenger trains and three fast freights in one direction and a corresponding movement in the opposite direction, in one day, with an outlay of not over $200 for overtime of freight trainmen, mostly those on way freights. Mr. Hammill cited instances of the block system preventing collisions where operators or despatchers had neglected to give proper meeting orders. If he were general manager of a railroad on which there were but two trains a day, one each way, he would use the absolute block system.

Mr. Campbell, in telling of the practice on the North Western, said that enginemen sometimes objected to running on a caution card at night when patches of fog are liable to arise; and the despatcher never compels an engineman to run on a caution card. Regarding the assertion that enginemen running under a permissive signal do not carefully regulate their speed, he said that the train sheets would show that the claim is not true, as regards his division; trains running under permissive signaling take much more time than those which get clear signals. In his experience, on two divisions, he has never known a train to get into trouble while running under a caution card. It must be acknowledged that the block system permits certain kinds of carelessness, "but all you need to do is to drill the men and discipline them a little stronger, and you will get the desired results." On the Iowa division 10 to 15 caution cards are issued daily; nearly all of them are for way freight trains.

Mr. Schevenell.—Mr. Woodruff has admitted that the manual block system is useful as a precaution against head end collisions; and I want to say that in the last ten years four or five disasters have been averted just in this way. Despatchers issue orders for a train to run extra and overlook an opposing extra; a despatcher seldom discovers an error of that kind until it is too late, while the block system does prevent the collision. This feature alone will pay for the extra expense of the block system. The claim that the block system increases expenses $1,000 a month is excessive. With the light traffic which has been referred to in this discussion it can be installed without one cent of extra expense; though, of course, it is necessary, at some stations where there is no night operator, to lengthen the block sections at night.

On the North Western for three years much double tracking has been done between Belle Plaine and Council Bluffs; 30 to 50 miles west of Boone, and the same amount east of Boone each year. For this work 40 to 65 work trains have been employed from early spring to late fall. There was, of course, much changing of grades also. The block system was in use and the work trains were run under permissive signals, but during all this time there was no accident.

## Storage Batteries for Signal and Track Circuits.

The Electric Storage Battery Company, of Philadelphia, has issued a description of the installations of its chloride accumulators on the Reading and the Pennsylvania roads; nd we give it, condensed, below. The Reading installation is in connection with Hall disk signals and the Pennsylvania with Westinghouse electro-pneumatic.

In the case of interlocking, when there is a considerable current demand within a limited area, storage batteries have already largely superseded primary batteries, but in block signaling the conditions are different. On a four track road, the decision will undoubtedly be in favor of the secondary battery; but on single track the primary battery will frequently show better economy. An installation has just been completed by the Philadelphia & Reading between Wayne Junction and Huntingdon street, Philadelphia, where the concentration of the devices requiring current has made the comparison of the cost of furnishing power by primary cells and by storage batteries greatly in favor of the latter. It is estimated that the cost of the storage battery installation will be returned within the first year's operation. This section consists of four tracks, and is 12,500 ft. long. The primary cells were distributed at eight points, a total of 1,203 cells being used. At each of these points storage battery cells, type PT, have been put in, requiring a total of 134 cells to displace the 1,203 primary cells. This type of cell has a capacity of 24 ampere hours. At each location there are two sets of storage cells, one being used to operate the signals while the other set is being charged. In other words, there are 67 storage cells in service at one time. The number of cells in each set at each battery point varies from a minimum of seven to a maximum of 20, this being necessary on account of the different voltages required. From some of the battery points several circuits of different voltage are desired, and this is accomplished with one battery. Resistance in the form of counter electro-motive-force cells is used to reduce the voltage to the requirements of the minimum voltage circuit.

At a point approximately 3,000 ft. from Wayne Junction is the charging station. Here are installed two direct-connected generating sets, each having a capacity of 275 volts and 10 amperes. Two generators are provided in order that one shall serve in case of a breakdown of the other. From this charging station two charging circuits are run, a No. 12 wire to Wayne Junction, and a No. 10 to Huntingdon street. There is a rheostat which can be inserted in either circuit. Each day one of the batteries at each battery point is thrown upon the charging circuit while the other is left to operate the signals. The batteries on charge at the various battery points on each charging circuit are, therefore, all in series with each other and are cut out one by one as they are filled. The system has been working in the most satisfactory manner, and the labor has been somewhat reduced.

The Pennsylvania Railroad is using storage batteries for signal work on the Philadelphia Division, from Philadelphia to Downingtown; on the Pittsburg Division, from Gallitzin to Wiltmere; on the Monongahela Division, from Pittsburg to Thompson; on the Maryland Division of the Philadelphia, Baltimore & Washington, from Philadelphia to Wilmington; and from Allegheny to Homewood on the Eastern Division of the Fort Wayne.

The first installation made by the Pennsylvania was on the division between Philadelphia and Paoli, about three years ago. The signals between these points are spaced approximately 3,000 ft., and in the base of each semaphore are from two to four cells of "Chloride Accumulator," type 5-E, capacity 80 ampere hours. One cell is discharged upon the track and signal circuits, while the other cells are being charged. Each day an inspector goes over the route and changes the batteries from charge to discharge. While the batteries are thus inspected each day and charged every second day, the cells are of sufficient size to operate the signals for five or six days. With the old system of gravity cells it would be necessary to install about 24 primaries in the place of each of the two storage cells, and it would require five or six times the number of men for handling the batteries. With gravity it was customary to have two distinct batteries, one upon the track circuit and one upon the signal circuit. With the storage battery one cell operates both.

The Southern Pacific Railway has storage batteries which are carried from the signals to the generating station, charged and returned. This road is using a cell of 50 ampere hours capacity, these cells being contained in rubber jars, mounted in wood cases —two cells to each case, with handles so that they can be readily transported. The weight of each of these cells is approximately 12 pounds.

Each of these storage cells replaces eight primary cells. Four of these cells are used to each signal, or to each pair of signals where the signals are near enough together to permit this. Once a month the cells are returned to the charging station, inspected and recharged. The cells are charged in sets of seven, four to each set, making 28 cells in all. These charged batteries are then returned and exchanged for others which have been in use for one month.

Many of the principal railroads of the country use chloride accumulators in signal service.

RAILROAD GAZETTE

## ST. LOUIS AND THE WORLD'S FAIR.

Articles in our issues of September 23, October 28 and November 11 gave some impressions of the Louisiana Purchase Exposition, ending with notes on the passenger cars. It remains to mention the freight cars, the electric cars and what may be called some unconscious exhibits—that is, those features of railroading in St. Louis outside the World's Fair, which one sees in going to the fair and which are of interest either to native or to foreigner. These last are chiefly at the Union Station. The two throats to the yard (plan published in the *Railroad Gazette*, March 20, 1903, p. 212) appear to make a very satisfactory arrangement—assuming that it is desirable to have a single station 600 ft. wide. The yard and its approaches make one of the two largest stations in the country; and as far as train movements are concerned it may perhaps be considered a larger yard than Boston for the reason that in the Boston station the trains of the Plymouth and Midland divisions can be kept entirely separate from those that run to the Back Bay, thus making two stations practically independent of each other. This is not true, or not so fully true, at St. Louis.

All through trains, and nearly or quite all local trains are invariably backed into the St. Louis station. This makes it possible to have the notices of prospective train arrivals, five minutes in advance, all sent to the offices in the station from one point, the signal cabin at the junction of the shed-track throats with the main line. The use of the telautograph for giving these notices was described in our issue of September 16, page 335. And backing the trains in is a good thing for the baggage department, as baggage cars both incoming and outgoing stop always at the same place, near the baggage storage rooms; but to the passenger it seems as though the multiplication of five minutes by the number of passengers arriving at the station in a year must foot up an enormous number of hours wasted. The freight-car passenger specials, run by the Wabash, between the station and the Fair grounds are run into the station head first. These trains, by the way, do not make very fast time. The moderate speed (which includes some slackenings on account of junctions or other yard conditions), with the unpleasant features of freight-car riding, seems to be sufficient to lead a good many passengers to take the street cars instead. These are more frequent, though they consume a good deal more time for the through journey; and as they are well managed and, for many passengers, start at places more convenient than the Union station train shed, they take the bulk of the business. Our friends from Europe will not see the best of tracks on these street lines, but in other respects will see probably as good an example of city "trolley" transportation as can be found outside of Massachusetts.

The reason that the baggage-room space at the Union station is nearly all at the outer end of the shed is that it is so extensive that there is no room for it elsewhere. It is beneath the tracks, with wagon ways approaching from both sides. The checking room—in the usual place, not far from the concourse—is connected with the large underground room by pneumatic tubes, so that claim checks and records of individual trunks are whisked back and forth with no appreciable delay. Every piece delivered at the underground room by a teamster or hackman for an outgoing train is weighed, and its weight entered on its card-check record so that excess-baggage disputes are done away with. Six or eight men in the checking room keep records of all baggage, so classified by check numbers, that the owner and his baggage are always quickly connected when required. In the month of August the number of pieces of baggage handled was 268,044, about double the number in that month last year.* Brass checks are now used for only a small fraction of the baggage sent from this station.

The main floor of the Union station, above the track-level floor, has always been unpopular because, as long as there was room in the lower story, passengers preferred to stay there because of its ease of access and nearness to trains; but this summer the upper room has been used from necessity. Two stairways were put in leading down to the concourse about 30 ft. out—the top landing being a bridge of that length—thus relieving the interior stairways of what must otherwise have been an intolerable crush.

The "pay toilets," put in this year, are of two grades, five-cent and ten-cent. The most obvious comment on these is that ten cents does not buy any more at some stations than five cents does at some others.

But to return to the World's Fair. The electric cars are noticeable chiefly by the details which indicate that they have been designed to afford comfort and facilities for comparatively long journeys, as distinguished from a city street car, which to a considerable share of its passengers is quite tolerable if it affords standing room and protection from wind.† One car, for the San Francisco & San Jose, has a row of electric lights along each side of the clear story, providing good reading light in every seat. The seats, as in all the interurban cars, are transverse, which has become the settled practice; although no one has yet, we believe, been bold enough to build a trolley car of the width necessary to make such seats entirely comfortable for two persons.

The two cars shown by the American Car & Foundry Company and the John Stephenson Company are the most ambitious imitators of steam railroad cars, in the matter of strength and large size. The Master Car Builders' type of coupler, seen on one of them, evidently must be adopted generally, sooner or later, if freight cars are to be taken to and from steam railroads. These two cars are so massive and well built that they could withstand a sizable butting collision. This reminds one of the question, still unanswered, and which must have occurred to many railroad men, whether our electric roads are going to safeguard their passengers by steel car-frames or by the better plan of not having collisions. In attractive designs and decoration, and in minor conveniences as far as possible, they have imitated steam railroad practice with much good judgment; but in the art of keeping trains from running into one another most of the interurban lines are about where the steam roads were sixty or seventy years ago.

Freight cars are not conspicuous at the fair. Doubtless they were deemed too prosaic for the purpose aimed at in filling up the long tracks of the Transportation building—to make a show that would attract the multitude. Therefore we have a half dozen cars which may be called specialties or advertisements, and that is all. These are all well-known to our readers.*

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The experimental electric locomotive for the New York Central, which is described elsewhere in this issue, marks a distinct advance in electric motive power, for it embodies a number of features never before applied. The first impression of the casual observer in looking over the machine is the closeness with which the best practice in steam locomotive design has been followed. In the general arrangement of the cab fixtures, in the frame, in the use of radial pony trucks, there is a striking similarity. One important object of the designers was to improve on the starting power and riding qualities of the steam engine without attempting to eclipse it in maximum speed. The Marienfelde-Zossen electric traction tests aimed only at the attainment of enormously high speed; this locomotive has been designed for a reasonably high rate of speed for continued runs, but its salient feature is its large starting effort and quick acceleration. Any difference in running time between the new and the old mode of traction will be attained by increasing the acceleration and not by increasing the maximum speeds on long runs. The best feature of multiple-unit traction is the quick starting power of the whole train, and in so far

*The car movements and the baggage movement at the Union Station for October were as follows, the total number of cars that month being 3,579 more than the total for the month before (September):

| | Oct.,'04. | Oct.,'03. |
|---|---|---|
| Passenger cars in and out... | 77,731 | 37,241 |
| Baggage handled, pieces..... | 300,959 | 141,584 |

The number of train and engine movements recorded at the signal tower for 24 hours from 4:00 p. m. July 14th to 4:00 p. m. July 15th, was 2,203, divided as follows:

| | |
|---|---|
| Loaded passenger trains ..... | 740 |
| Empty coach sets to storage yards ..... | 396 |
| Light engines, including switch and road engines ..... | 792 |
| Switching movements ..... | 188 |
| Freight movements ..... | 87 |

From 7:00 to 8:00 p. m. there were 158 moves, the heaviest during 24 hours. From 8:00 to 9:00 a. m., 139 moves; and from 8:00 to 9:00 a. m. there were 56 loaded passenger trains handled in 60 minutes.

†The most prominent novelty among the electric cars is a private car for the President of the Milwaukee Electric Railway & Lighting Co. This car has all the luxury and elegance of the ordinary private car, and, in fact, might be a copy of a standard railroad officers' car, except in size. This car was built by the St. Louis Car Company, which shows a half-dozen others, including one with a steel frame in which parts are left unfinished so as to give a good idea of the different processes in making the frame and the different stages of the painting. One of the cars is for the Northwestern Elevated of Chicago, and one, with copper siding, is for the Interborough Rapid Transit Company of New York. The J. G. Brill Company shows a convertible car, to be made open in summer and closed in winter; and another semi-convertible. The American Car Company and the John Stephenson Company show one car each. These cars are heavy and strong, and designed for high speed. The last-mentioned has six-wheel trucks and journals, 5 in. x 9 in.

*The American Refrigerator Transit Company exhibits a refrigerator car built at its own shops, and the American Car & Foundry Company a refrigerator car for fruit. The Schwarzschild & Sulzberger Company has a long car filled with samples used by its traveling salesmen. A salesman takes a car of this kind from city to city, inviting prospective customers to visit the car at the railroad station. There is a Bettendorf cylindrical tank car of 10,000 gallons capacity; a Rodger ballast car and a Hart convertible flat car.

as it is possible, this locomotive is intended to equal the accelerations obtained with the multiple-unit system. It is designed for 32,000 lbs. maximum drawbar pull; and in the tests conducted last week successfully demonstrated its high power In starting a nine-car train easily and quickly with no jerking or slipping of the drivers. The curves of speed, current and voltage accompanying the description show the uniform acceleration obtained; and the diagram, Fig. 2, shows the remarkable efficiency of the machine through all ranges of speed. No steam locomotive yet built can approach this machine in that respect.

### Victorian Railways.

For the first time in 15 years the railroads of Victoria, Australia, show this year a surplus of gross income over operating expenses and interest on State loans; and this showing is more remarkable because of the excessive deficit of $1,471,815 in 1902-03. The report for the year ending June 30, 1904, just received, shows a surplus of $2,500 over and above all charges, and in many other details indicates a strong and apparently successful effort on the part of the Railway Commissioners to operate the lines on a paying basis. It will be remembered that early in 1903 Mr. Thomas Tait, then Manager of Transportation on the Canadian Pacific, was appointed Chairman of the Victorian Railway Commissioners, a position carrying with it control of the operation of all of the railroads in the colony, which aggregate 3,381 miles. While the success of the first year's operation under Mr. Tait's management is not, of course, to be wholly attributed to methods which he has introduced, he is undoubtedly entitled to a large share of the credit as a personal achievement.

The operating conditions in Victoria are in many respects quite similar to those on American railroads. There are the same long stretches of single-track road carrying light traffic, both freight and passenger, heavy grain crops to be moved within a short time, and, in and around Melbourne, a fairly large suburban and industrial traffic to be served. The gage of lines owned by the Government is 5 ft. 3 in., with the exception of about 80 miles of 2-ft. 6-in. gage line, but the narrow gage lines are more than usually well adapted to heavy rolling stock. Naturally, the first work of the incoming Chairman and his associates was to make an inventory of the equipment and an inspection of the condition of the lines, and to follow this with a comprehensive scheme for an immediate reduction in expenses. Fifteen years of inefficient management had left the lines with extraordinary liabilities amounting to $3,851,483 in the shape of deferred repairs and renewals. With this discouraging prospect Mr. Tait set earnestly to work to apply his more progressive methods. During the first six months of the year the gross income was the smallest for five years, but during the last half, owing largely to an exceptionally heavy grain movement, following fine harvests, the gross income was the largest ever obtained, and for the whole year amounted to $16,640,602, being $340,237 more than for any previous year. At the same time operating expenses were reduced to 52.6 per cent. of gross receipts, the lowest since 1879, notwithstanding that the expenditures for maintenance of way and rolling stock were larger than in any of the preceding three years. A general increase of nearly 25 per cent. in the cost of fuel and supplies also worked against a reduction in operating expenses. The total ordinary working expenses for the year just closed were $8,753,943 as against $8,885,998, a decrease of $132,055. Net earnings, less amounts deducted for repayments and belated repairs, were $7,336,765, or 3.84 per cent. on the indebtedness of the railroads, the largest per cent. since 1899.

The report in dealing with traffic volume and density, reduces all statistics to a comparative basis of train-miles and hence the ton-mileage increase does not show. Including live stock, 3,439,203 tons of freight were carried with 2,887,917 train miles. This is an increase of 5,576 tons over the largest previous year's tonnage (1901-02) and a decrease of 1,380,274 train miles, showing the decided increases in train load accomplished. This was chiefly brought about by the methods introduced to load engines and cars up to their full capacity and preventing as far as possible the unnecessary movement of empty cars. Twenty new engines, four passenger cars and 200 steel freight trucks of 12 and 15 tons capacity were put into service during the year.

The Italian Ministry, which had till next June to decide whether it would renew contracts with corporations for working the railroads of the country (which are state property), or have them worked directly by the State, has at last decided for State operation, a plan for which was submitted a few months ago, in case this decision should be taken. The railroads at present are worked by three great companies, organized for the purpose, on contracts which were terminable June 30, 1905, on three years notice from either party. Both parties gave the requisite notice, and an investigation was made as to the best policy to pursue, the ministry apparently inclining to a new contract with the operating companies, if a favorable one could be secured. The decision in favor of direct operation by the State is therefore somewhat unexpected, the more so because it was part of the program of the party opposed to the Ministry, which has just been defeated at the elections for Parliament. The Ministry evidently had difficulty in deciding, and announces that it believes that "on the whole" the change will be advantageous. The operation by the companies has been bitterly complained of; the public has been dissatisfied; the employees have fairly revolted; the State has received substantially no direct return on its immense investment, and the companies, we see, were unwilling to continue under the old contracts. The fact is that it is extremely difficult to work the Italian railroads satisfactorily, the conformation of the country, the nature of its products, and the economic condition of the people all making the transportation problem different from that of the countries further north. With this change the railroads of the continent of Europe east of France become to an overwhelming extent State systems, a large part of the Austrian and less than a third of the Russian lines being worked by corporations, and some others which make but a small part of the total mileage.

Major J. G. Pangborn, Chief of the Baltimore & Ohio Railroad Company's great historical exhibit in the Transportation building at the World's Fair, is doing what he can to interest railroad companies in the establishment of a permanent railroad museum, of which this exhibit would form the nucleus. We understand that he has already communicated with a number of companies and has met with a fair degree of success. It is understood that the city of Philadelphia has offered the use of an existing structure which Major Pangborn thinks admirably adapted to meet the requirements of the project. When these locomotives and models were exhibited at Chicago they occupied 30,000 sq. ft. At St. Louis the exhibit occupies 60,000 sq. ft.; and the building now offered at Philadelphia affords a clear floor space of 120,000 sq. ft. This building has track facilities and power connections, is well lighted and is in a central location near the Schuylkill river. It is hoped that the leading railroads and allied interests will assure the maintenance of an exhibit in this building until an endowment can be secured and permanent arrangements made. The completion of an exhibit at Philadelphia before next May, when the International Railway Congress will meet in Washington is, of course, much to be desired. Nowhere in the world, except on paper, is there such a rich collection of historical material concerning locomotives and tracks as this one, not even in Kensington museum; and its preservation and adequate care may almost be called a public duty.

### Union Pacific.

The rehabilitation of the Union Pacific to its present condition of extraordinary prosperity is one of the most brilliant achievements in the railroad world. Less than eight years ago the Union Pacific was contemptuously referred to as two streaks of rust. Today it is one of the very strongest roads on the continent.

Last year the company earned 10.4 per cent. on its common stock; this year it earned 10.6 per cent. This year, therefore, it was able to set aside $3,500,000 for betterments and extraordinary expense as against $1,500,000 last year. The average mileage operated decreased 410 miles, or 7.11 per cent. This was due to the sale to the San Pedro, Los Angeles & Salt Lake Railroad, of certain lines which would naturally form part of that new system. This road, the San Pedro, Los Angeles & Salt Lake, is under construction from Salt Lake City to Los Angeles. The Union Pacific has taken a one-half interest in the enterprise. The entire mileage turned over to the new company was 512 miles, 17 locomotives, 13 passenger cars and 209 freight cars going with it. The balance sheet shows that the Union Pacific realized on this sale something over $7,000,000.

Extensive new construction work was in progress during the year. The completed new mileage aggregates 271 miles. The betterments were continued on a large scale. Considerable additions were made to the equipment. The number of locomotives was increased by 32 and the freight cars by nearly 1,000. The road does not pay for its new equipment by car trusts. The report covers the operation of the Union Pacific, Oregon Short Line and the Oregon Railroad & Navigation Company, a total of 5,137 miles of road.

The balance sheet is as follows:

| | | |
|---|---|---|
| Cost of road and equip. | $353,788,807 | |
| Stocks and bonds | 139,927,571 | |
| Trust funds | 236,673 | |
| | | $493,953,049 |
| Current assets— | | |
| Agents and conductors | $562,526 | |
| Cash | 3,524,257 | |
| Individuals and companies | 1,486,801 | |
| Material and supplies | 4,245,932 | |
| Traffic balances | 350,898 | |
| U. S. government transfer | 805,905 | |
| Loans to Southern Pacific | 20,460,927 | |
| Bills receivable | 884,655 | |
| | | $32,521,905 |
| Deferred assets— | | |
| Advances for construction and acquisition of new lines | $4,357,276 | |
| Payments for S. P., L. A. & S. L. | 14,960,000 | |
| Ocean steamships | 5,055,310 | |
| Rolling stock | 3,181,227 | |
| Due from proprietary cos | 331,222 | |
| | | $27,885,036 |
| Land and town lots | | 2,352,651 |
| | | $556,712,644 |

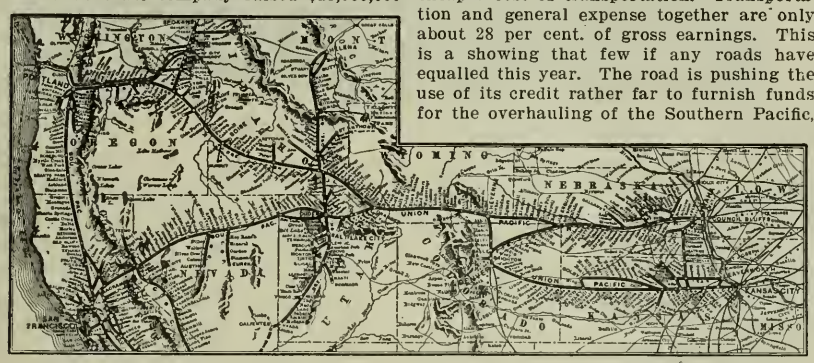
| | | |
|---|---|---|
| Liabilities— | | |
| Common stock | $108,770,900 | |
| Preferred stock | 99,558,900 | |
| Auxiliary companies stock | 44,871 | |
| Funded debt | 279,741,500 | |
| | | $488,116,170 |
| Current liabilities— | | |
| Floating debt | $23,128,000 | |
| Sundry accrued charges | 11,922,562 | |
| | | $35,050,562 |
| Deferred liabilities | | 1,589,837 |
| Reserve funds | | 5,950,391 |
| Profit and loss | | 26,005,681 |
| | | $556,712,644 |

We have given the balance sheet in full because Union Pacific's credit has been freely used in financing the needs of Southern Pacific, and Pacific Mail and the Los Angeles road. Union Pacific now has a floating debt of $23,000,000 if we include the $10,000,000 of short term notes due in February, 1905.

The financing during the year was as below:

| | |
|---|---|
| *Debit:* | |
| Decrease of assets— | |
| Cost of road | $5,780,981 |
| Contingent assets | 964,708 |
| Increase of liabilities— | |
| Preferred stock | 7,000 |
| Funded debt | 469,500 |
| Notes | 10,000,000 |
| Deferred liabilities | 622,642 |
| Contingent liabilities | 1,515,089 |
| Profit and loss | 4,873,442 |
| | $24,233,362 |
| *Credit:* | |
| Increase of assets— | |
| Stocks and bonds | $31,355 |
| Trust funds | 112,447 |
| Current assets | 7,096,542 |
| Deferred assets | 15,829,244 |
| Current liabilities | 1,163,774 |
| | $24,233,362 |

In short by notes and by increasing the funded debt the company raised $15,000,000 from the sale of lines to the Los Angeles road $6,000,000 more, and from surplus nearly $5,000,000. Some $16,000,000 went into deferred assets, of which nearly the whole amount was to the Los Angeles road aud $7,000,000 went into current assets, most of which represents advances to Southern Pacific and about $1,500,000 being cash.




Union Pacific, Oregon Short Line and Oregon Railroad & Navigation Co.

*The lines west of Ogden and south of Portland are not treated of in the report. The line south of Salt Lake City has been sold to the San Pedro, Los Angeles & Salt Lake.*

The entire capital and betterment expenditures for the year were a little over $4,000,000. But if we add the amounts advanced to other companies and spent by them, we have a total of such expenditures of about $20,000,000.

The betterment work was largely change of line, reduction of grade, ballasting and replacement of wooden bridges with steel. About three miles of such bridge work was done. The income account was:

| | 1904. | 1903. |
|---|---|---|
| Gross earnings | $55,279,230 | $51,075,188 |
| Expenses and taxes | 30,497,442 | 28,747,215 |
| Net earnings | $24,781,788 | $22,327,972 |
| Other income | 4,266,843 | 4,625,121 |
| All income | $29,048,631 | $26,953,094 |
| Charges | 12,451,539 | 11,676,452 |
| Surplus | $16,597,092 | $15,276,642 |
| Dividends | 8,333,636 | 8,333,168 |
| Balance | $8,263,456 | $6,943,474 |
| Special appropriation | 3,550,000 | 2,000,000 |
| Balance | $4,713,456 | $4,943,474 |

Gross earnings increased about 8 per cent., while expenses increased but 6 per cent. The decrease in "other income" was due to suspension of dividends by the Northern Securities Co. by order of the court. But because of the interest on the heavy advances made during the year to subsidiary lines the loss to "other income" from suspended dividends was nearly all made good. The increase of gross earnings was made up of an increase of $1,000,000 in passenger and $4,000,000 in freight. Both the passenger and freight business increased about 10 per cent. There was practically no change in the average ton-mile receipt.

The showing made in expenses is very reassuring. With $5,000,000 increase in gross earnings there was but $457,000 increase in conducting transportation expense. This amounted to an increase of but 3.4 per cent. Maintenance was most liberal as indicated by the next table:

| | 1904. | 1903. |
|---|---|---|
| Total maintenance | $12,608,792 | $11,032,769 |
| Maintenance: | | |
| Of way per mile of main and second track | 1,192 | 941 |
| Of locomotives, per loco. | 3,565 | 3,590 |
| Of pass. trn. cars, pr car | 813 | 728 |
| Frt. train cars, per car. | 75 | 70 |
| Miles new 80-lb. steel rails | 220 | 195 |
| Total number cross-ties | 2,300,000 | 1,707,000 |
| Same reduced to trk-miles. | 851 | 608 |

The train load this year reached 451 tons as compared with 412 last year, and 288 in 1898. The year has been one of vigorous growth, the enormous expenditures for betterments having reached fruition in the cheaper cost of transportation. Transportation and general expense together are only about 28 per cent. of gross earnings. This is a showing that few if any roads have equalled this year. The road is pushing the use of its credit rather far to furnish funds for the overhauling of the Southern Pacific, for the two new steamers for Pacific Mail, and the construction of the Los Angeles road; but one is forced to admire the boldness of a policy in which ten-million-dollar items are almost an everyday occurrence.

## NEW PUBLICATIONS.

*Poor's Manual of Railroads.* Thirty-seventh Annual Number. Poor's Railroad Manual Company, 68 William street, New York.

This indispensable hand-book is so well known to our readers that we need make no further announcement than to say that the volume for the present year is now ready. As everybody knows, it is the only available handy and complete history of the railroads of the United States, Canada and Mexico, and in addition it has a great mass of information about street railroads and industrial corporations. Like the statistics published by the Interstate Commerce Commission, it always seems a long time coming, but no one has yet found any practicable way of more quickly compiling such a mass of detailed information and doing it with the necessary accuracy. Unlike the government statistics, Poor's gives a great mass of details, concerning each important road. The government does not even attempt this. Moreover, such a compilation is hardly to be considered as within the functions of a government office, because of the necessity for the exercise of much discretion on the part of the editor in omitting, condensing and explaining; and in this he must feel at liberty to exercise a pretty free judgment. On the one hand he must leave out a great mass of material which would overload his book, while on the other hand he must take care to give his readers the essential facts which they are looking for. Poor's not only keeps up its reputation of a quarter century as the best example of wise condensation and compact statement, but shows improvements year by year. The principal totals and averages from the present issue were given in the *Railroad Gazette* of Nov. 4, p. 528.

*Cements, Mortars and Concretes.* By Myron S. Falk, Instructor in Civil Engineering, Columbia University. New York: M. C. Clark. 1904. Cloth, 170 pages. Price $2.50.

This book treats only of the physical properties of cement and cement mixtures, with particular reference to those properties which most concern engineering calculations. Much of the data is compiled from outside sources, but where the necessary data has been missing the author in many cases has supplied data of his own based upon tests made for that particular purpose. The scope of the work can be divided into four general headings; physical properties, elastic properties, flexural properties and shearing resistance. One of the most interesting and timely sections is that which treats of the effect of freezing on cement mixtures. The author quotes the results of a number of tests, and in summing up the experiments says that no damage results if the concrete is frozen once only and then thawed out. An appendix to the work contains the report of uniform tests of cement by the special committee of the American Society of Civil Engineers. In addition to this, one chapter is devoted to a brief description of the ordinary commercial tests to which cement is usually subjected.

## TRADE CATALOGUES.

*The Allis-Chalmers Company*, Milwaukee, Wis., is distributing an illustrated booklet bearing the title, "The Powers of the Subway." It gives some interesting comparisons of the power in the subway as compared to other great power equipments. A description of the Allis-Chalmers engines used in the subway power plant is given. There are nine of these, each having a capacity of 12,000 h.p. Interior views of the subway, the subway station, the cars and an illustration of the viaduct at 129th street are also shown.

*The American Blower Company*, Detroit, Mich., has issued Sectional Catalogue No. 166, relating to dry kilns for timber products. It states briefly the theory of lumber drying and then describes in detail the "A B C" moist-air dry kiln and method of operation; the "A B C" blower dry kiln; "A B C" hot-blast apparatus; and "A B C" apartment moist air kilns. Dry kiln appurtenances are also described and illustrated and a large number of views are shown of installations of "A B C" kilns.

*The Watson-Stillman Co.*, New York, sends a folder descriptive of a new liquid for use in hydraulic jacks. It is called "Jackohol," and it is claimed that it is an anti-freezing,

non-corrosive and lubricating compound, which will not thicken in freezing weather or cause the valves to clog. It is about 50 per cent. cheaper than the standard formula, which is generally used, and the company guarantee that by its use the cost of jack maintenance will be reduced.

*The Ingersoll-Sergeant Drill Company*, New York, sends a pamphlet bearing the title, "Driving the New York Subway." It contains some interesting data and illustrations in regard to the subway in general. This is followed by descriptions and illustrations of work done in the subway by the Ingersoll-Sergeant tools and machines, as well as of machines which are now in use, such as ticket cancellers, air compressors, etc.

*The Otto Gas Engine Works*, Chicago, issues Bulletin No. 1, relative to "useful uses of gasoline." The applications described and illustrated include high-pressure sand-blasting, pneumatic tool cars for field work, railroad draw-bridges, air compressor plants and locomotive turn-tables. The book also shows a view of a 12-in. Otto stand-pipe with flexible spout. The bulletin is a 15-page pamphlet with good, clear engravings and printing.

*Joseph Dixon Crucible Company*, Jersey City, is distributing its November issue of "Graphite." It contains a number of interesting articles on lubrication, including hints on the care of Corliss valves. The company also sends a pamphlet with the title "Graphite for the Motor," which describes the benefits derived from the use of lubricating graphite on motors, together with descriptions of various graphite lubricants made by the company.

*The Edward Hines Lumber Company*, Chicago, is distributing copies of XXth Century Interest Tables. These tables are computed for ten different rates ranging from 2 to 7 per cent., and show the interest on any amount from $1 to $10,000. It is divided into five sections, and gives a greater variety of tables than most compilations of this kind. Section 5 contains a short compilation of condensed business laws.

*The Lehigh Valley Railroad Company* issues a map of New York City, which shows all street car, elevated railroad and subway lines. It also gives complete information in reference to the location of hotels, theatres, etc.

## Test of the New York Central Electric Locomotive.

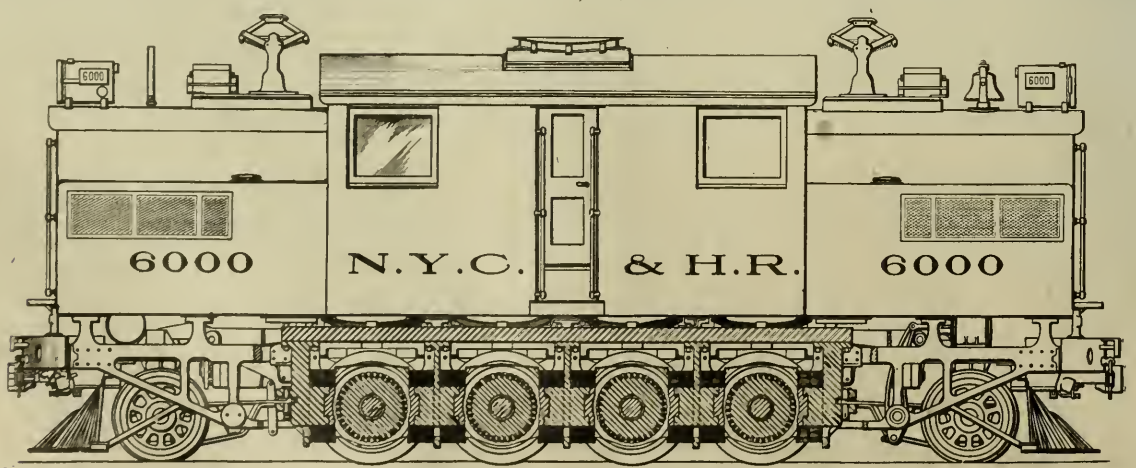
The first official test of the experimental electric locomotive built by the General Electric Company and the American Locomotive Company for the New York Central was held on the four-mile stretch of experimental track which has been equipped with third-rail at Hoffman's Ferry, three miles west of Schenectady on the main line, on Saturday, November 12. A party of distinguished and representative railroad officers and engineers from all parts of the United States were present as the guests of Mr. W. J. Wilgus, Fifth Vice-President of the New York Central, and several runs were made in the morning with the electric locomotive hauling trains of from three to nine cars. In the afternoon some further tests were made for the benefit of a number of representatives of the technical press who were present as guests of the American Locomotive Company and of the General Electric Company.

The occasion marks a new era in the development of transportation facilities in this country. Although the Baltimore & Ohio has for a number of years been hauling its trains through the tunnel at Baltimore with electric locomotives the New York Central's electrification scheme is the first radical change on the part of an existing steam road to electric operation for comparatively long distances. The plans of the New York Central have been briefly described in the *Railroad Gazette* from time to time since their first inception, and it is not necessary now to more than briefly touch upon some of the essential features of the operation of its trains by electricity as they have been developed within the last year.

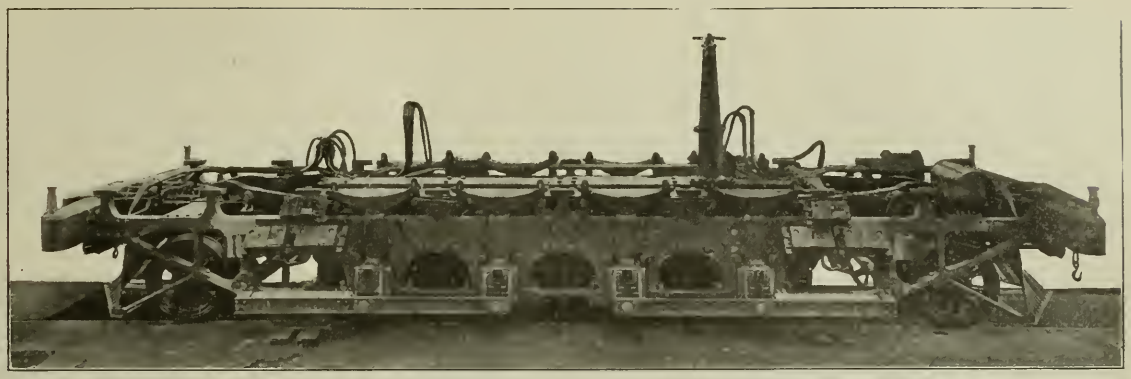
In the *Railroad Gazette*, June 3, of this year, a preliminary description of the electric locomotives to be used for hauling the through trains between Grand Central Station and Croton, 34 miles out on the Hudson division, and White Plains, 24 miles out on the Harlem division, was given. The experimental locomotive, as built, conforms closely to the weights and sizes given in this preliminary description, but in its general appearance and the arrangement of apparatus there have been a number of decided changes. The principal dimensions and data of the completed locomotive are given again here. From 30 to 50 of these locomotives will be required for hauling the company's through passenger trains. These trains vary in weight from 250 tons to 875 tons and the schedule calls for maximum speeds of from 60 to 70 miles an hour. For trains exceeding 450 tons in weight, two or more of these locomotives can be coupled together and operated from the cab of the leading locomotive as a single unit, since they are equipped with the Sprague-General Electric system of multiple unit control.

The distinguishing features of the design in which it differs from all other electric locomotives previously built are the absence of all gearing and a complete system of

Electric Locomotive Ready for Test.




Side Elevation of Electric Locomotive and Longitudinal Section through Motors.



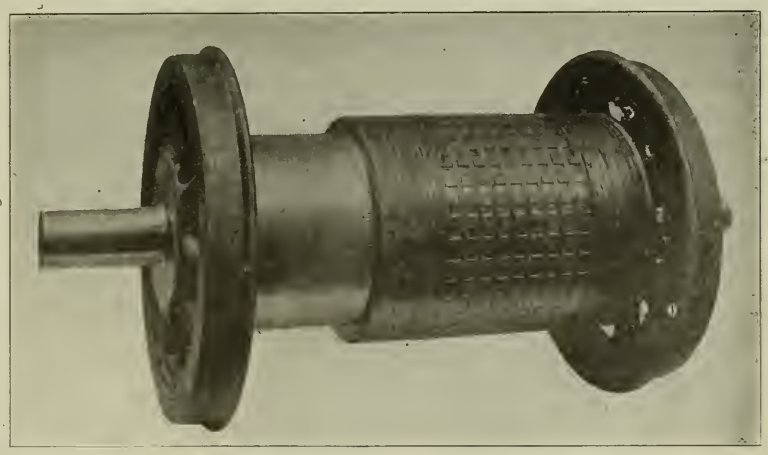
Frame and Motors of Electric Locomotive Assembled.

spring suspension and equalization throughout all of the driving and truck wheels. The armatures are mounted directly upon the axles and the field poles are integral parts of the frame. Other gearless electric locomotives have been built, but in these the armatures have been mounted on quills and supported with a spring suspension from the driving axles; these complications are dispensed with in this design. When repairs are required to the wheels or motor the axle and its armature can be dropped from between the poles in the same way as an ordinary pair of wheels. Because of the high speeds required it was essential that a perfect system of equalized spring resistance should be introduced between the wheels and frame of the locomotive. All of the four pairs of driving wheels are equalized by suspending the main frame and the superstructure from a system of half-elliptic springs and equalizing levers connected together over the tops of the pedestals. The pony trucks at each end are of the radial type similar to the standard construction used for steam locomotives on the New York Central. These are pivoted by means of radius bars to the underframe of the main truck and the inner ends of these radius bars are connected to the equalizing system on each side. The equalizing system is cross-connected so as to equalize the load under all conditions and to furnish at least three points of support necessary for perfect equilibrium. The frame of the locomotive immediately over the pony trucks is supported by means of suitable links, so that the trucks are free to swing about their centers and are self-centering on straight track.

PRINCIPAL DIMENSIONS OF ELECTRIC LOCOMOTIVE.

| | |
|---|---|
| Number of driving wheels | 8 |
| Number of pony trucks | 2 |
| Total weight of locomotive, tons | 95 |
| Weight on drivers, tons | 69 |
| Rigid wheel base, ft | 13 |
| Total wheel base, ft | 27 |
| Diameter of driving wheels, ins | 44 |
| Nominal horse-power rating | 2,200 |
| Maximum horse-power rating | 3,000 |
| Maximum starting drawbar pull, lbs | 32,000 |
| Voltage of current supplied | 600 |
| Maximum full load current, amp | 4,300 |
| Number of motors | 4 |
| Rating of each motor, h. p | 550 |
| Number of third-rail shoes | 4 |
| Number of overhead collectors | 2 |

The superstructure of the locomotive is clearly shown in one of the accompanying illustrations. It is entirely separate from the frame and is supported on the frame by lugs cast on the top bar. It is made of sheet steel throughout and contains all of the auxiliary electric and control apparatus, air compressor, sander boxes, etc. A rectangular cab over the center of the locomotive is built out to the maximum clearances both as to width and height. The control apparatus, air-brake valves and whistle cords are arranged in duplicate at diagonally opposite corners of the cab, so that the locomotive may be run in either direction without turning. A seat for the motorman is provided along the side of the cab in the corner, and convenient to his left-hand is the handle of the controller. This moves in the arc of a circle very similar to the throttle handle on a steam locomotive, and, in fact, the entire arrangement of apparatus is very similar to that now in use, with the exception of the entire absence of the heavy and cumbersome reversing lever and quadrant. A small reversing handle on the controller box controls the direction of movement. The brake valve is mounted on the end wall of the cab and the whistle cord is within easy reach. A push button for operating the sanding device is also mounted on the side wall. Above the motorman's head on the end wall are mounted the direct reading ammeters and volt-meters, which are an essential part of the equipment. A central aisle runs through the entire cab and superstructure so that the locomotive may be entered from either end, and doors in the sides are also provided.



Motor Armature and Driving Wheels.

Third-Rail Collector Shoe.

The control apparatus, including the contactors, resistance and reversing switches, is mounted in the space at each end of the superstructure on either side of the central aisle. The resistance is placed next to the floor, which is open to provide for ample ventilation and cooling, and the other ap-

paratus is mounted above it. In the middle of the cab is mounted a two-cylinder motor-driven air compressor supplying air at 130 lbs. for the air-brake system, sanding device and whistle. This operates automatically and keeps the pressure in the main reservoir at all times above 120 lbs. The interior of the cab is painted green and the exterior is painted the standard New York Central colors of black and aluminum.

The experimental track which the General Electric Company has equipped west of Schenectady is at present four miles long, and an additional two miles is now under construction. The stretch selected is the northernmost of the four tracks of the main line at this point and it is practically level, with only two or three curves of large radius, so that it is suitable in every way for making the experiments which are to be conducted there this winter. The General Electric Company has built and installed a complete sub-station transformer equipment at about the center of the stretch of track and alternating current at 11,000 volts and 25 cycles is supplied from a Curtis turbo-generator, installed at the company's works at Schenectady. In the sub-station is a rotary converter, normally rated at 1,500 k.w., but capable of carrying 100 per cent. overload for some time. The alternating current is stepped down through oil transformers from 11,000 volts to 400 volts and delivered to the third rail from the rotary converter at 660 volts. No attempt has been made to build a special track for the experiments. The existing track, which is 85-lb. rail laid on gravel ballast, has been bonded at the joints and the only additional precautions taken to strengthen the fastenings have been to put in two clips on each rail which are bolted through the web and spiked down to the tie to prevent any possibility of the rails spreading. The third rail construction does not differ in any essential respect from other installations of a similar kind. Every fourth tie is extended out and carries an insulated support of the usual inverted cup type. The standard position of the third rail is 55½ in. out from the center line of the track and 3½ in. above the top of the track rail. There are a number of grade road crossings on the experimental stretch and at these points an overhead construction has been employed which will be experimented with in order to determine if it will be a satisfactory method of overcoming the difficulties of using the third rail at complicated switches and crossings in the yard. This consists of an inverted strip of tee iron supported from side poles with hangers, and this strip overlaps the broken ends of the third rail on each side of the crossing. The locomotive is provided with overhead contact collectors, one at each end, and these are operated by a pneumatic valve. A trip near the end of the third rail throws open the pneumatic valve as the locomotive passes and the overhead contactors are thrown up so that they come in contact with the overhead conductor before the third rail shoes leave the third rail. Similarly, the collector shoes pick up the current before the overhead contacts are broken, so that there is no sparking or break in the power current supply. At a number of places along the line short stretches of different kinds of third-rail protection have been built and other methods will be tried during the winter to determine the best method of protection not only against accidents to employees but interruption of the service due to snow and sleet. This feature is one of the most essential to be considered in the preliminary tests, because it is absolutely necessary that no delays occur in the yard at the Grand Central Station which can be in any way avoided.

The third rail shoe, shown in one of the accompanying illustrations, is of special design intended to be used with a top contact on the third rail, but also permitting a close fitting protecting strip over the rail. A supporting bar is bolted on the outside of the journal boxes of the driving wheels and the third rail shoes are attached to this bar, one at each end outside of the end driving wheels. Each shoe consists of two flat plates, free to move in the vertical arc of a circle, but held down on the rail by spiral springs wound on the pivot shafts. The main leads from the shoes run up outside of the frames to fuse boxes located outside of and just below the floor of the cab. These fuse boxes are open at one end and their position is such that in case the fuse burns out the flame blows down and away from the cab. Similar fuse boxes are provided for each of the overhead collector shoes and the fuses supplied to these boxes are intended to be the weakest point in the electric apparatus. They are easily accessible and there is no danger in case one of them blows out.

In the tests conducted on Saturday the most noticeable feature was the smooth riding qualities of the locomotive at high speeds. A nine-car train was started easily and without perceptible jar, and when running at speeds up to 60 miles an hour there was an entire absence of the nosing effect and longitudinal vibration throughout the train which is always present with steam locomotives having imperfect counterbalance and uneven rotative effort on the crank. The locomotive itself rode as smoothly as a heavy passenger car, and with the excep-

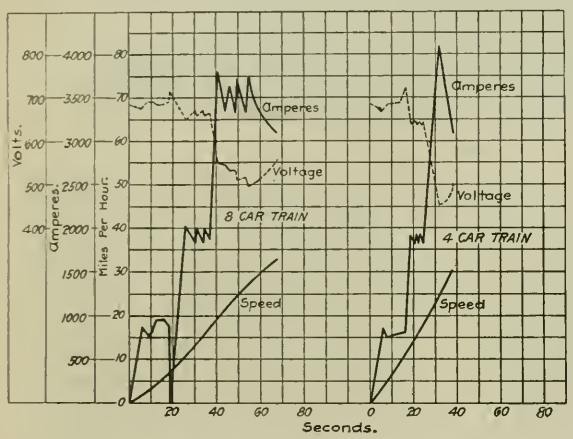



Fig. 1—Starting Test with 4-Car and 8-Car Trains.

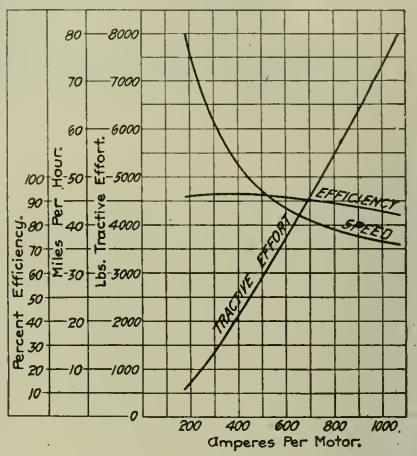



Fig. 2—Characteristic Curves for One Motor.

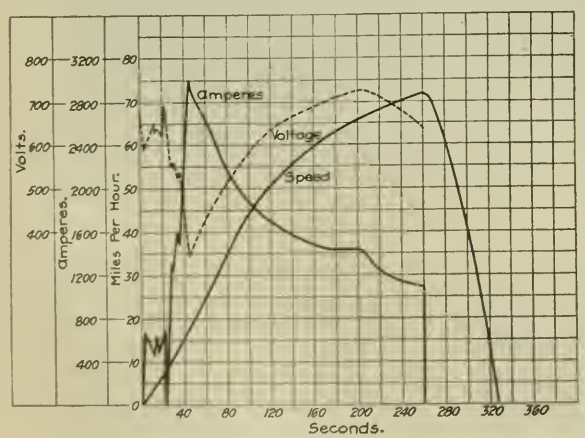



Fig. 3—Speed Run with 4-Car Train.
*Weight of train, 170 tons. Weight of locomotive, 95 tons.*

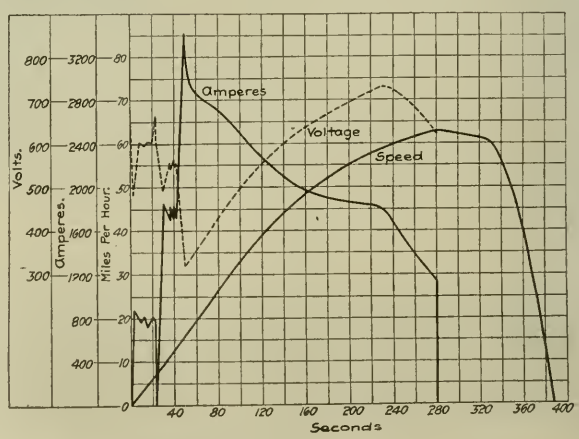



Fig. 4—Speed Run with 8-Car Train.
*Weight of train, 336 tons. Weight of locomotive, 95 tons.*

tion of the slight surging which takes place when the controller is moved from the series to the series-parallel position there was no jerking or slipping of the drivers. The rapid acceleration which was possible was also very noticeable. The engine has been designed to accelerate from rest to 30 miles an hour in 37½ seconds, or .8 of a mile when pulling a four-car train weighing 265 tons including the locomotive. This rate of acceleration will, it is expected, be improved upon as the locomotive passes the experimental stage. While the locomotive has been designed primarily to handle heavy trains at speeds of from 60 to 70 miles an hour and light trains at higher rates, the object has not been to obtain a locomotive that can reach abnormally high speeds for short stretches at infrequent intervals, but rather to obtain a high average speed without heating and to have sufficient power to accelerate with great rapidity. For the test of November 12 a special train, made up of seven cars weighing 478.5 tons, including the locomotive, was hauled at speeds exceeding 60 miles an hour, and even higher speeds were attained with a light train of three cars. The spectacular feature of the tests occurred when the locomotive with three cars behind it was started in a race with the fast mail No. 3 hauled by one of the company's standard Atlantic type engines. The electric locomotive drew away with a fine burst of speed and was more than half a mile ahead at the end of the four miles.

One problem which had to be taken into consideration in designing the locomotive was the heating of trains after the steam locomotives had been cut off. It is expected that sufficient heat will generally be retained in the trains delivered to the electric locomotives at the end of the steam run to carry the cars to the terminal without supplying additional heat. In order to meet contingencies, however, it is probable that a flash boiler of the automobile type will be installed in the operator's cab. This will occupy only a small amount of space, and as liquid fuel can be supplied there will be no dirt and but little extra weight to be carried.

Before any more locomotives of this type are turned out the experimental machine now ready will be subjected to every conceivable test to develop any defects of design, and should such defects show up the remainder of the locomotives included in the order originally placed will be modified to meet the new conditions encountered. There has probably never been such an extensive series of tests arranged and the New York Central is certain to have complete knowledge of the possibilities of its new mode of hauling trains before it is ready to put its electrification scheme into actual operation.

The first section of the Bagdad Railroad, 124 miles long, from Konia to Bugurles, was opened Oct. 25. This is an extension of an old railroad from the Bosporus opposite Constantinople southeastward 464 miles to Konia.

## Tidewater Terminal of the Western Maryland at Baltimore.

The recent completion of the Western Maryland Tidewater Railroad at Baltimore is another step in the plans of the Gould interests to secure a seaboard outlet for the Wabash System. For many years the freight and passenger service of the Western Maryland has been reached over the tracks of the Union Railroad, which is controlled by the Pennsylvania. Over $100,000 a year is paid for this service, so that the new tidewater line will not only save a large part of this expense, but will open up the present line of the Western Maryland to tidewater shipments. The work, which was begun in November, 1902, included the building of an extension from the main line of the Western Maryland at a point near Walbrook to tidewater, a distance of about six miles, and the erecton of large coal and freight piers along the river. The only part of the work remaining unfinished is the terminal yard at the water front where grading and track laying are still in progress. The new line runs along the western and southern borders of Baltimore through the Gwynns Falls valley to Port Covington, on Winans Cove, Patapsco river. It crosses under the Philadelphia, Baltimore & Washington, the main line of the Baltimore & Ohio, and several highway bridges, and crosses the South Baltimore branch of the Baltimore & Ohio at grade near Westport. A manual interlocking plant will be installed at this crossing.

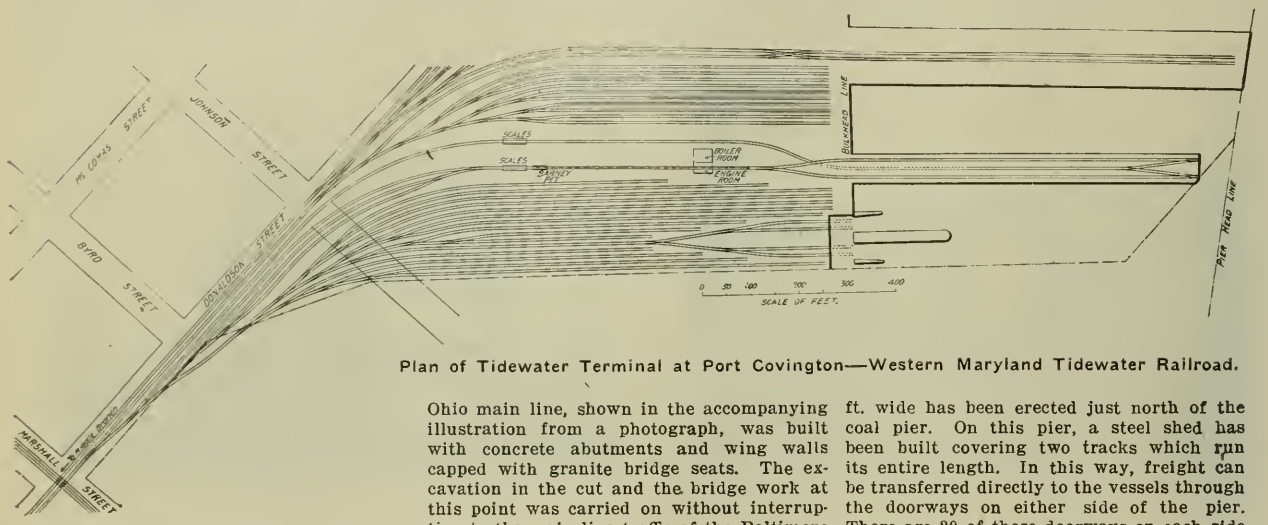
Bridge under Main Line of Baltimore & Ohio.

Draw-Bridge over Patapsco River.

New Freight Pier of Western Maryland Tidewater Railroad at Port Covington, Maryland.

Gwynns Falls is crossed twice; the first time by a 95-ft. steel girder bridge supported on concrete abutments, and the second time by a two-span girder bridge, each span being 55 ft. long. The line also crosses the Patapsco river on a draw bridge and long trestle approach at a point where the river is nearly half a mile wide. The draw span over the channel is nearly in the center of the river and the trestle approaches are each about 1,000 ft. long. There are also four short deck plate girder approach spans each 55 ft. long resting on six concrete piers built on pile foundations. The draw span is 225 ft. long with a clear channel 85 ft. wide on each side of the center pier and fender. The center pier is concrete 30 ft. in diameter, resting on piles driven in the mud bottom 60 ft. below mean low water. After the piles were driven they were cut off 27 ft. below low water with a circular saw on the end of a 40 ft. shaft mounted in the ways of a pile driver. A circular open caisson with a grillage floor 3 ft. thick was built and floated over the foundation. It was sunk to the tops of the piles and the concrete placed in open air. The steel work of the bridge was built and erected by the Pennsylvania Steel Co. and its total weight is about 730 tons, the swing span alone weighing about 500 tons.

The extension involved some heavy cutting at various points. The deepest cut was at a point near the House of Refuge, where solid rock was encountered. The cut at this point was 40 ft. deep and about 500 ft. long and necessitated the removal of a large amount of rock, clay and sand. The line is rock ballasted throughout, laid with 85-lb. rails and is double track, except two places where the second track has not yet been laid. The crossing under the Baltimore & Ohio main line, shown in the accompanying illustration from a photograph, was built with concrete abutments and wing walls capped with granite bridge seats. The excavation in the cut and the bridge work at this point was carried on without interruption to the main line traffic of the Baltimore & Ohio.

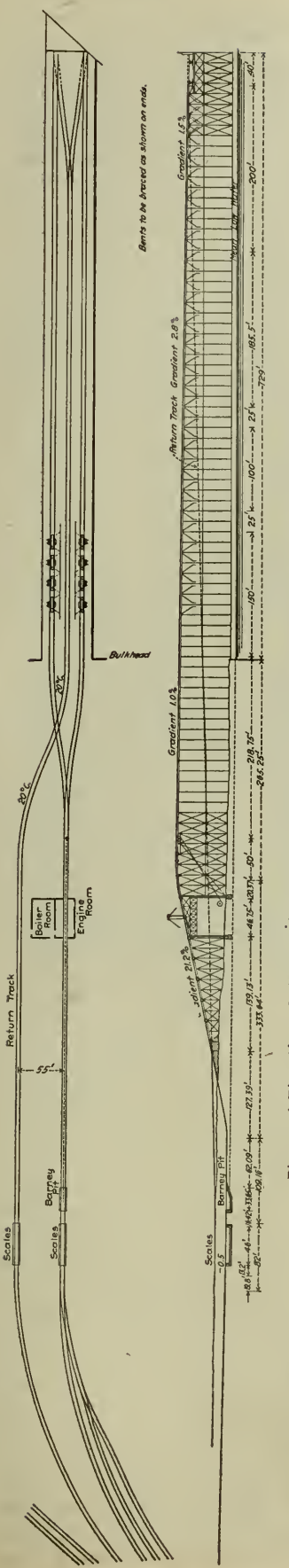



Plan of Tidewater Terminal at Port Covington—Western Maryland Tidewater Railroad.

At the new terminal at Port Covington, a large coal handling pier 750 ft. long and 60 ft. wide has been built. This pier is equipped with 20 coal chutes on each side, into which the cars will discharge the coal directly to the holds of the vessels lying alongside. The tracks on top of the pier are 70 ft. above mean low water. There are two outbound and two inbound tracks, the latter being in the middle. Loaded cars are hauled up the incline on the inshore end by a "barney," power being supplied by a hoisting engine placed directly under the incline. It is estimated that the cars can be carried up this incline and unloaded at the average rate of one a minute. At the extreme end of the pier are two turntables which will be used to transfer the cars as soon as they are emptied, from the outbound tracks to the inbound tracks, where they will run by gravity down to the yard. Two track scales, one for loaded cars and the other for empty cars, are placed just beyond the "barney" pit, so that the cars can be weighed without delay. A concrete and masonry engine house containing the hoisting engine has been built directly under the incline, as shown in the accompanying drawing. This arrangement saves a large amount of space. An export freight pier 850 ft. long and 120 ft. wide has been erected just north of the coal pier. On this pier, a steel shed has been built covering two tracks which run its entire length. In this way, freight can be transferred directly to the vessels through the doorways on either side of the pier. There are 20 of these doorways on each side closed by steel rolling doors, and vessels lying alongside can be loaded through any number of hatches at the same time. Two transfer bridges have recently been completed at the extreme south side of the yard, as shown in the accompanying drawing.

When work on the terminal yard was begun, it was found necessary to build a bulkhead along the entire water front by driving six rows of piles. These piles were cut off at low water and a crib of 12-in. timbers was built up to an elevation of 8 ft. above mean low water. Earth filling was dumped in behind the bulkhead to make an even grade in the yard. An area of about 16 acres was purchased for the terminal yard at the water front. This yard contains about 25 tracks not including the main line tracks leading to the coal and freight piers and to the transfer bridges. The river at Port Covington along the shore was originally from

New Coal Pier of Western Maryland Tidewater Railroad at Port Covington, Maryland.




Plan and Elevation of New Coal Pier at Port Covington—Western Maryland Tidewater Railroad.

8 to 15 ft. deep. This has been dredged to 30 ft., so that the largest vessels may now approach the piers. In addition, the company has also dredged a channel 30 ft. deep to the new channel in the middle of the river, recently opened by the government. This work involved the removal of about 1,000,000 cu. yds. of material. All the grading and masonry was done by the Degnon Contracting Co., of New York.

The work has been carried on under the supervision of the Consulting Engineer, Mr. Virgil G. Bogue, Mr. J. W. Galbreath, Principal Assistant Engineer of the Western Maryland, having immediate charge under Chief Engineer J. Q. Barlow. Most of the plans for bridges and piers were made by Mr. A. W. Buel.

## Paris Metropolitan Subway Lines.*

*By* L. BIETTE, *Chief Engineer.*

The Municipal Metropolitan Railway of Paris is to be double-tracked with a standard gage of 1.44 m.; the width of the cars is to be 2.40 m.; a clearance of 0.50 m. is to be provided between passing cars, and a clearance of 0.70 m. is required between cars and side walls, or parapets, at a height of at least 2 m. above the rails. The franchise was granted to the Compagnie Générale de Traction for a period of 35 years. This company was reorganized as a corporation whose only purpose should be the operation of the Metropolitan Railway, and by a State decree of April 19, 1899, was called the "Compagnie du Chemin de Fer Metropolitan de Paris."

The City of Paris takes charge of all structural work, that is all tunneling, excavations and viaducts necessary to complete the roadbed and to restore the streets utilized for the work to their former condition. In addition to this the city must construct the passenger platforms in the stations, but not the passageways giving access to them. All other expense, such as constructing tracks and electric transmission lines, plants and power stations, as well as purchasing the necessary sites, providing the stairways or elevators for the stations, and the rolling-stock, etc., is borne by the company to whom the franchise was granted.

The rates are 0.15 franc for a second-class and 0.25 franc for a first class ticket from one point on the railroad to another. A part of the gross earnings belongs to the City of Paris in the ratio of 0.05 franc for each second class and 0.10 franc for each first class ticket; this amount will increase by 0.001 franc for each 10,000,000 passengers till it reaches 0.055 and 0.105 franc, respectively, per ticket, in proportion as the number of passengers will increase at the same rate from 140,000,000 to 190,000,000 per year.

The eight lines laid out have a total length of about 77 km., exclusive of the spurs connecting them, and form three distinct systems. The first three lines form a system 42 km. long, the next three form a second system 20.7 km. long and the last two, a third system 14.5 km. in length. The first system must be completed in eight years at the most, this limit expiring March 30, 1906; the second and third systems must be completed ten years later. Consequently the entire Metropolitan System must be completed by March 30, 1916, at the latest, and it is now certain that this time will be considerably shortened.

The Metropolitan will be elevated for 10.45 per cent. of the total length of the Circular Line and the line from the Cours Vincennes to the Place d'Italie. All other lines will be underground. The maximum grade will be 4 per cent. The normal minimum curve will have a radius of 75 m. decreased occasionally to 50 m., but to as great an extent as possible the radius will be at least 100 m.

The lines already opened to traffic have been successful beyond all expectations. For instance, on Line No. 1 from the Porte de Vincennes to the Porte Maillot the number of passengers carried was:

52,096,285 in 1901;
63,021,067 in 1902;
67,993,147 in 1903.

The number of passengers reported per kilometer for this same line was: 4,925,752 in 1901; 5,958,700 in 1902, and 6,428,816 in 1903. This increase in traffic is greater than any increase obtained elsewhere to date.

The engineers in charge of the survey of the Paris Metropolitan System adopted a plan which may be defined by the following characteristics: absolutely no metallic tubings, except in crossing the bed of the Seine; adoption of a double-tracked masonry tunnel running as near the surface as possible. The advantages of this plan are: Doing away with the metallic casings effects an important economy in construction; the adoption of a single double-tracked tunnel facilitates operation; the track, being near the surface, affords easier access to the stations, lessens the inconvenience and expense caused by the use of elevators, and the danger to adjacent buildings during construction and inconvenience during operation.

Objections to the surface plan adopted in Paris may be raised on the ground that it requires altering underground conduits, sewers, water and gas mains, electric cables, etc., which are very numerous in the subsoil of the metropolitan highways. This objection cannot be denied, but it has always been possible to replace these conduits without serious trouble, and the expense incurred, although very heavy, is nothing compared to the increase in cost which the tube would have caused to no purpose; this cost, in any case, has no weight if the advantages of the adopted plan are considered.

The standard section of the double-tracked subway is formed by an elliptical arch having a width of 7.10 m. and a rise of 2.07 m. supported by two side walls, 2.91 m. high, finished inside by circular arcs; the section is completed by an invert having a rise of 0.22 m. The total inside height of the tunnel, consequently, is 5.20 m.; the rail is 4.50 m. from the intrados at the keystone, and 0.70 m. above the bottom of the invert. At the rail level the width is 6.60 m., and the thickness of the arch at the keystone is 0.55 m., at the side walls, 0.75 m. The invert, limited below by a horizontal surface, is 0.50 m. thick at the center. This cross-section is feasible only where the distance between the rail and the surface of the ground is not less than 6 m. Where it has not been possible to comply with this condition, a metallic roof, supported by masonry walls, has been built, so that there is always a minimum clearance of 3.50 m. above the rails.

The parts of the tunnels connecting the different lines are built with single track. The arch roof is 4.30 m. wide and rests on side walls 2.62 m. high; the surface of the floor is slightly curved with a rise of 0.075 m. The total inside height, consequently, is 4.695 m. at the axis, the rail being 4.00 m. from the intrados at the keystone and 0.695 m. above the floor. The thickness of the arch at the keystone is 0.50 m., the side walls, 0.60 m., and the floor, 0.55 m. at the lowest point.

On curves having a radius of less than 100 m. for a double track or 50 m. for a single track, the sections specified above would not be wide enough to give the clearance required by law between the cars and the side walls; in such places the width of the tunnel has been adequately increased. Where

*Extracts from a paper presented to Section C of the International Engineering Congress, St. Louis, Oct. 5, 1904.

Lines Nos. 4 and 8 cross the bed of the Seine, separate metallic tubes will be used. The details of these tubes have not yet been completely worked out, but they do not differ much from those of similar works already achieved in England and the United States.

The stations are arched wherever the clearance allows, that is, where there is at least 7 m. between the rail and the surface; they are metal-roofed when this height cannot be obtained. When the station is arched, the section is formed by two semi-ellipses having a common major axis 14.14 m. long and 1.50 m. above the rail. The first ellipse forms the arched roof and the second, the arched floor; the minor axis of the first ellipse is 3.70 m. and that of the second, 2.20 m., giving a total height for the station of 5.90 m. The depth of the arch at the keystone is 0.70 m., and the floor, 0.50 m.

The metal-roofed stations are 13.50 m. between walls. The metal roof supported by masonry side walls is 1.50 m. thick at the base and 1.15 m. thick under the beams; between these walls is a concave arched floor 0.50 m. thick. The rail is 4.70 m. below the lower flange of the beams and 0.70 m. above the lowest point of the floor. The roof beams are built beams with solid web, 1.02 m. deep and extend from one side wall to the other without support; they are connected by longitudinal beams parallel to the axis of the track which form springing for small brick arches. This structure supports directly the concrete foundation of the wood paving in the streets.

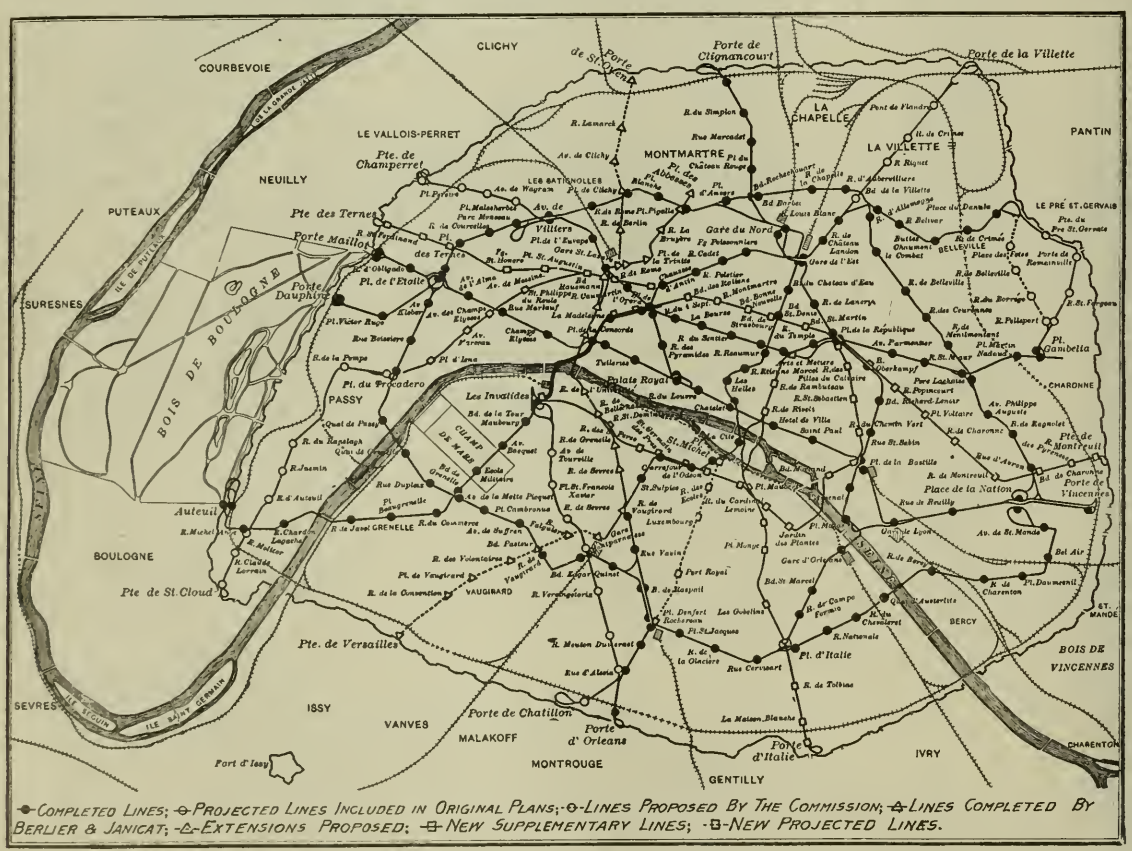
A standard station, whether arched or metal-roofed, has two side platforms 75 m. long and 4.10 m. wide; the level of these platforms is 0.25 m. under the floor of cars, supposed to be new and empty, and 0.85 m. above the rail. The stations are reached by staircases opening on the streets. These staircases with single, straight flights, and a width of from 3 m. to 3.50 m. in ordinary cases, lead into underground rooms where tickets are sold. From these rooms, passengers reach the nearest platform by another staircase 2.75 m. wide and the farthest platform is reached by a similar staircase after crossing the railroad tracks by means of a footbridge 3 m. wide. The lowest staircases generally pass out to the platforms through apertures in the front walls of the stations and in a few instances through passageways cut through the abutments.

In the elevated parts of the system, the tracks are supported by a metal viaduct formed by a series of separate bents of variable leugths, composed of two side beams supporting the floor system on their lower flanges. These bents are supported on cast-iron columns wherever it has seemed consistent with the strength of the works; where it has been necessary, on account of stability, to adopt masonry pillars, their size has been reduced to a minimum in order to interfere as little as possible with street traffic. This viaduct is designed so as not to interfere with existing streets. To accomplish this the length of the trusses has to conform at a number of points with local conditions; wherever these conditions do not exist a span of about 22 m. has been found to be best adapted to the various necessities of the construction. Larger spans had to be resorted to in crossing important streets or railroad tracks. For instance, the crossing of the Northern and Eastern Railroads by the Circular Line, on the right bank of the Seine, required three spans 75.25 m. long.

The side beams of the viaducts have N-shaped lattices, their lower chords being straight and their upper ones parabolic. Their average height is about one-tenth of the span, and they are either single or composed of two built beams, according to the distance between supports. The platform is formed of cross-beams; the track is generally ballasted and the ballast is supported by brick arches connecting the cross-beams. This design has been adopted for the purpose of reducing the vibration when the trains pass and reducing the resulting noise and tremors to a minimum. However, where the spans are longer than usual the ballasting of the track would increase greatly the dead weight and consequently the cost. The track is then laid directly on a platform formed of cross-beams connected by stringers covered with metallic plates.

In the elevated parts the rail is at least 6.36 m. above the surface of the streets; this distance leaves a clearance of 5.20 m. under the beams, which is sufficient to allow the passage of the highest loads circulating in Paris. The elevated stations are constructed on the same plan as the viaducts. Each station, with a total length of 75 m., is composed of five independent bents, including four rows of beams. The two inside solid webbed beams support both the floor system and also the station platforms which are 4.10 m. wide; the outside N-shaped latticed beams form the second support for the station platforms. An iron and glass roof covers the platforms for the convenience of passengers when the weather is bad. The elevated stations are reached by a staircase starting from the street and leading to an intermediate floor where the ticket offices are located; from this floor two side staircases reach the platforms at one of the ends of the station.

The masonry used in the Metropolitan System is made almost exclusively with cement mortar. Lime has been used only in exposed masonry, such as piers supporting the iron structure in the elevated parts of the system. In underground work, two kinds of masonry are used: sandstone masonry and




Map of Paris and Suburbs Showing Lines of the Metropolitan Underground.

concrete. The first is used for arches and the second for side walls and floors.

The sandstone used is a silicious, light, and porouus stone, which easily takes the mortar and is found around Paris, chiefly in ground of tertiary formation. The pebbles used for the concrete are found in great numbers in the alluvions of the Seine basin. The cement used is a slow-setting Portland cement or a slag cement. The Portland-cement mortars are mixed at the ratio of 300 kg. per cu. m. of sand when they are used for masonry and at the ratio of 400 kg. for the same volume of sand when used for concrete. The slag-cement mortars are proportioned at a ratio of 50 kg. more. The concrete is composed of 0.80 cu. m. of broken stone for 0.55 cu. m. of mortar.

Cut-stone masonry is used for exposed structures, such as great bridges on the Seine, supports for viaducts, works at points where the road changes from elevated to underground. Inside the stations all visible facings are covered uniformly with white tiles made of enameled ceramic sandstone, or of opalin or even sometimes of enameled bricks. All other works are coated only with cement; quick-setting Vassy cement for the arches, and Portland cement for side walls and floors. The viaducts and generally all metallic work such as bridges, roofs of tunnels or stations are made of soft rolled steel elongating 23 per cent. under a breaking load of 43 kg. per sq. mm. of section.

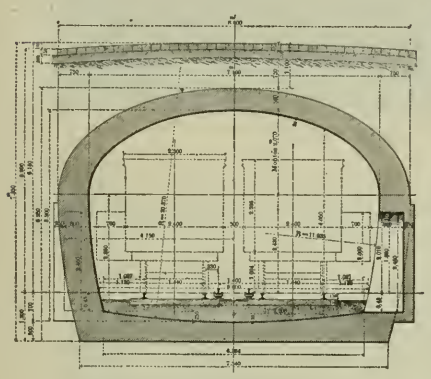
In driving the tunnels under the surface are made over the whole surface of the arches and to 0.50 m. below the springing. Cement mortar gaged at the ratio of 650 kg. of Portland cement per cu. m. of screened sand, is injected with the Greathead injector or a similar device. The usual pressure is from 2 to 3 kg.

The standard cross-section is of course reinforced in ground without any solidity or when the tunnel has to support exceptional loads, as when it passes under other galleries for instance.

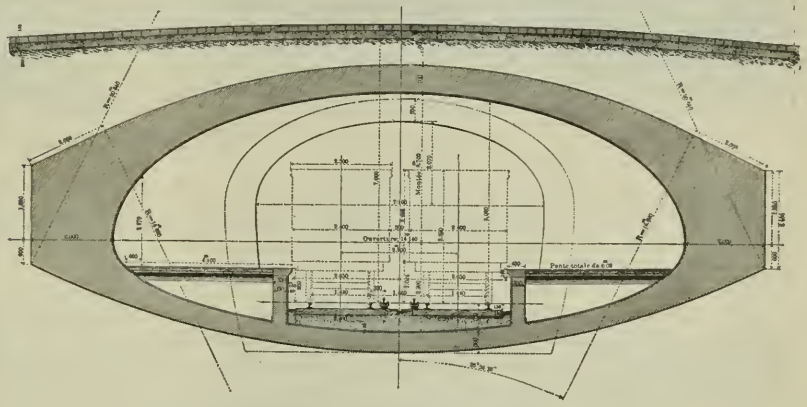
For quite a long distance, the tunnel runs under counter-alleys or wide gravel sidewalks planted with trees, so that during the rainy season or when the trees are watered troublesome infiltrations penetrate through the masonry if special precautions are not taken. The method adopted has been to dispose small circular conduits with a diameter varying from 0.06 to 0.07 m. and opening under the floor, carefully along the inside surface of arches and walls. The water drained into these conduits is absorbed in the adjacent sub-soil or is carried to drainage wells. In order to make these conduits in the arches, straw strands are imbedded in the masonry when building but not so deep as not to appear on the intrados. After taking down the centers, these strands are removed and replaced by rubber tubes; a coating of quick-setting cement mortar is then applied to the tubes and the conduits are made by removing the rubber tubes.

In the parts of the tunnel constructed entirely in water-bearing ground, the following process has given good results in keeping out the water. The masonry is constructed in a single ring along the whole development of side walls and floor. There are two layers of masonry separated by an inside cope, 0.030 m. thick, made of compact, tempered, well-rammed, cement mortar. The cement used is Portland cement gaged in proportions of 650 kg. per cu. m. of sand, or, quick-setting Porte-de-France cement gaged at 1,000 kg. per cu. m. of sand. The cope is made with the greatest care without any solution of continuity and each new section is carefully joined to the last one whose end is scraped and washed. As soon as the cope is finished on the surface of a ring, the second layer of masonry is begun, taking care not to injure the cope. Where Line No. 3 crosses under the St. Martin Canal at the Avenue de la Republique, the tunnel is laid entirely in aqueous ground for 76 m. and partially for 340 m.; it has been constructed as explained above, and the infiltrations do not exceed 550 liters per 24 hours which is equal to 0.0064 liter per second.

One of the most intricate problems to solve in the construction of the Metropolitan Railway has been the removal of the excavated material and the carrying in of materials of construction. If it is considered that when the bench is removed an average section produces from 800 to 1,000 cu. m. per 24 hours, it is easy to understand how difficult it was to remove such amount of earth by means of ordinary carts in the center of the heavy traffic of Paris. Methods more modern, more rapid and more economical have been sought. For instance in the central part of Line No. 1 running at a short distance from the Seine, the contractors built special galleries many hundreds of yards long in order to connect the tunnel with the Seine and thus allow the removal of the excavated material by boats. At other points the street car tracks connecting with the suburbs of Paris have been taken advantage of; spurs have been constructed from these tracks to the elevators in the working sites so as to allow the direct removal of excavated material without reloading. Even on Line No. 3 the earth coming from the central sections near the St. Lazare Station, the Opera and the Bourse, has been carried beyond Paris by means of a temporary spur specially constructed to connect with the Ouest Railroad.



Section of Tunnel.



Cross-Section Through Typical Station.

## Swiss Railroads.

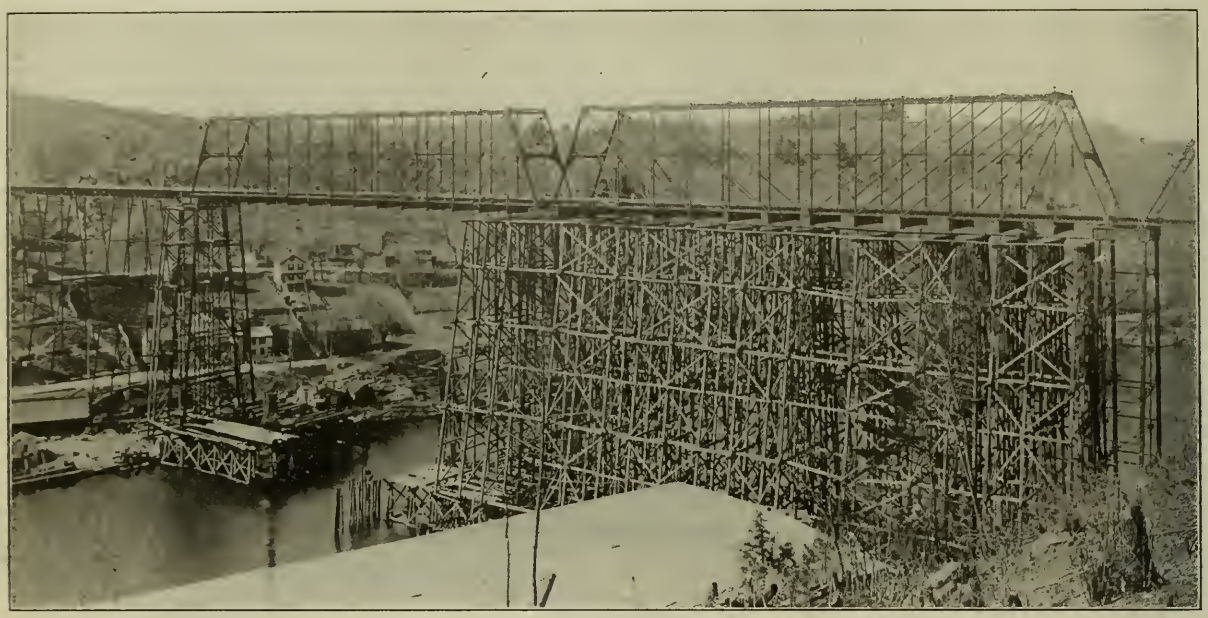
The executive council of the Swiss State Railroads has drawn up its estimates for the year 1905, and accompanied them with a warning that the authorities should be more conservative for the future. Unless there should be an unexpected increase of traffic, the expenditures (including interest on cost) are likely to be $400,000 more than the receipts next year, and provision already made for increasing wages will still further increase expenses in 1906. When the railroads were acquired by the State, the legislature provided for considerable improvements, and more liberal train service, some increase in the number of employees and a general increase in their pay and privileges, and at the same time some reductions in rates.

## The Simplon Tunnel.

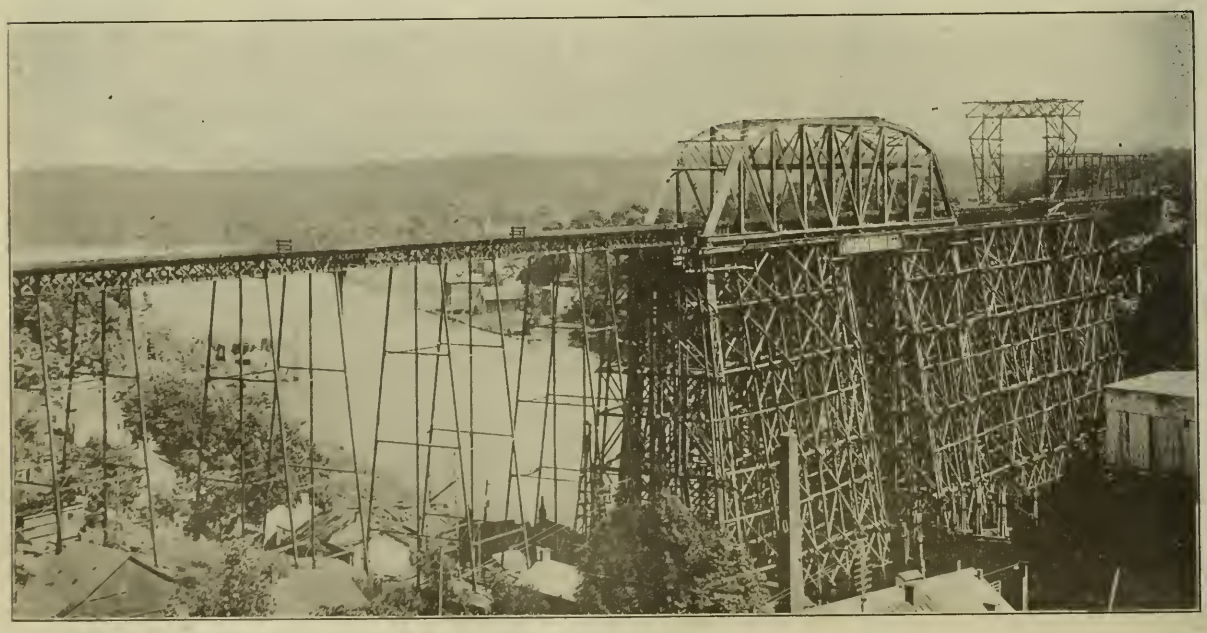
The unfortunate Simplon Tunnel, which, until the hot water spring was struck by the south heading Sept. 6, was to be open through by the middle of October, is now unlikely to be done before the end of this year, and possibly not till months later. It will be remembered that the north heading had advanced about half a mile beyond the midway summit when hot-water springs were struck, the difficulty of draining which up over the summit caused the abandonment of work on that face. Water-tight iron

gates were set up, which dammed the water at that place and made it possible to continue the work of enlarging the tunnel and revetting it with masonry where necessary up to that point, awaiting the excavation from the south, which was behind hand because of difficulties encountered at earlier stages of the work. The hot spring is formidable not on account of the quantity discharged, which is much less than some other springs which have been cut; but because it makes it too hot to work. The south heading was advanced only 81 ft. in September, leaving 798 ft. between it and the north face.

After Sept. 6 the work was almost exclusively in cutting a drainage channel to the side tunnel (which hereafter is to be excavated for a second track). In walling out the hot spring, and getting in order the cooling apparatus which alone will make it possible to work in rock which has a temperature of 109 deg. The rock is so broken up that it is necessary to arch the side tunnel at the bottom in many places near the present south face. When work was resumed on the south face of the main tunnel (which was to be done in October), machine drills could not be used until it had advanced some yards past the hot spring, and the operators with the hand drills have an exceedingly uncomfortable task, in spite of the streams of cold water forced in to keep down the temperature. If no more hot springs be encountered it will probably be possible to cut the main tunnel through by the end of this year; but the character of the strata at both faces is very unpromising—limestone, much fractured, which according to the geologists was not likely to be found at this depth.



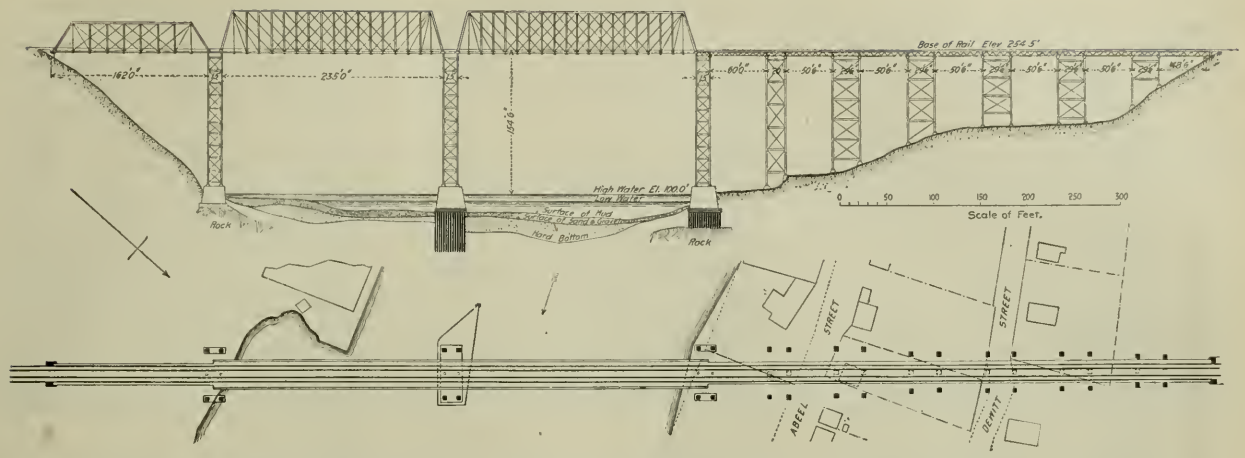
Old Rondout Viaduct Showing Falsework Partially Completed.



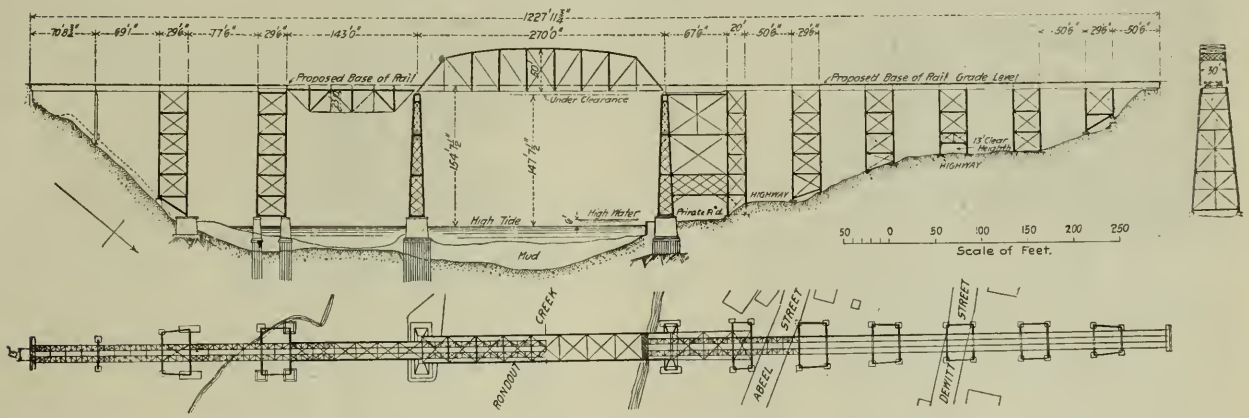
New Rondout Viaduct Showing Completed Falsework and Traveler.

### Renewing Bridges on the West Shore.

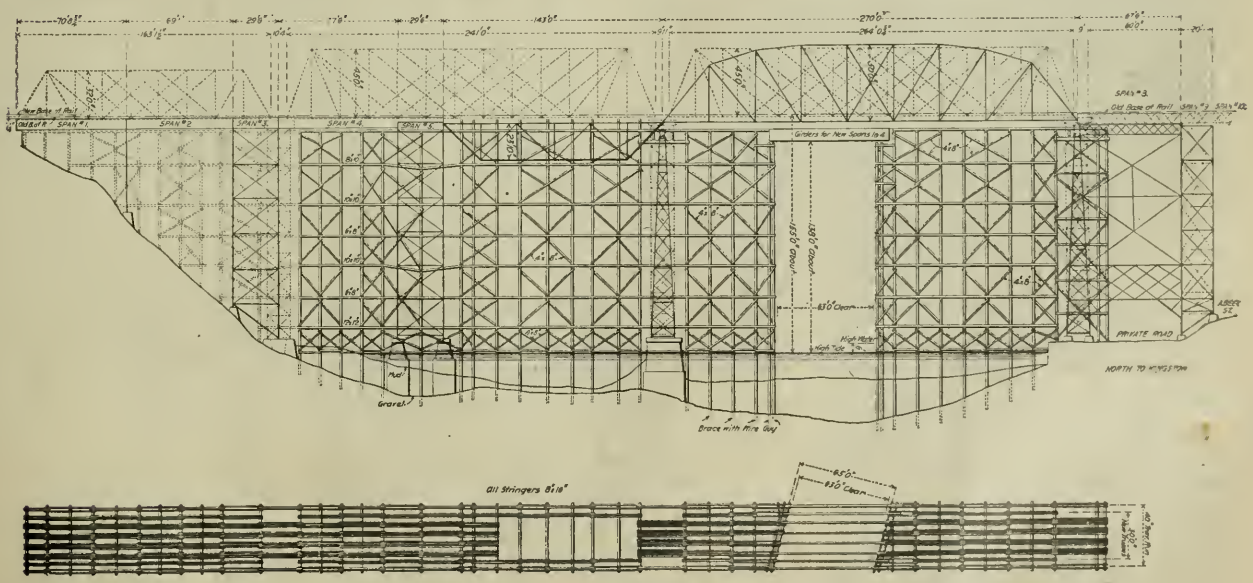
It has long been the aim of the New York Central to utilize the West Shore Railroad which it owns and operates, for hauling all of the heavy through freight between New York and Buffalo and to use its main line, which is four-tracked for most of the distance, for fast freight and passenger trains. The West Shore between Albany and Buffalo parallels the Erie Canal and the New York Central. It is a double-tracked road, but never since it was first built in the early eighties has it been up to the standard of a first class road. Some six years ago the New York Central began a systematic scheme of improvements designed to ultimately put this road in shape for handling heavy traffic. This work, which included laying heavy rails,




Plan and Side Elevation of Old Bridge over Rondout Creek, West Shore Railroad.




Plan and Elevation of New Bridge over Rondout Creek, West Shore Railroad.




Plan and Elevation of Falsework Used in Erecting the New Rondout Viaduct.

New Bridges on the West Shore Railroad.

*River Division, Weehawken to Ravena, Bridges over 75 Ft. in Length.*

| Bridge No. | Location. | No. of Spans. | No. of Tracks. | Type. | Total length of bridge. |
|---|---|---|---|---|---|
| 4 | Granton | 1 | 2 | T. P. G., F. B. & S. | 121 ft. 6 in. |
| 8 | Little Ferry | 1 | 2 | T. P. G., F. B. & S. draw | 102 ft. 8 in. |
| 17 | West Nyack | 1 | 2 | D. P. G. | 86 ft. |
| 64 | Cornwall | 1 | 2 | T. P. G., F. B. & S. | 87 " |
| 25 | West Haverstraw | 1 | 2 | D. P. G. | 84 " |
| 96 | Marlborough | 1 | 2 | T. P. G., F. B. & S. | 82 " |
| 141 | Kingston | 20 | 2 | Viaduct | 1,228 " |
| 152 | Mt. Marion | 5 | 2 | D. P. G. | 448 " |
| 172 | Catskill | 18 | 2 | D. P. G. & D. L., viaduct | 1,222 " |
| 185 | North Baltimore | 4 | 2 | D. P. G. | 221 " |

Smaller Bridges: 13 deck plate girders, 14 through plate girders, 15 I-beam and plate bridges.

*Mohawk Division, Ravena to Syracuse.*

| | | | | | |
|---|---|---|---|---|---|
| 197 | Bethlehem | 4 | 2 | D. P. G. & T. P. G. viaduct | 186 ft. |
| 199 | Bethlehem | 1 | 2 | T. R. T., F. B. & S. | 103 " |
| 213 | Fullers | 3 | 1 | D. R. T. & D. P. G. | 347 " |
| 337 | Harbor over Erie Canal | 1 | 2 | T. R. T., F. B. & S. | 172 " |
| 340 | Utica | 4 | 2 | T. P. G., S. F. on columns | 184 " |
| 346 | New York Mills | 2 | 2 | D. P. G. | 104 " |
| 356 | Clark's Mills | 2 | 2 | D. P. G. | 104 " |
| 404 | Canaserago | 2 | 2 | T. R. T. & S. F. & T. P. G., S. F. | 236 " |
| 412 | Chittenango | 2 | 2 | T. P. G., S. F. | 88 " |
| 372 | Vernon | 2 | 2 | T. P. G., S. F. | 90 " |
| 383 | Oneida | 2 | 2 | T. P. G., S. F. & D. P. G., S. F. | 114 " |

Smaller Bridges: 10 deck plate girders, 18 through plate girders, 6 I-beam and plate bridges.

*Western Division, Syracuse to Lyons.*

| | | | | | |
|---|---|---|---|---|---|
| 443 | Amboy | 3 | 2 | D. P. G. | 139 ft. |
| 453 | Jordan | 1 | 2 | T. R. T., F. B. & S. | 129 " |
| 454 | Jordan, over Erie Canal | 1 | 2 | T. P. G., F. B. & S. | 116 " |
| 457 | Weedsport, over Erie Canal | 1 | 2 | T. P. C. T., F. B. & S. | 207 " |
| 461 | Port Byron | 3 | 2 | T. P. G., F. B. & S. | 181 " |
| 470 | Clyde, over Erie Canal | 1 | 2 | T. R. T., F. B. & S. | 168 " |
| 471 | Clyde | 2 | 2 | T. P. G., F. B. & S. | 109 " |
| 473 | Clyde | 2 | 2 | T. P. G., F. B. & S. | 121 " |
| 474 | Clyde | 2 | 2 | T. P. G., F. B. & S. | 188 " |

Smaller Bridges: 4 deck plate girders, 3 through plate girders, 1 I-beam and plate bridge.

re-ballasting, and renewing bridges, has been going on steadily and is now nearly completed.

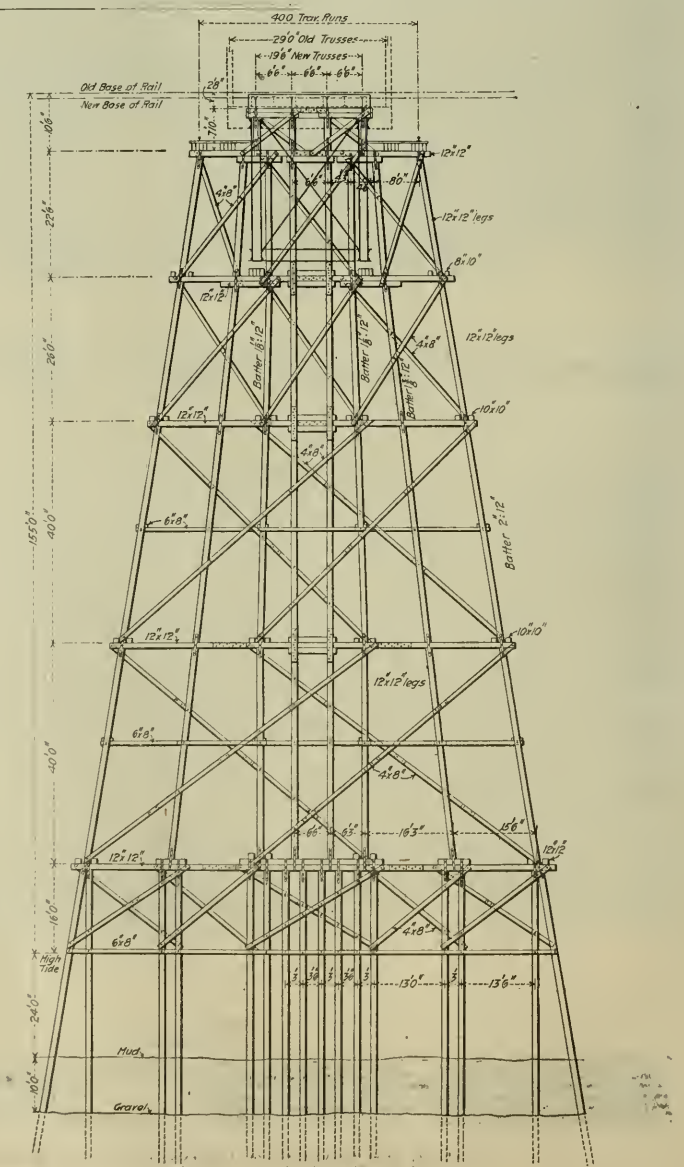
An interesting feature of this betterment policy was the renewal of nearly all of the bridges on the West Shore from Weehawken to Buffalo, which necessarily had to be done without interrupting the already heavy traffic. The greater part of this renewal work has now been completed. Thirty bridges of over 75 ft. in length have been renewed with new and modern steel structures and 84 smaller spans have also been renewed. The old bridges taken out were mostly built of iron, having been put in when the road was first built. In addition to this all of the remaining bridges have been thoroughly overhauled, repaired and strengthened. The accompanying table shows the location, type and span of the important bridge renewals on each division from Weehawken to Buffalo. About 9,000 tons of steel were required in all for the renewals on the River Division and as much more for new bridges between Ravena and Buffalo.

All of the new bridges have been built to conform to the standard specifications of the New York Central. In general the type of bridge selected was as follows: For spans up to 13 ft., solid rail floor; for spans up to 25 ft., rolled beams with cover plates or longitudinal trough floors; for spans from 25 ft. to 100 ft., plate girders; for spans from 100 ft. to 180 ft., riveted trusses; for spans of over 180 ft., pin connected trusses. The truss spans are usually of the sub-trussed Pratt type. For all bridges the standard assumed live load is two consolidation engines and tenders with a total wheel base of 104 ft., a total weight of 284 tons, and 40,000 lbs. on each driving axle, followed by a uniform load of 4,500 lbs. per lineal foot of track. An alternative loading also used is 60 tons equally distributed between two axles spaced 7 ft. apart followed by a uniform load of 4,500 lbs. per lineal foot of track beginning 5 ft. behind the rear axle.

The new bridges were all designed in the office of the Chief Engineer of the New York Central and were built by the American Bridge Company, and the Pennsylvania Steel Company. Some of the truss bridges and most of the plate girder bridges and short rolled beam spans were erected by the railroad company's own forces. All other spans were erected by the contractors.

The two most important bridge renewals made were the viaduct over Rondout creek, a mile south of Kingston on the River Division, and the Catskill viaduct at Catskill. The Rondout viaduct is the longest bridge on the line being 1,228 ft. long, and the Catskill viaduct, which is the next longest, is 1,222 ft. long. The old bridge at Rondout, built in 1882, consisted of three iron, Whipple, through truss spans at the south end, 162 ft., 235 ft. and 255 ft. long respectively, supported on iron latticed towers and seven deck latticed girders for the north approach, resting on light iron towers with short connecting girders over the tops of the towers. It was a light structure throughout, being designed only for loads of two 80½-ton consolidation engines followed by a moving load of 2,240 lbs. on each track. The level of the base of rail above high tide on the old bridge was 154 ft. 6 in. A sketch of the original structure is shown in one of the accompanying drawings.

The new bridge put in consists of three deck plate girder approach spans at the south end, one deck truss 143 ft. long, one through truss 270 ft. long over the channel, and seven deck plate girder approach spans at the north end. New steel towers were




Elevation of Typical Falsework Bent.

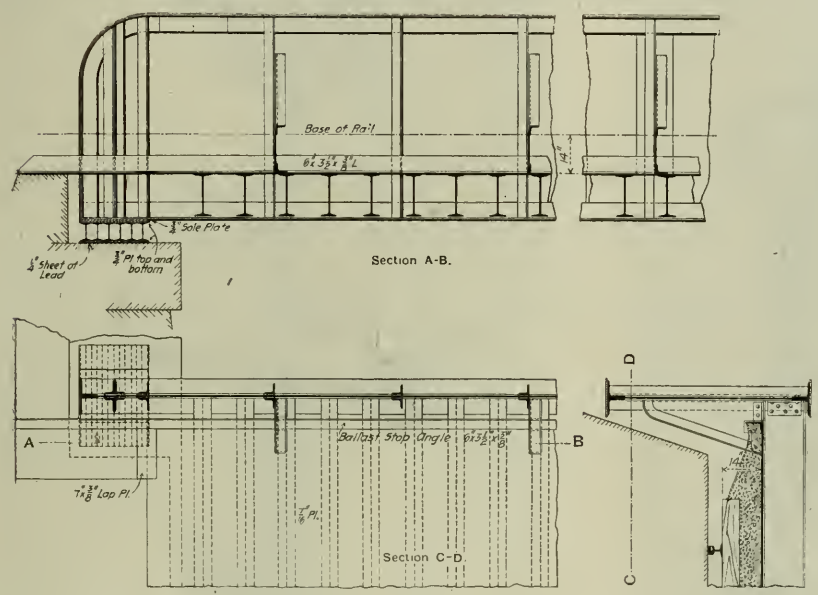
built to support the structure and the bridge as renewed will now carry the heaviest traffic on both tracks simultaneously at high speeds. A comparison of the accompanying drawings of the old bridge and the new bridge shows the changes in the substructure made necessary by the renewal. At the south end the old abutment was allowed to remain as before but a new coping course and back wall were put in. About halfway down the bank, two pier foundations were put in for the rocker bent supporting the plate girder approach spans, Nos. 1 and 2. The foundation piers for the old tower at the foot of the south bank were used for supporting the outer legs of the new tower and two new piers were built higher up the bank to support the in-shore legs. Tower 3 is entirely new and the four piers resting on piles were sunk before the tearing down of the old bridge had begun. The piers for all of the other towers are the original masonry with new coping courses. The towers under all of the approach spans consist of four legs battered 1 to 8 toward the center line of track but vertical in a longitudinal plane. They are 29 ft. 6 in. between bents and the tracks are carried over them on short plate girders. All of the towers are stiffened longitudinally and laterally with diagonal and cross-braces, and towers Nos. 5 and 6 are also connected together top and bottom with stiffening trusses.

After the new masonry was completed and before the dismantling of the old bridge was begun, falsework was built up from the ground and the bottom of the creek to support the track while the bridge was being renewed and to form a runway for the traveler used in erecting. This falsework consisted of 41 bents supported on piles and tied together with 4-in. x 8-in. diagonal braces and longitudinal struts. The two outside posts on each side of the bents were battered and the four middle posts were vertical. The bottom sill rested on the tops of the piles which were driven in pairs under each post and the number of stories in each bent was varied according to the rise of the bank. As far as possible all the braces, sills and caps were made of uniform sizes to save cost in getting out the timbers in the mill. A general plan and elevation of the falsework and an elevation of a typical bent under the deck span are shown in the drawings.

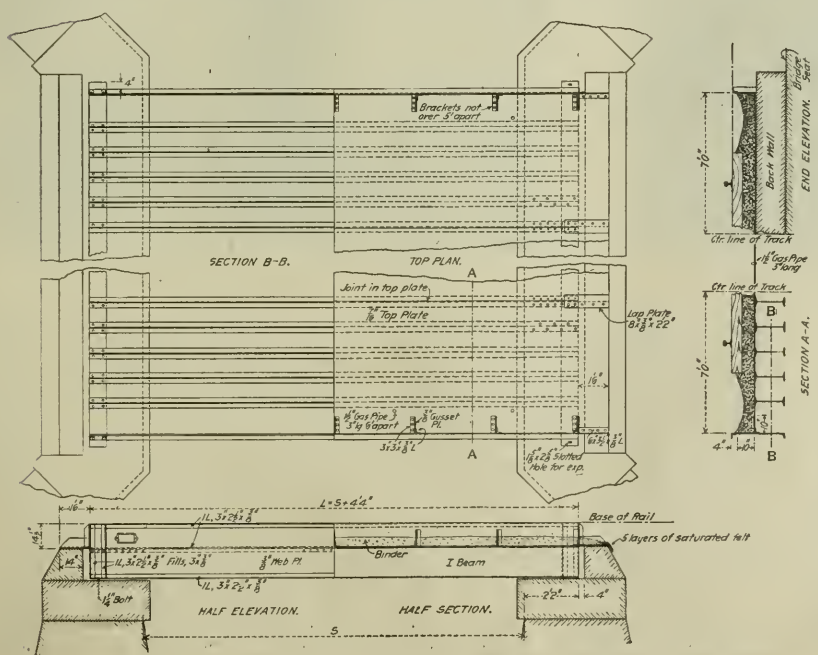
The stringers, laid on the caps of the bents, were all 8 in. x 16 in. and were grouped in banks of three under each rail and in banks of two under the traveler runway on the outside. The bents were spaced, in general, 15 ft. apart and the stringers were made 32 ft. long to rest on three bents. Where the towers interfered with the regular spacing of the bents, 18-in. I-beams, three under each rail, were substituted for the wooden stringers. Rondout creek is navigable for canal boats and small steamers and it was necessary to preserve a clear waterway in the channel. Two bents close together were built on each side of the 63-ft. clear channel opening which was left, and the eight new plate girders intended for spans Nos. 1 and 4 were laid on the caps of these bents. One girder was placed under each rail and one under the traveler runway on each side. All of the falsework was designed in accordance with Cooper's E-35 loading.

After the falsework was all up, the traveler used for dismantling and erecting was assembled on the runway and the work of taking down the old through spans was begun from the north end. The traveler used is shown in one of the illustrations from a photograph. It was of the ordinary form, having two legs or towers of four posts each with a bridge across the top having sufficient clearance to move over any of the old or new spans. The old through truss span at the north end over the channel was taken down first and the new 270-ft. truss was erected on the new towers already built up from below. The second through truss was then taken down and as the work progressed the iron stringers over the channel tower were fleeted ahead to rest on the pony bents of the falsework, no wooden stringers being put in under that part of the old span above the new deck truss. After the deck truss had been erected, the remaining through truss was replaced with the plate girders used in the temporary span over the channel and finally the latticed girders in the north approach were replaced with plate girders resting on the new towers. The whole work was done with little interruption of traffic and with no accidents. The American Bridge Company, which built the superstructure at its Pencoyd, Edgemoor and Athens plants, designed and built all of the falsework and erected the bridge on the site. About 3,000 tons of steel were used in the superstructure.

We are indebted to Mr. Olaf Hoff, Engineer of Structures, New York Central, for the illustrations and information.




Details of Standard Through Plate Girder Bridge with Solid Plate Floor.




Details of Standard Rolled-Beam Bridge for Short Spans.

The Prussian authorities are reported to have become satisfied that further experiments with fast trains hauled by steam locomotives on the Military Railroad are unnecessary. Based on the results attained, they will aim to increase gradually the speed of express trains, not expecting to exceed a maximum of 120 kilometers (74½ miles) an hour. The authorities now are turning their attention to improved brakes. A mechanical engineer has been investigating the subject in America.

## The German Railroad Union.

The convention of the German Railroad Union was held in Dantzic on Sept. 1, 2 and 3, at which delegates representing more than 60,000 miles of railroad were present. The chief subjects discussed (all presented in reports which had been long in preparation) were: The admission of electrical railroads to membership. Only lines which have through traffic, and which therefore must in certain respects be uniform with connecting railroads, are members of the Union; and this discussion is evidence that there is or is expected soon to be, an interchange between steam and electric roads, and of electric roads with each other. The committee believes that the time has come for ascertaining and formulating the regulations necessary for such interchange; and it was instructed to prepare such a body of rules.

Another subject was the continuance of what we would call coupon passenger tickets for routes not only over different railroads but in different countries. These tickets are issued for lines not only belonging to the Union but also for railroads in France, Italy, Belgium, Scandinavia, the Balkan States and Finland, and numerous steamship lines on the North Sea and the Mediterranean, and next year will extend also into Africa, over the Algerian railroads. Heretofore such tickets were authorized at each convention only for the two years till the next convention. At Dantzic it was decided that they should continue to be authorized until action to the contrary is taken.

The subject of automatic car-couplers came to this convention from its technical commission, which had been instructed to report upon it, and has been making experiments since 1898, when the Bavarian State Railroads equipped some cars with American automatic couplers. Later a trial train of 38 cars equipped partly with American couplers and partly with the Krupp hook coupling was provided. Much information was given as to the cost and the time required for the transformation which was universally regarded as desirable; but the interchange of cars practically all over the continent west of Russia makes it desirable that it be introduced in all countries at the same time. The convention favored a continuance of experiments on a larger scale.

President Kranold, of the Berlin Directory of the Prussian State Railroads, who has presided over the Union for eleven years, announced his retirement from active service May 1 next. The convention chooses not a person but a railroad management as its executive; and the Berlin Directory was re-elected for four years.

The sessions of the convention usually occupied the mornings only, and the afternoons and evenings were devoted to excursions and entertainments of various and very attractive kinds.

The private Russian railroads had somewhat greater earnings in the first three months of this year than last year.

## Railroad Shop Tools.

*(Continued.)*

### UPRIGHT DRILLS.

The 26-in. upright drill, Fig. 1, is made by the Hoefer Manufacturing Company, Freeport, Ill. It is fitted with a sliding head, lever, wheel and power feed, automatic stop and back gears. The spindle is $1^{11}/_{16}$ in. in diameter and has a vertical adjustment of 12 in. by means of a rack and pinion. It is driven by cut steel gears and is provided with anti-friction fiber collars and a quick return lever. Both the spindle and the sliding head are counterbalanced. A combination screw and miter gear arrangement is used for raising and lowering the table, which is 22 in. in diameter. It is provided with T slots, and can be swung out of the way of the spindle when work is to be done on the base plate of the machine. The maximum height of the machine is 80 in. and the greatest distance from the spindle to the base is 45 in.; greatest distance from the table to the spindle is 27 in., and the distance from the column to the center of the spindle is 13 in. The diameter of the column is 6½ in. The diameter of the large gear is 8.4 in. and the diameter of the small pinion is 4 in. A floor space 58 in. x 22 in. is re-

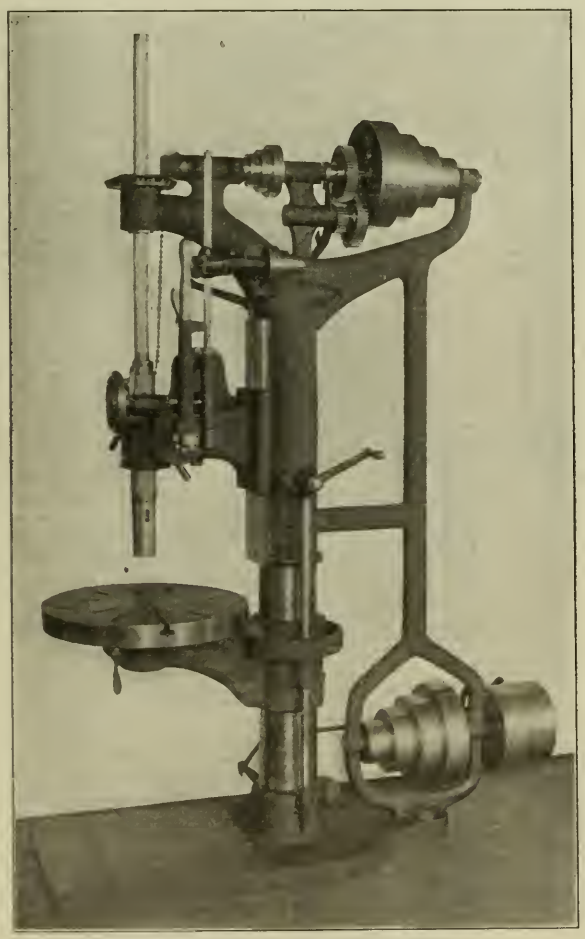


Fig. 1—The Hoefer Upright Drill.

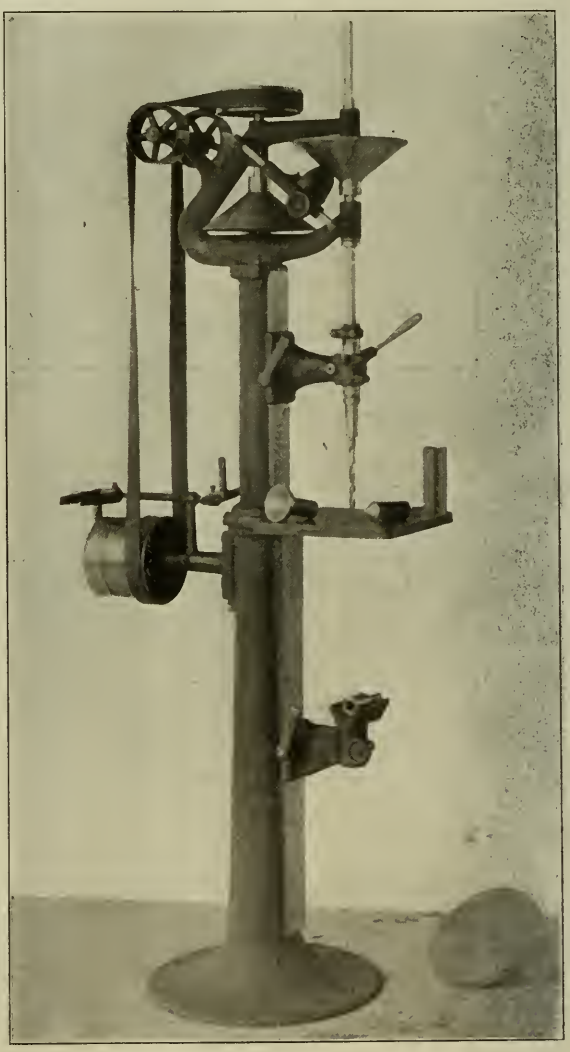


Fig. 2—The Knecht Sensitive Drill.

quired and the net weight of the machine fitted complete is about 1,500 lbs.

The Knecht friction sensitive drill, Fig. 2, made by The Knecht Brothers Company, Cincinnati, Ohio, is used in many railroad shops, and it is especially adapted to tool-room use. A wide range of spindle speeds can be obtained without stopping the machine. These speed changes are procured by sliding the friction roller frame, upon which is mounted the friction roller, up and down on the cones, from one extreme to the other, a distance of only 4½ in.; any number of speeds can be obtained for any size drill from the smallest up to and including 9/16 in. The driving friction roller is built up of leather disks, held firmly between two iron flanges. These leather disks are durable and are easily replaced. More or less driving power to the drill spindle can be applied as the size of the drill or the nature of the work may require by turning a hand adjusting nut under the rear driving cone, which increases or decreases the tension of the friction roller between the two cones. The cone that drives the spindle is mounted on a sleeve or bushing which extends through both bearings in the frame. The spindle is thus relieved from any lateral pressure and the pressure on the driving mechanism is thrown upwards and is relieved by a thrust bearing. Graduations for speed are marked on the bar on which the friction roller frame slides, so that the operator by placing the end of the roller frame at the figures on the bar corresponding to different sizes of drills and clamping it in position by means of clamping screw can always obtain the proper speeds for drilling. Other graduations for indicating the depth of the hole to be drilled are placed on the sleeve which passes through the spindle bracket. A stop collar is also provided by means of which any number of holes may be drilled to the same depth. Ball-bearings placed between the collar on the spindle and the sleeve reduce the friction to a minimum and the spindle is counterbalanced by a quick-acting coil spring. The driving pulleys are enclosed in a frame which is adjustable on the column and by means of a small adjusting screw any desired belt tension may be obtained. An endless belt is furnished with each machine. Two brackets, one for the spindle and another for a round table, are provided; both of these are adjustable on the column and can be clamped in any position by the attached wrenches. Both sides of the square table are finished, so that in case it becomes defaced it can be reversed, and practically becomes a new table. It is ⅞ in. thick and can be swung aside so that the drills can be used on work held in the lower round table bracket. This machine will drill holes up to ¾ in. in diameter in cast iron. The general dimensions of the machine are as follows: Height of drill, 76 in.; distance from column to center of spindle, 6½ in.; greatest distance from end of spindle to round table, 42 in.; vertical adjustment of round table, 28 in.; vertical adjustment of spindle bracket, 13 in.; diameter of spindle, 15/16 in.; throw of spindle, 3 15/16 in.; hole in spindle conforms to Morse taper No. 1; square table, 12½ in. x 14 in.; round table, 10¼ in. in diameter; floor space required, 20 in. x 34 in.; largest size of driving pulley, 7½ in. x 2 in.; size of countershaft pulleys, 7 in. x 2 in.; speed of countershaft, 460 r.p.m.; driving belt, 1¾ in. wide; endless belt, 1½ in. wide by 9 ft. 8 in. long.

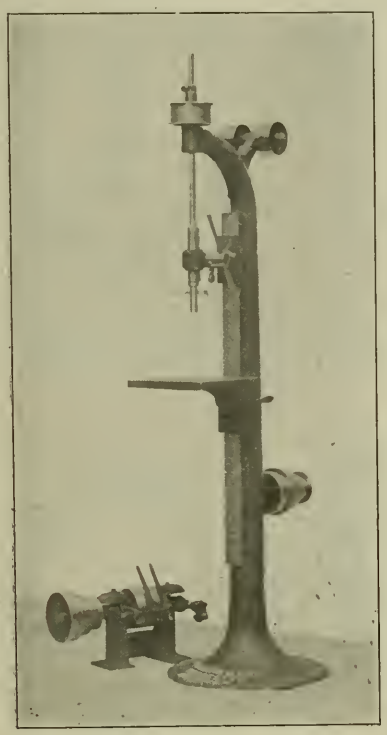


Fig. 3—The H. G. Barr Vertical Drill.

The No. 1, 14-in. swing, vertical drilling machine shown in Fig. 3 is made by H. G. Barr, Worcester, Mass. This is a useful machine for the tool room or for drilling oil or tap holes up to ½ in. in diameter. It has a counterbalanced spindle, a sliding head and lever feed. The table is 11 in. square and has an adjustment of 32 in. on the column. Maximum distance from the table to the spindle is 27 in. and the distance from the post to the center of the spindle is 7 in. The spindle is ⅞ in. in diameter and has a vertical traverse of 3½ in. by means of a rack and pinion. The sliding head has a vertical adjustment of 7½ in. Graduation is provided on the spindle quill and the total height of the machine is 6 ft. 5 in. It requires a floor space of 20 in. x 26 in. and its net weight is 255 lbs. Multiple spindle drilling machines having similar spindle arrangement to the one shown are also made by H. G. Barr. The spindles of these machines can be independently driven when desired and they are provided with three different speeds. The table is in one piece and is raised and lowered by means of a screw inside of the column.

RAIL DRILLING MACHINE.

The rail drilling machine, Fig. 4, is made by the Mark Flather Planer Company, Nashua, N. H. It has a capacity for drilling three holes 1¼ in. in diameter in steel rails. Any distance from 3¼ to 9½ in. can be obtained between the spindles. The two outer spindles have a vertical adjustment of 3½ in. by rack and pinion, and can be clamped in any position required. The spindles are bored out for No. 4 Morse taper, and on account of the spindle adjustment, taper shank drills can be used, thus doing away with the set screws which are used for the adjustment of straight shank drills.

The three spindles are carried on one saddle, which is counterweighted and feeds the three spindles simultaneously. The center spindle is driven by a large planed bevel gear on top of the column, and this in turn drives the two outer spindles by spur gearing through intermediate gears that are pivoted to both the central and outer spindles and move in and out with the horizontal movement of the spindles.

The saddle carrying the spindle has three changes of power feed and quick return. The feed is driven by cones of gears, has three changes, and is changed quickly by a lever on side of column. The work table is provided with adjustable vise for holding the rails, and both right and left hand stops for end of rail can be used.

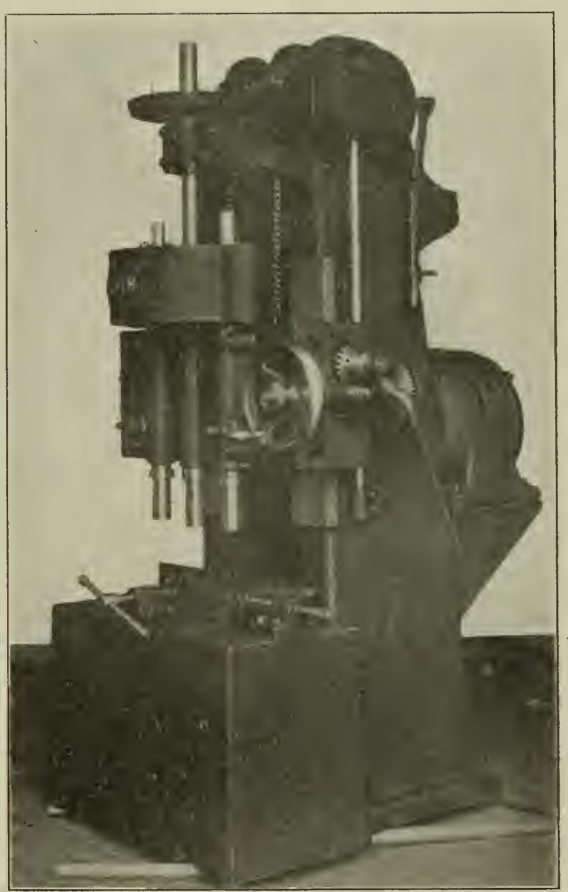


Fig. 4—The Flather Rail Drilling Machine.

The borings drop through an opening in top of table and out through an opening in back of column, taking them out of the way of the operator. There is also an opening 10 in. square through the back of the column level with the top of table, allowing work to be put through the column to be operated on. The principal dimensions are as follows: Height to top of cone pulley, 8 ft.; width of face of columns, 26 in.; dimensions of top of box table, 18 in. x 36 in.; height from top of table, 24 in.; length of saddle, 39 in.; width of saddle, 16 in.; minimum distance of centers of spindles, 3¼ in.; maximum distance of centers of spindles, 9½ in.;

width of driving belt on cone, 3¾ in.; largest diameter of cone pulley, 18 in.; weight about 6,300 lbs.

*(To be continued.)*

## How to Maintain Surface, Line and Gage.*

To maintain perfect surface, line and gage, it is essential, first, to have banks sufficiently wide, with a slope of 1½ to 1, and so prepared for ballast as to permit of perfect drainage. The shoulder should slope slightly from the base of the ballast and should be wide enough to extend at least 7 ft. outside the rail.

It is important that ballasting should be well done according to the best standards; ties should be as near uniform in width and thickness as is possible, and spaced equally center to center; they should be lined on one side of track, preferably the line side of track. Care should be taken that ties are perfectly square across the track, and that all ties are equally and thoroughly tamped outside the rail and 16 in. inside the rail, leaving a space of 22 in. in the center of the untamped, which, however, should be thoroughly filled under the ties.

Track when ballasted or given a general surface should be put up to perfect surface, line and gage, and a shoulder of ballast sufficiently heavy to hold same in line should be distributed; for first class track, the shoulder should be 5 ft. outside the rail, 2⅛ ft. level and 2½ ft. slope. The track should be filled inside to the level of the base of the rail, keeping the flange of the rail and top of ties clean.

Where the roadbed happens to be on a level with lands on either side of track, ditches sufficiently large to insure perfect drainage should be dug outside of and parallel with the shoulders of the track.

For cuts, the roadway should be sufficiently wide to permit of ditches outside the shoulder to thoroughly drain all surface water, and if cuts are spouty or underlaid with quicksand, they should be tiled in addition to ditches, the tiles being laid in a V-shaped trough made of 1-in. x 6-in. fencing lumber, just below the theoretical frost line, and covered with fire-box cinders to a depth of at least 1 ft. The sides of the cut should be sloped 1½ to ft. where possible, faced smooth and kept free of obstructions that may cause portions to slide down, filling ditches and obstructing track. Where possible, surface ditches should be maintained on embankments of cuts alongside of the right of way to carry water to the nearest water way, and prevent water flowing over the embankment, making numerous drains and washing earth down and defacing the sides of the cut. Fills should in like manner be kept clear of obstructions and the surface kept smooth.

To maintain perfect line, the track must be kept up to almost a perfect surface. Where track becomes low in places on one side and then the other, it causes a deflection to the low side of engines and cars passing over it. Under conditions of this kind the only thing to do is to raise the low track to a level, as no track can be made to stay in line when out of surface.

To maintain perfect gage, the track must also be kept in perfect surface, as the engines and cars have the same influence on gage as on line.

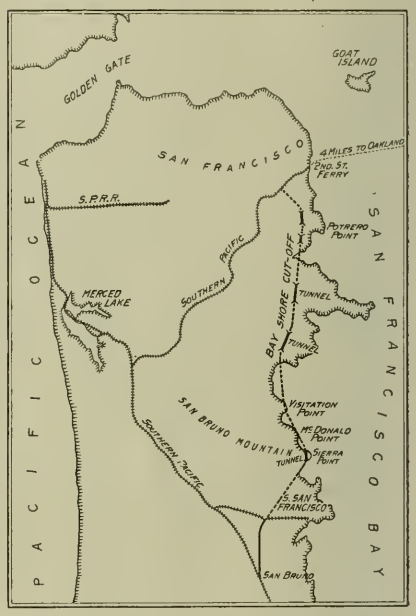
*Committee report to the Roadmasters and Maintenance of Way Association, presented at the 22d annual convention, St. Louis, Sept. 13.

When renewal of ties is being made, the track should be carefully gaged, all spikes that are not snug up to the rail should be pulled and holes plugged, then the spikes should be redriven in the plug to prevent any oscillation. On curves of 4 deg. or over, where traffic is heavy or a high rate of speed is attained, a claw tie plate should be used to prevent the rail being crowded out by heavy engines.

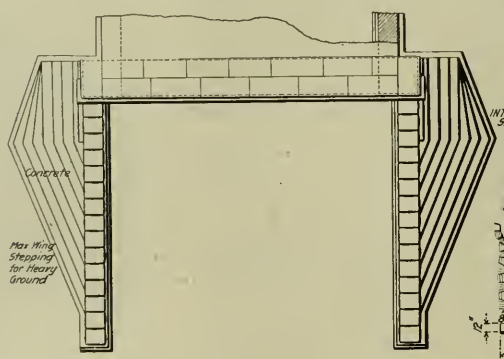
## Bay Shore Cut-Off of the Southern Pacific.

Work has recently been begun by the Southern Pacific on its Bay Shore cut-off. This line is being built to secure a more direct entrance into San Francisco for the trains of the Coast Line division. On account of the steep grades and curves in the San Bruno Mountains in San Mateo County, helping engines have to be employed for the heavier trains. By the Bay Shore cut-off these heavy grades will be avoided. The line runs along the shore of San Francisco Bay and joins the present line at San Bruno. It is about 10½ miles long, and of this that part between South San Francisco and San Bruno, two miles, has already been finished, leaving eight and one-half miles between South San Francisco and San Francisco yet to be built. The distance by the present Coast Line division between San Bruno and San Francisco is 13 miles. The building of the cut-off will involve five tunnels besides some deep cuts. The maximum grade is to be .3 per cent., which is a great improvement over the grades on the present route. The cut-off will start at Townsend and Third streets in San Francisco and will then run southwest through the Potrero hills and along San Francisco Bay, touching at Visitation Point, Macdonald Point and Sierra Point, to South San Francisco.

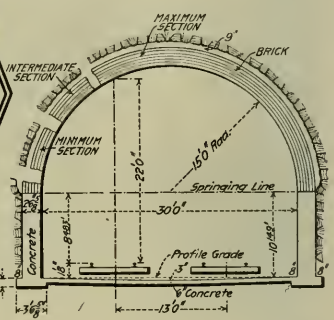
The line will have two tracks but the rights of way, as well as the bridges over the streets in San Francisco, provide for four tracks. The number of streets crossing at grade is very small. The five tunnels on the cut-off aggregate 1.93 miles, and their respective lengths are as follows: No. 1, 1,786 ft.; No. 2, 1,235 ft.; No. 3, 3,446 ft.; No. 4, 3,547 ft., and No. 5, 1,166 ft., a total of 10,180 ft. The heaviest work outside of these tunnels will be at Visitation Point, where there will be a cut 95 ft. deep. The tunnels will be of standard arch construction and will be faced with stone and lined with brick and concrete masonry. They will be sufficiently wide for a double track. The more important details of the tunnels are shown in the accompanying drawings.



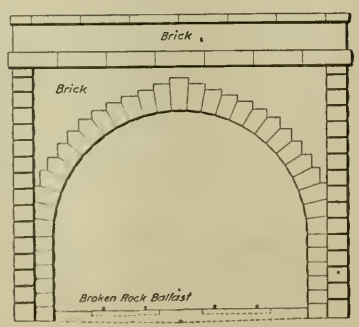

Bay Shore Cut-Off, Southern Pacific.



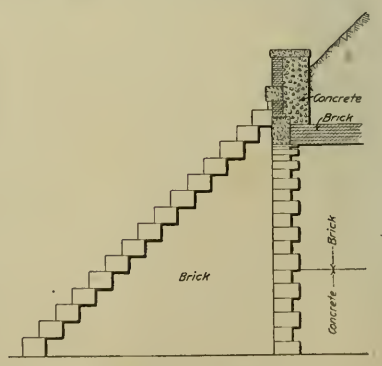

PLAN OF PORTAL.




TUNNEL SECTION.




ELEVATION.




LONGITUDINAL SECTION.

Detail of Tunnels and Portals, Southern Pacific Bay Shore Cut-Off.

## Repairing Broken Spokes on a Driving Wheel.*

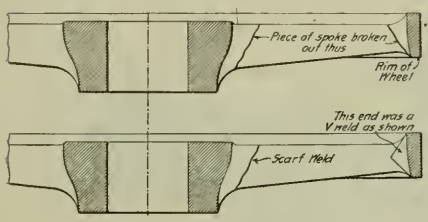
During last winter a passenger engine came into Hillyard shops for repairs. It has three pair of drivers. Cast steel centers 56 in. in diameter. The back driver on the right side had two spokes between the crank pin and the counterbalance broken off. About 1¼ in. of the hub was left on one side and about 1½ in. on the other side, or the break formed an angle of about 60 deg. About 1 in. of stock was left on the rim.

Having no centers in stock at the general stores, and to order from the factory would greatly delay the work on the engine and keep same out of service, our general foreman came to me and informed me that he had a driving wheel center minus two spokes and wanted me to weld two wrought iron ones in place of the same. You may imagine what I thought, or how I looked.

Anyway he asked me to go along with him and look at it. So I did and I looked at it good and long.

Previous to this we had been welding in new centers in cast steel braces, so I thought if it was the same metal in the wheel center, I would undertake the job, although I must say it looked dubious just then.

In the first place I got a heavy car axle and flattened it on one end with an offset so that I could bolt it to the one side of the wheel for a porter bar. Then I got a car wheel on the other end of the axle for a




Welding a Broken Spoke.

counterbalance, with a man on the tail end to manipulate the wheel in and out of the fire.

I made the spokes of wrought iron axle and scarfed as shown in the accompanying The rim end of the spoke I made a "V" weld as you will see in the sketch. There was hardly enough stock left to form a perfect V, so the scarf came up pretty well on the rim. I took separate heats on the first weld, which was, of course, on the hub end, and placed the V end in position, allowing stock enough to hammer down with heavy sledges, while the rim prevented it from slipping down, afterwards taking a heat on each side.

After the hub and spokes had cooled off the spokes stood off from the rim half an inch, so I had a liner to fit in between the new spoke and the rim. Before taking a heat on this end to weld, I heated the wheel each way from the new spokes so that it would give a little when the expansion took place, from welding the small end of spokes to the rim, which I welded by taking a heat on each side of the rim. Those welds turned out all right, although I was a little afraid on account of the expansion in the rim and spokes.

This wheel center had a solid rim. Sometimes, as you know, there are slots left in the rim in three or four places. Those slots we fit with shims before shrinking the tire on, but as I said before there were no slots or openings in this wheel center, so you will understand it was a little more difficult to do a good job. After cooling off it looked O. K. The wheel was then put on the boring mill and skinned off where it was a little lumpy and the tire shrunk on. The axle fit was not disturbed. The engine has been running ever since with wrought iron spokes in a cast steel center.

*From a paper by W. H. James read before the National Railroad Master Blacksmiths' Association at Indianapolis, August 18, 1904.

## University Courses in Railroad Transportation.

The University of Chicago announces a series of evening courses in railroad transportation with the object of providing special instruction for the large railroad community in and around Chicago and thus enable clerical and other staffs in the service to gain a wider comprehension of railroad working in general. Young men wishing to enter the service should find attendance upon the courses a material help and a recommendation in their favor. The announcement states that the movement has been heartily endorsed by prominent railroad officers, and the outline of courses prepared has been submitted to them and has met with their approval.

Two short introductory courses are offered first, in order to get the movement under way without delay, and also to see how it will be supported. These courses began on the 15th inst. and will continue over the third week in December. The results obtained will determine future action, and whether or not further efforts will be justified. The University signifies its willingness to undertake, subject to the approval of railroad authorities, a scheme of instruction including courses of from three months to four years duration.

The work will be primarily in charge of Professor E. R. Dewsnup, an English economist of considerable experience in conducting similar courses in England. The first of the special introductory courses, for the autumn quarter, is on Railroad Conditions and Problems, treated under the following heads: (a) the outbound freight house; (b) railroad organization; (c) roadbed and signaling; (d) equipment; (e) passenger service; (f) rates and fares; (g) railroad statistics. The second course is on English Railroad Practice. There will be one lecture a week in each for six weeks.

Subject to the successful establishment of the autumn work, the following additional courses are announced for the winter and spring quarters: (3) Railroad Conditions in the United States: Organization and Mechanism. (4) Railroad Conditions in the United States: Traffic Working and Present Day Problems. (5) and (6) History and Present Condition of Railroad Mechanism and Railroad Working. (7) History of Express Companies: Past and Present Methods. It is expected that persons engaged in the work of express companies, car lines, etc., will find much that is profitable in the work.

The foregoing covers the first year's work. The tentative outline for advanced work is as follows:

1905-6.—Railroad Organization; History of Railroad Development; Railroad Geography; Railroad Law; Freight Traffic; Railroad Finance.

1906-7.—Development and Conditions of Railroad Transportation in England; Passenger Traffic; Railroad Accounts and Statistics; Rates and Fares; Relation of Railroads to the State.

1907-8.—Development and Conditions of Railroad Transportation in France and Germany; Development and Conditions of Railroad Transportation in Other Foreign Countries; Inter-Relations of Railroads; Railroad Problems—a research class.

For students who take up regular university residence, courses in the department of political economy are also provided, which cover the whole range of transportation economics.

## Car Service Records and Car Loading.*

The Committee on Office Methods and Accounting reported on five subjects: duplication of initials and numbers in marking cars; graphic vs. book records; train and engine mileage; per diem and penalty accounts, and tracing car load shipments. On the first subject it is recommended that roads having initials similar to other roads be requested to renumber their cars; some proper authority should be designated to assign initials or numbers as may be necessary. For example, the Canadian Northern, the Carolina Northern, the Cincinnati Northern and the Choctaw Northern have many cars bearing identical numbers. The same thing occurs in private cars, as, for example, the Pennsylvania Coal Company and the Pittsburg Coal Company. On the third subject, mileage, the committee recommends the endorsement of the rules adopted at Washington last May (page 67 of the minutes). On the fifth subject, tracing, no action is recommended, as the subject is under consideration by the Central and Western association of car service officers.

On per diem records the committee strongly recommends the interchange slip, Form A, recently recommended by the American Railway Association. Transposition of car numbers makes much work; better clerks should be employed. The committee recommends that in making up per diem reports car numbers be entered in numerical order; most roads keep their record of home cars in this order. Penalty notices should be issued in triplicate; one copy being retained by the office issuing such notice, the other two being forwarded to the road having possession of the car, the possessor road to make notation upon one copy, retaining same from which to work car home and returning other promptly to the car owner. Upon receipt of penalty notice there are various ways of handling same. A popular method is to trace the cars by wire, and when located have them tagged with penalty cards, following them up either by wire or mail until delivered off the line. Such cars may be designated on the running record by a capital "P" in colored ink entered on the date which corresponds to that upon which the penalty will become effective. Some of the larger systems make out weekly statements showing cars which are liable to penalty, these lists being furnished to the several division superintendents upon whom it devolves to have the cars released and rushed home, the home route of each car being indicated on the statement. Other plans have been suggested. The committee believes that the most effective method is to keep each penalty car in sight, following it by wire, telephone or special delivery messages as may be most available until it is finally disposed of.

On relative benefits of the graphic as compared with book records the committee secured from members of the Association data as follows: Of 100 roads answering the circular letter 85 roads use the Book Record; 13 roads use the Graphic Record for home cars and the Book Record for foreign cars; one road uses the Cabinet Record, an adaptation of the Graphic for home cars, and Book Record for foreign cars; one road uses the Pin Record for home cars and Book Record for foreign cars. None of these roads

*Extracts from committee reports presented at the meeting of the Association of Transportation & Car Accounting Officers at Cleveland, Nov. 15.

have attempted to work foreign cars by the Graphic, and of those using the Graphic for home cars seven keep a separate junction record in book form of home cars on foreign roads or draw the same off the Graphic two or three months at a time for the purpose of checking per diem.

The general consensus of opinion as expressed by these answers is that the Book Record entered direct from wheel and junction reports is the best system. While the Graphic Record has the advantage of quick location, it is found more difficult to handle per diem matters by this method than by the Book Record. It is also the general opinion that a system of transcribing is desirable after the number of records to be entered per day amounts to a figure variously estimated at 8,000 to 30,000 records per day.

This transcribing is now done in three ways—on sheets, on slips or cards, and on tickets. When tickets are used the work is usually done by typewriter. The advantage of the use of the typewriter for transcribing has not yet been clearly established. Many roads have been experimenting with it, and your committee does not feel satisfied to make a recommendation on this subject at present. Six roads tried typewriters, but abandoned them, and eight roads abandoned the Graphic Record after trial.

A number of roads use loose leaves and adjustable binders. It is the opinion of the committee that this is a good method, as it permits of increasing or decreasing the assignment to a book as the cars run lighter or heavier, also reduces cost of binding books.

The Southern Pacific Company has a form of record leaf for holding four months' home records, with the numbers at the top and the dates at the side, which strikes the committee as being a good form for roads where the record clerk is supposed to do all the work connected with the cars in his charge. Of the roads answering the circular letter 83 roads do not transcribe; 14 roads transcribe all cars; one transcribes foreign cars only; one transcribes system cars only, and one transcribes cars on conductor's reports only; four use sheets, six slips or cards, and seven use typewriters (on tickets). The average records entered per clerk per day varies with the different systems 700 to 3,000, with the average about 1,200.

A part of the Southern Pacific leaf form is shown below. The full form is for five car numbers and 31 days.*

The Committee on Car Service made a report on uniform card waybills and on loading cars to their full capacity. The committee believes that for both slow and fast freight there should be a uniform card waybill that will carry the car to destination, and, in the absence of the regular billing, enable the agent at destination to deliver the freight. Such a form would abolish bills for reclaim for per diem on account of non-arrival of the regular billing. For loading L. C. L. freight most economically the committee recommends the clearing house system; the establishment of transfer houses at suitable points to consolidate loads. If these clearing houses are not too near together the road can afford to employ a higher grade of supervision than if there are a larger number of smaller houses. Responsibility is concentrated, claims are more quickly handled and police protection is cheaper. The clearing houses should be sufficiently few in number to warrant provision of the best facilities, including track room sufficient to place cars at platforms at one time for 24 hours' loading.

Freight sent in car loads must be dealt with according to the circumstances of each commodity. Pig iron and ore can always be loaded to 110 per cent. of the capacity of the car. Coal loaded in open cars should be put in to fill the car; bituminous should be heaped, but with anthracite this does not pay, as considerable coal will be lost off. Each railroad should number its cars so that the number will indicate the dimensions and capacity of the car. Lumber in large orders can be loaded to the full capacity of cars, but where an order is for just enough lumber to make a certain house or barn there is no use in trying to get the car fully loaded, unless that order fills it. Records of 200 cars of lumber arriving at a certain station showed an average of 19 tons; 20-ton cars averaged 18 tons; 40-ton cars averaged 21.5 tons. Many freight tariffs are found to discourage the loading of lumber to the full capacity of some cars.

*Southern Pacific Co. Record of Home Cars.

| Car. | 6201 | | | | 6202 | | | | 6203 | | | | 6204 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month. | Jan. | Feb. | Mar. | Apr. | Jan. | Feb. | Mar. | Apr. | Jan. | Feb. | Mar. | Apr. | Jan. | Feb. | Mar. | Apr. |
| Transfer. | | | | | | | | | | | | | | | | |
| Date. 1. ..... | | | | | | | | | | | | | | | | |
| 2..... | | | | | | | | | | | | | | | | |
| 3..... | | | | | | | | | | | | | | | | |

## Foreign Railroad Notes.

The signs of a "car famine" on German railroads increase, after two years of pretty satisfactory supply of all demands. This usually sets in during the sugar-beet harvest, which makes great demands for short hauls for some weeks in the fall, just at the time people are laying in their winter's supply of coal. This year a special cause of freight blockade is the low water in the rivers. Shipments have been delayed in hopes that the cheap water transportation might yet become available, and when no further delay is possible and the railroads are crowded with other freight, the river and canal freight is brought to them.

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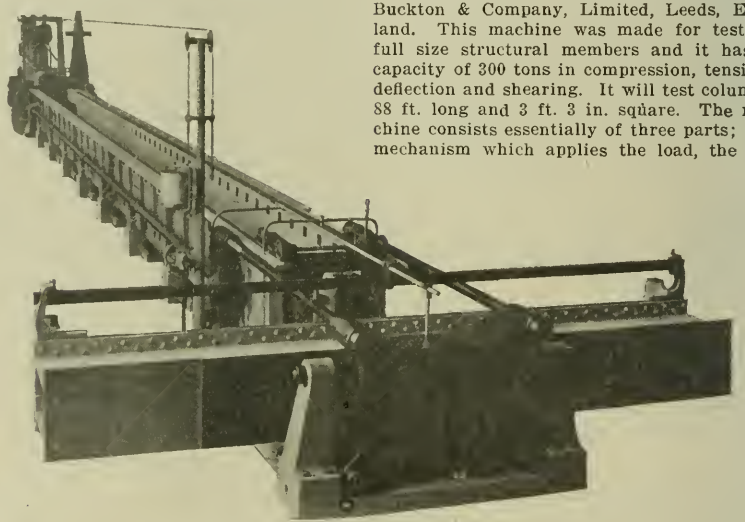
The number of Mahometans in Russia is so great that the railroads have joined with steamer lines which ply between the Black Sea and the Eastern Mediterranean in issuing through tickets from Russian stations where there are many Mahometan pilgrims to Mecca, who take ship at Sebastopol going, but are landed on their return at another port nearby. These tickets are good for nine months.

## A Testing Machine for Full Size Structural Members.*

The universal testing machine shown in the accompanying illustration is made by J. Buckton & Company, Limited, Leeds, England. This machine was made for testing full size structural members and it has a capacity of 300 tons in compression, tension, deflection and shearing. It will test columns 88 ft. long and 3 ft. 3 in. square. The machine consists essentially of three parts; the mechanism which applies the load, the apparatus which measures it and the frame or bed. The two advantages of this machine which make it differ from others is that the frame or bed instead of being fixed as in the ordinary machine, is movable, and that the weighing levers contrary to the general arrangement with fixed beds, are at the same end as the straining cylinder. The levers are mounted on the stationary cylinder instead of being carried on the moving ram. Owing to the above combinations the machine possesses facilities for testing a variety of sizes and for testing either in compression or tension, without being rearranged. The hydraulic ram is between the trough at the far end of the machine and is connected to a straining frame and crosshead, which in turn is connected to the balancing system which floats upon rollers, and nowhere touches the sliding trough. From the balance the load is delivered to the steel yard at the far end of the machine.



300-Ton Universal Testing Machine.

The straining frame is both surrounded and traversed by a balancing frame. The result is that the straining crosshead can push on to one part of the balancing frame and pull on to another part, and the straining crosshead can itself be run along the straining frame into a position for pulling or pushing either long or short pieces.

The machine is also fitted with a complete apparatus for making autographic records.

*From a paper by J. H. Wicksteed, read before Section G of the British Association, Cambridge meeting.

RAILROAD GAZETTE

## YOUNG RUNNERS FOR FAST TRAINS.

There ought to be an age limit beyond which enginemen should not be employed on fast trains, and perhaps not on any main line train. It would be difficult to fix the limit, so as to secure agreement upon it, even among the officers of a single large road, and it would be an unpleasant thing to enforce, at least until it got established, as has the age-limit among officers in the army; but the subject is brought to mind by a remark made by President Mellen, of the New York, New Haven & Hartford, when addressing a meeting of conductors at New Haven recently. A New Haven paper quotes:

"I do not think that ambitious and energetic young men should have their path blocked by a rule that places above them men who are in many instances not so capable. I have no prejudice against old men, but I do not think that the seniority rule should be ironclad. If we ever have a four-hour train between New York and Boston, as I hope that we shall, I do not want the oldest conductor and engineer on the road to handle it." Continuing, Mr. Mellen said, in reference to appeals from the Grievance Committee, that in many instances these were brought where they could do no good, and were not important. If only the cases in which the men had good causes were brought, they would receive better attention.

The seniority rule is *not* ironclad. Mr. Mellen does not say that it is; but other presidents have said so, or at least have taken pains to convey that impression when giving their views on the causes of collisions. By the usual regulations or agreements, seniority is to govern promotions, but with the important proviso, "other things being equal"; and when a man 55 years old, who has been in the service 30 years, is less desirable for an important run than one 50 years old, who has served only 25 years, it is the duty of the superintendent to establish that fact and promote the younger man. The *Railroad Gazette* has preached this doctrine but has found few to practice it systematically; and it is a good sign to have a president speak plainly on the subject. Of course, no one finds fast engines manned by men obviously superannuated; the trouble lies in dealing with the border line between efficiency and inefficiency; in the disinclination of timid superintendents to act at the proper time in each individual case. Most superintendents will smile when they read that word "timid," but does it not in this case fit a good many men who in other matters are firm? Where there is a doubt about the fitness of a man who is getting too old, the public and the company should have the benefit of the doubt; but after listening to the plea of the Grievance Committee the superintendent gives it to the engineman—knowing that such action means taking a risk. It is, indeed, difficult to settle conflicting interests where the margin is as narrow as in the case supposed above (between 50 years and 55 years); but the difficulty does not excuse evasion of the duty. The fact that it is hard to settle such cases by balancing the facts is a good reason for establishing an arbitrary rule. It requires courage and a firm policy to do this, but it is only by arbitrary rules that we are able to settle half the important questions of life.

To provide for the elasticity that is desirable even in administering arbitrary rules, and to fortify himself with facts to justly settle cases which will arise before an arbitrary rule can be established, the wise superintendent will keep a detailed record of each man's conduct and efficiency and will cultivate the acquaintance of his men. These are trite precepts, but conditions seem to indicate that they will bear repeating. Some things we must assume: for instance, a superintendent who is clear-headed, who not only has the right sense of justice but the courage to carry it out in his acts; and a management above him who will support his decisions. These conditions secured, the best backing for a decision putting a young man ahead of an older one is a convincing showing that he has really been ahead of him, so far as qualifications are concerned, for some years already. The right kind of records kept by a conscientious superintendent will do this.

It is to be hoped that "Boss Grievers" everywhere will take to heart the last part of what Mr. Mellen said. That was a polite way of telling the New Haven committees that they come to headquarters so often that they make the officers tired. It is one of the hard facts of business life that the most amiable railroad manager in the world cannot afford to spend his time on matters of second rate importance, and grievance committees have got to recognize this hard fact, as other people do. A superintendent who desires to be friendly, patient and familiar with his subordinates is forced to deny himself that pleasure, by the pressure of his work. When an officer keeps his callers waiting an hour and then gives them only 15 minutes (when they want an hour), it is usually because he is unable to find any other way to get his day's work done, not because he likes to freeze his friends.

Brotherhood committee men who have no important grievances to occupy their energies, but who yet must keep themselves promiment, ought to establish saints' days, and have celebrations; and the first saint should be Saint Arthur. Mr. Arthur always saw the essentials, and devoted his attention to them; and was willing to treat a "magnate" as an equal.

## STEEL vs. WOODEN CARS.

The paper on steel cars, read before the New England Railroad Club, which is printed elsewhere in this issue, presents broad claims as to the advantages of this type of construction and offers a general refutation of the alleged disadvantages. The author, who represents a large builder of steel cars, will naturally be taken as a prejudiced investigator, and some of the data on which he bases his statements are certainly open to question; nevertheless, the subject is one of vital interest, and the paper is worthy of attention. It attempts to show that cars built entirely of metal or with metal underframes, whether of large or small capacity, are more economical than wooden cars. The discussion which followed the reading of the paper showed plainly that the railroads, at least in New England, are not yet convinced that, for their requirements, the high capacity car, whether made of steel or of wood, is more suitable than the wooden cars of comparatively small capacity which they are now using.

For certain kinds of freight the high-capacity steel car or composite wood and steel car is, without doubt, highly economical. But on such roads as those in New England where even the bulk freight is handled, as a rule, in small consignments to local points, it cannot be so readily conceded that cars of more than moderate capacity, say 60,000 lbs., are desirable. A steel underframe box car of 60,000 lbs. is no lighter than a wooden car; in fact, it is usually heavier. Wooden cars carrying even more than 30 tons have been built which are lighter than steel cars of equal capacity, notably a number of box cars of the Southern Pacific designed by Mr. F. E. Canda, which carry 100,000 lbs. and weigh only 33,000 lbs., as against 44,300 lbs. for the standard steel underframe box cars of the Pennsylvania. It is true that the usual design of wooden car will not carry without great risk the excessive overloads to which steel cars are often recklessly subjected; but where the average load of cars seldom exceeds 20 tons there is no need of building a car capable of carrying 40 or 45 tons and marking its capacity at 30 tons as is done with steel cars.

As regards the life of the wooden car, compared with steel, the whole argument is based largely on conjecture. None of the modern steel cars have been in use long enough to determine their ultimate length of useful service, and the author's estimate of 25 years is assumed from service records in Europe where the conditions are different. There is a mass of conflicting data about the loss of weight in steel due to corrosion, and until some definite conclusions can be drawn, based on a wide range of observation under every service condition, such data must be used with caution. Although there are a large number of cases in which wooden cars have been in continuous use for from 20 to 30 years, it is probable that such cars have been rebuilt from the sills up once or even many more times in that period, so that we are not disposed to question the assumption of the average life of such cars being about 15 years. But the high cost of repairs, from $35 to $80 per car per year, which has been taken as a basis of comparison, probably includes the cost of this rebuilding, which is usually done piecemeal. For steel cars, the cost of repairs is said to be from $9 to $15 per year; but most of the cars, on the repairs of which these figures are based, have only been in service from two to five years, and the oldest have not been running more than seven years. Any machine or structure which has a given number of years of useful life requires only light repairs during the first half of that period; later the repairs begin to increase rapidly. Our steel cars have not yet reached that point.

The strongest argument in favor of the general adoption of all-steel and steel underframe cars, and one which was barely touched upon either in the paper or in the discussion, is the fact that wooden-framed cars are always damaged when in collision with steel underframe cars, while the latter escape uninjured. If because of their decided economy, the high-capacity steel cars are continued in use, then it is essential that other cars which must be coupled up in the same trains with these "battle ships" should be made strong enough to withstand the severe shocks incident to the movement of the long trains of to-day. The

same argument of uniformity holds in this respect as in the case of couplers, or air-brake equipment. A light wooden car may be strong enough to carry the load for which it was designed, but it needs a stiff backbone in the underframe to protect it from being crushed between two heavy steel cars. The most efficient spring or friction draft gear will not prevent damage from this cause and thousands of old light cars are annually being destroyed in that way. It would seem that this is the primary cause for the need of metal frames for cars of light capacity, rather than a questionable economy in operating expense due to carrying larger loads and less dead weight.

Engineers of the New York Central are reconnoitering in Connecticut, and it appears that the company proposes to survey a route from a point on the Harlem division near Brewster, 52 miles from New York, across northwestern Connecticut to connect with the Boston & Albany not far west of Springfield. The fact, of course, suggests future competition for the passenger traffic between New York and Boston now monopolized by the New York, New Haven & Hartford; and there is also in the move a strong hint of a counter stroke to the recent acquisition of the New York, Ontario & Western by the New Haven company. Boston and southern New England journals manifest considerable interest in the survey; but probably, in essence, it is a mere gesture to warn off the New Haven company from using its new western purchase in a way seriously detrimental to the New York Central. While the foiled attempt of the Vanderbilts to buy control of the New York & New England several years ago will be recalled, there are more serious obstacles to the present proposition. It would involve (1) the construction of a very expensive line across the Berkshire hills; (2) the new line would have almost no local business, and at best would have steep grades; and unless it were an air line—the mere suggestion of which is grotesque—the distance through between Boston and New York would be considerably longer than by the longest of the three New Haven routes—232 miles by the Shore Line, 212 miles by the Air Line and 234 miles by way of Springfield; and (3) it would require consent of the Connecticut Railroad Commission on the layout and probably a special charter from the Connecticut Legislature, which never has been very inhospitable in such matters to the New Haven company's wealth and influence. There is another phase of the subject. There is a New Haven-New York Central contract that contains a clause—inserted, if we are not mistaken, at the time the New Haven built the Portchester road and established its Harlem River terminal—that pledges both parties not to compete from the New York terminals in the territory of the other, the whole contract terminable should the clause be violated. Under the contract the New Haven is now paying the New York Central for trackage and Grand Central Station terminal facilities about $1,100,000 a year, a sum not lightly to be surrendered. This contract, by the way, has its speculative suggestion on the question of the New Haven company's securing an independent entrance to New York through the subway. The subway is pushing population northward in such a way that nobody can tell where the center of the great city will be half a century hence.

## October Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of October, printed in another column, contains accounts of 25 collisions, 16 derailments, and three other accidents. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | | Killed. | Injured. |
|---|---|---|---|
| 2d. | Driscoll, N. D. | 3 | 3 |
| 5th. | Mitchell, Ga. | 1 | 5 |
| 10th. | Warrensburg, Mo. | 30 | 60 |
| 10th. | New Iberia, La. | 1 | 0 |
| 10th. | Saluda, N. C. | .. | .. |
| 20th. | Yuba Pass, Cal. | .. | .. |
| 21st. | Geneva, N. Y. | 3 | 0 |
| 27th. | Lincoln, Neb. | 2 | 0 |
| 30th. | Tipton, Mo. | 3 | 10 |

The Warrensburg collision was reported in this paper October 14, but the cause is now more fully explained. The car in which the passengers were killed was next to the tender. Wrecks like this, and that at West Dunellen, N. J., a few years ago serve as reminders that in abolishing the old rule to have a baggage car ahead of the passenger cars in all trains a certain risk is being taken—unless the means of preventing collisions are bettered. One European government railroad administration has lately relaxed the legal regulations requiring that such a safety car be run in every passenger train—but probably those European despatchers and trainmen understand their business better than we do ours! The verdict of the coroner's jury at Warrensburg says that the trainmen responsible for the collision slept at their post of duty; but whether this was shown in the evidence or was only the jurymen's belief, is not clear. We never heard, however, of an engineman who started his train out of a side track while asleep, or of a conductor who give an all-right signal when not awake; so that this accusation—which has been repeated in the newspapers on similar occasions before—seems illogical. The essential fault of the men was not the sleeping, but the reckless action which they took when they were awake; and as recklessness of exactly the same kind has been found a good many times in cases where no one claimed that the culprits had been asleep, the present charge puts the emphasis in the wrong place.

In this collision and in that at Tipton in the same State, on the 30th, both on the same road, the passengers were going to or from the St. Louis exposition, so that the phrase so familiar in 1893, "caused by World's Fair travel," which the reporters have all summer been holding ready for use, at last came into play. But, as many other railroads also have had unusually heavy passenger traffic this year to and from St. Louis, and as the other most notable collisions of the summer have been between trains on lines not doing world's fair business, the burden of proof is on those who like to thus easily assign the blame to show what the world's fair has to do with the real cause. It is to be expected, of course, that in running 100,000 trains more collisions will occur than in running 50,000; but that is nothing but fatalism. The argument would forbid all efforts to increase traffic. The real question is, whether the methods or the men ought not to be improved; and on that the considerations pro and con are well understood.

The number of electric car accidents reported in the newspapers in October was 30, in which eight persons were killed and 189 were injured. One of the accidents was a rear collision of trains of empty cars on the Manhattan Elevated, New York City, in which the motorman was killed and the cars were damaged by a fire which appears to have been started by short-circuiting of the power current. No less than three of the accidents were runaways, in which the presence of leaves on the rails, impairing the efficiency of the brakes, was given as the immediate cause.

Some persons seem to think that railroad accidents have been harped upon too much of late. For the comfort of such—if they can get any comfort out of it—we copy from a Chicago paper the following report of the violent deaths occurring in that city in the month of October from all causes:

Forty-seven persons were killed by cars (railroad trains, 34; street cars, 13) in Chicago in October, according to the report of the coroner. The total number of accidental deaths was 107, so that the persons killed by cars constitute 44 per cent. of the whole number of accidents. The total number of deaths with which the coroner had to deal was 233. There were 43 suicides and 16 murders. In the accident list eight were run over by wagons, nine fell down stairs, six fell out of windows, ten fell in various other ways, two were electrocuted, one was killed in an explosion, eight were drowned, one was shot, one was bitten by a dog and later died of hydrophobia, one was accidentally poisoned, three died from burns, one was gored to death by a bull, one was kicked to death by a horse, six were asphyxiated by gas, and one fell down an elevator shaft.

## Baltimore & Ohio.

The B. & O. reports a surplus for the year ending June 30, 1904, of $12,357,360. This amounts to 8.0 per cent. on the common stock after provision for the preferred. Last year the stated surplus was $13,818,163, or 9.2 per cent. on the common stock. There was charged to expenses $408,650 for betterments. Restoring this to income we find the common stock earned actually 8.3 per cent.

The system mileage compares as below:

| | 1904. | 1903. | Inc. |
|---|---|---|---|
| Road, miles | 4,442 | 4,397 | 45 |
| 2d, 3d and 4th tr'ks, miles | 1,138 | 1,084 | 54 |
| Sidings, miles | 2,205 | 2,062 | 143 |
| Total miles of track | 7,785 | 7,543 | 242 |

Eighty-two passenger cars and 120 freight cars were added to the equipment; but on the other hand, 21 locomotives, 16 passenger and 2,004 freight and service cars have been condemned. This road a few years ago went heavily into new equipment. The past year as a road it has practically done nothing in the way of new equipment save the 7 per cent. of new coaches. The 109 new locomotives have been furnished by the Southwest Equipment Co. The equipment of the system, including affiliated lines, compares as follows for the two years:

| | 1904. | 1903. | Inc.-Dec. |
|---|---|---|---|
| Engines | 1,848 | 1,769 | 79 I. |
| Passenger cars | 1,214 | 1,158 | 56 I. |
| Freight cars | 82,026 | 84,742 | 2,716 D. |
| Service cars | 1,732 | 1,629 | 103 I. |

The increases are on the affiliated lines and in the property of the Southwestern Equipment Company. There was spent on the Baltimore & Ohio and the affiliated lines for construction the grand total of $11,552,053. It was charged up as follows:

| | |
|---|---|
| Capital account, B. & O. | $3,754,814 |
| Capital acc't, other roads owned by B. & O. | 470,257 |
| Railroads, in general account | 5,326,982 |
| Surplus income of B. & O. | 2,000,000 |
| | $11,552,053 |

The work was of every kind so that it is difficult to characterize it in a general way. There was the building of a good deal of track, both main line and other tracks, and some spurs were pushed out to coal mines. At other points main line was relocated to eliminate curvature. Considerable expendit-

ures were made at the Mount Clare shops and in a small way at the various shops all over the system. But the B. & O. is known to be weak here and the expenditure in this direction this year does not in any way meet the situation. A good deal of money has gone into terminal improvements, especially at Cincinnati and at Washington. At the latter point the expenditures to date aggregate $2,731,624. They are borne jointly by the Baltimore & Ohio and the Philadelphia, Baltimore & Washington. Several years will be required for the completion of the work there, which is to include an imposing marble union passenger station in architectural keeping with the capitol and other

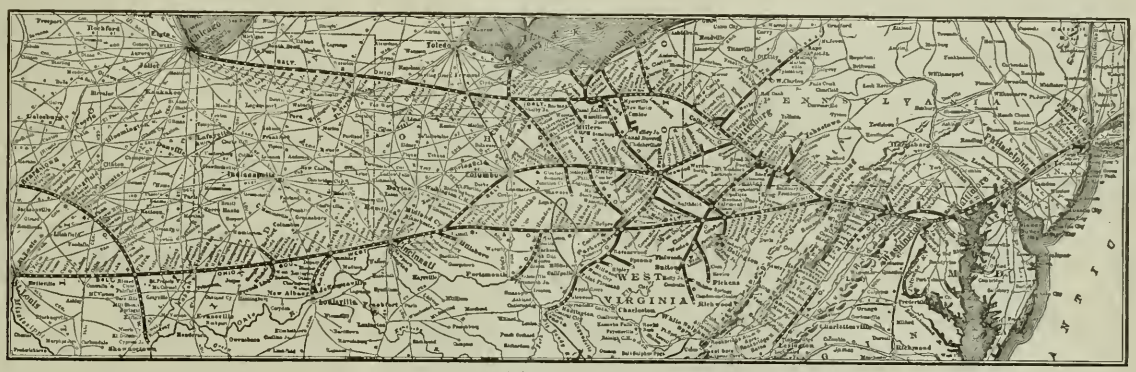
into the securities of other companies, and $7,000,000 to advances to auxiliary companies for their new construction work. Its financial position is practically unchanged except for the $10,000,000 note issue. The income account is:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Earnings | $65,071,080 | $63,449,633 | $1,621,447 I. |
| Expenses | 43,628,863 | 39,569,963 | 4,058,900 I. |
| Net | $21,442,217 | $23,879,669 | $2,437,452 D. |
| Other income. | 2,648,597 | 1,609,850 | 1,038,747 I. |
| All income. | $24,090,814 | $25,489,519 | $1,398,705 D. |
| Deductions | 11,733,454 | 11,671,356 | 62,097 I. |
| Net inc. | $12,357,360 | $13,818,163 | $1,460,803 D. |
| Betterments | 2,000,000 | 3,500,000 | 1,500,000 D. |
| Balance | $10,357,360 | $10,318,163 | $39,197 I. |

the equipment was practically the same as last year this would seem to indicate excellent work in utilizing home cars and in sending foreign cars promptly back to their owners.

The train load has declined from 416.43 to 401.25 tons. This is explained probably by the falling off in ore and iron products. The irregularity of the traffic has produced another expensive condition in an increase of 6 per cent. in the empty car mileage.

The programme of renovation which began on such a sweeping scale under the receivers is still apparently in full force. When Mr. Underwood was on the Baltimore & Ohio the needs for many years to come were canvassed




Baltimore & Ohio.

government buildings in that city. The balance sheet:

| | |
|---|---|
| *Assets.* | |
| Cost of road | $291,645,959 |
| Real estate | 13,653,604 |
| Gas and electric plants | 667,723 |
| Equipment | 31,761,107 |
| Cost of other roads owned by B. & O. | 13,296,306 |
| New stocks and bonds to retire old. | 263,722 |
| Miscellaneous assets | 1,395,392 |
| Due from other roads | 8,130,796 |
| S. W. Equip. Co. loan account for purchase of equipment | 10,373,079 |
| Cash | 14,701,570 |
| Cash assets | 12,425,498 |
| Securities of sundry companies | 57,039,077 |
| Material on hand | 4,616,740 |
| | $459,970,573 |
| *Liabilities.* | |
| Capital stock: Preferred | $59,982,751 |
| Common | 124,262,060 |
| Funded debt | 227,262,530 |
| Miscellaneous fixed debt | 11,271,945 |
| Miscellaneous liabilities | 2,922,583 |
| Two-year notes | 10,000,000 |
| Current liabilities | 16,956,747 |
| Profit and loss | 7,311,957 |
| | $459,970,573 |

The $10,000,000 of two year notes reflect the condition of the money market the past year when railroads found it impracticable to sell bonds for new capital.

The financial transactions for the year are shown by the next table:

| | |
|---|---|
| *Debit:* | |
| Liabilities increased— | |
| Preferred stock | $608,462 |
| Funded debt | 5,281,041 |
| Miscellaneous liabilities | 9,322,303 |
| Profit and loss | 1,805,308 |
| Assets decreased— | |
| Equipment | 481,113 |
| Current assets | 1,264,255 |
| | $18,762,482 |
| *Credit:* | |
| Assets increased— | |
| Cost of road | $4,808,937 |
| Real estate | 734,819 |
| Cost of other roads | 1,457,632 |
| Miscellaneous assets | *7,178,728 |
| Securities other companies | 3,314,131 |
| Liabilities decreased— | |
| Current liabilities | 1,268,235 |
| | $18,762,482 |

*In the balance sheet above miscellaneous assets have been separated into "miscellaneous assets" and the two items following.

The company raised nearly $6,000,000 from stock and funded debt and about $10,000,000 on notes. It has also drawn down assets about $2,000,000. Of the proceeds, $5,542,000 have gone into the road, $1,500,000 into other roads which the company owns, $3,000,000

The whole story is here told in an increase in expenses which is $2,437,452 greater than the increase in earnings. Other income showed a handsome gain of over $1,000,000. The remaining difference was used up in a reduction of the betterment appropriation by $1,500,000. Earnings increased but 2 per cent. Passenger and freight earnings are:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Passenger | $13,146,448 | $12,520,987 | $625,460 |
| Freight | 48,617,103 | 47,756,251 | 860,852 |

The freight business was much disturbed during the year. The tie up of lake traffic at the beginning of the season was a large factor. The hesitation in the iron and affiliated industries cut off much. The increased freight receipts were entirely due either to better rates or a better class of freight, the average receipt per ton mile having been 5.82 mills this year compared with 5.56 last year. The actual freight movement fell off nearly 3 per cent. The decline was in coke, ores and iron products and grain. Bituminous coal ton mileage showed a gain of 10 per cent. and an increase of 4 per cent. in the average ton mile revenue. The average haul of bituminous coal is 197 miles. Expenses were:

| | 1904. | 1903. | Inc. or Dec. |
|---|---|---|---|
| Maint. of way | $7,687,840 | $6,175,115 | $612,724 |
| Maint. of equip. | 10,374,591 | 8,270,156 | 2,104,434 |
| Cond. transp. | 24,761,628 | 23,653,780 | 1,107,847 |
| Gen'l expenses | 1,704,803 | 1,470,911 | 233,892 |
| Total | $43,628,863 | $39,569,963 | $4,058,900 |

There was no stinting of maintenance; all maintenance increased 18 per cent. In maintenance of equipment alone the increase was nearly 25 per cent. On roadway and structures there was spent $1,703 per mile; 38,200 tons of new rails were put in track and 1,411,094 ties. The maintenance of equipment was: Per locomotive, $2,624; per passenger train car, $604; per freight car, $55.

There is an increase of $1,107,847 in transportation expense with an actual decrease in ton mileage. In the detail table we find an increase of half a million in the fuel bill, $100,000, or 18 per cent., in superintendence, and $271,244 in damage expenses. This last expense has this year reached $1,238,000. But there is one very handsome decrease, namely, $367,000 in car mileage balance. As

most thoroughly and it is along the lines then laid out that most of the work has since proceeded.

## Chicago, Burlington & Quincy.

The Burlington earned $12,814,916 in 1904 compared with $13,326,108 in 1903. The earnings amounted to 11.65 per cent. on the stock. If the amount appropriated for sinking fund is restored the actual earnings upon stock will be 12.30 per cent. Of the surplus for the year 65 per cent. was distributed in dividends. The company added 55 miles to its line by taking over the Iowa & St. Louis Railway, by completion of the new line from Oskaloosa to Tracey, Iowa, and by the completion of the line from Old Monroe to Mexico, Mo. The latter connects with the Chicago & Alton and forms a through line between St. Louis and Kansas City.

The company has added 50 new locomotives, 85 passenger train cars and 2,000 coal cars to its equipment.

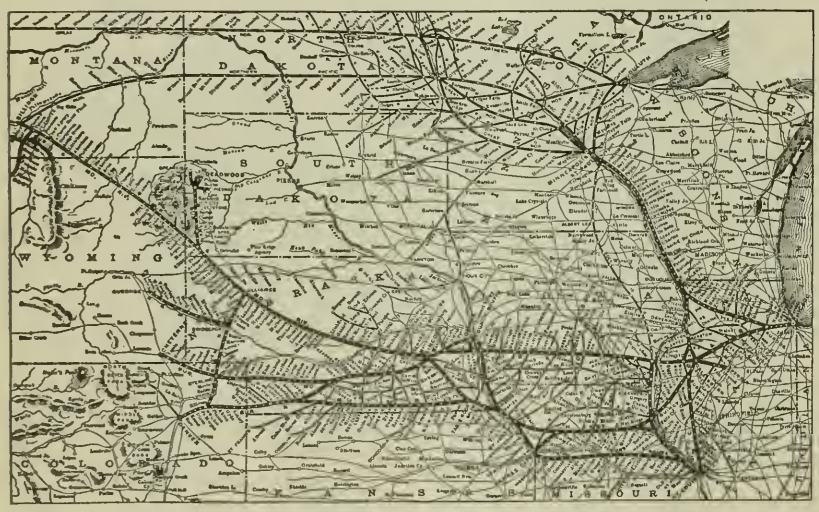
During the year about $13,000,000 was spent on the property. Of this $4,200,000 went for equipment, about $2,800,000 for new lines whose construction was completed this year, over $1,600,000 for grade deductions, about $1,000,000 for passing and side tracks, and nearly $1,000,000 for bridges and ballast. Sundry smaller items with $1,220,000 discount and premium on bonds sold and bought swell the total to $13,046,000. All the cost of new work and new equipment was charged to capital account. No part of it was provided out of earnings.

The financing during the year was as follows:

| | |
|---|---|
| *Debit:* | |
| Liabilities increased— | |
| Funded debt | $14,964,200 |
| Special funds | 2,566,347 |
| Profit and loss | 5,275,347 |
| Sinking fund | 1,408,674 |
| Assets decreased— | |
| Controlled roads | 5,780,650 |
| | $29,994,938 |
| *Credit:* | |
| Assets increased— | |
| Cost of road | $19,318,858 |
| Sundry investments | 1,303,489 |
| Sinking fund investments | 883,306 |
| Materials and supplies | 934,024 |

| | |
|---|---|
| Sundry securities | 74,600 |
| Cash | 1,742,629 |
| Liabilities decreased— | |
| Coupon interest reserve | 56,576 |
| Current assets and liabilities | 5,954,456 |
| | $29,994,938 |

The sum of it all is that the company has completed some extensive construction work and taken over some new lines. To do this it transferred several millions from the item "controlled roads" to "cost of road." It drew upon its special funds and current assets for part of its needs, but principally drew its money from the proceeds of a fifteen million dollar increase in the funded debt. Altogether "cost of road" has been increased $19,318,000. A considerable part




Chicago, Burlington & Quincy.

of the proceeds of the bonds sold went to reduce current liabilities and to increase cash. In its immediate finances the company has much improved its position, having now nearly $2,000,000 more cash and about $6,000,000 less of current liabilities. The income account below shows a decline of nearly half a million in surplus, or about 4 per cent.

*Income Account.*

| Earnings from: | 1904. | 1903. | Inc. or Dec. | |
|---|---|---|---|---|
| Freight | $44,651,996 | $42,782,405 | $1,869,591 | I. |
| Passgr., mail & express | 18,086,395 | 17,417,104 | 669,291 | I. |
| Misclnous | 2,489,800 | 2,438,869 | 50,931 | I. |
| Total | $65,228,091 | $62,638,378 | $2,589,713 | I. |
| *Expenses*: | | | | |
| Cond. trans. | $20,266,481 | $17,985,963 | $2,280,518 | I. |
| M. of E. | 8,376,602 | 7,719,044 | 657,558 | I. |
| M. of W. | 10,277,274 | 9,341,728 | 935,546 | I. |
| Gen'l expns. | 3,751,936 | 3,717,261 | 34,675 | I. |
| Total | $42,672,293 | $38,763,996 | $3,908,297 | I. |
| Net | $22,555,898 | $23,874,382 | $1,317,484 | D. |
| Taxes | 1,906,649 | 1,778,476 | 128,173 | I. |
| Net earn'gs | $20,649,249 | $22,095,906 | $1,446,657 | D. |
| Net inc. on securities | 204,116† | 346,540 | 550,656 | D. |
| All income | $20,445,133 | $22,442,446 | $1,997,313 | D. |
| Charges | 7,630,217 | 9,116,338 | 1,486,121 | D. |
| Net income | $12,814,916 | $13,326,108 | $511,192 | D. |
| Dividends | 8,834,749 | 8,834,570 | 179 | I. |
| Balance | $3,980,167 | $4,491,538 | $511,371 | D. |

†Deficit.

The loss of half a million in surplus is the result of three factors, first, a decrease in net earnings; second, a decrease in charges, which is just about large enough to offset the decrease in net earnings; third, a decrease in the profits on investments of about $550,000.

Gross earnings increased about $2,600,000, or 4 per cent., most of it being in freight. The average receipt per ton mile decreased from 8.7 mills to 8.6, so that the increase in freight earnings is due entirely to an increase in the business handled. In the passenger business there was a slight increase in the average rate. The passenger mileage increased less than 1 per cent.

The conspicuous feature of the income account is the enormous increase in transportation expenses. Gross earnings increased but 4 per cent., while transportation expense increased almost 13 per cent., or about three times as fast. In fact, the increase in transportation and general expense absorbed nearly 90 per cent. of the increase in gross earnings. The report is very meagre in the information that bears vitally on operation. Hence we can form no opinion as to how this heavy increase occurred. In the train load, both passenger and freight, the company made substantial improvement:

| | 1904. | 1903. | Inc. |
|---|---|---|---|
| Pssgr train-mile revenue | $1.36 | $1.26 | $0.10 |
| Freight train-mile revenue | 2.38 | 2.31 | .07 |
| Tons per freight train | 2.78 | 2.66 | .12 |
| Tons per loaded freight car | 15.53 | 14.78 | .75 |

This improvement in the freight train load is the more to be commended because it was in face of a bad balance of traffic. The empty car mileage increased nearly 10 per cent. Expenditures for maintenance of way appear to have been liberal, being $1,168. On the equipment the outlay was yet more liberal—$2,500 per locomotive, $75 per freight car, and $800 per passenger train car. The entire maintenance outlay was 10 per cent. greater than last year.

Burlington has had a fair year of growth. The stable character of its prosperity is amply evident, as also the conservatism in its operation. It is financially in a strong position. The extraordinary transportation expense must have some explanation in extraordinary conditions in the past year; no other explanation is consistent with the reputation of the men in charge of the company's affairs. We do know, however, that the winter in the northwest was one of unprecedented severity.

## NEW PUBLICATIONS.

*Elements of Mechanical Drawing.* By A. P. Jamison, Assistant Professor of Mechanical Drawing, Purdue University. New York: John Wiley & Sons, 1904. Cloth, 226 pages. Price $2.50.

Mechanical drawing is a subject not to be learned entirely from books, but a good book is a great aid to the student in teaching him some of the fundamental principles of drawing. In many ways there is as much skill and manual dexterity required in making mechanical drawings as there is in making free-hand drawings, although possibly the imagination cannot be given such free play. The average college course in mechanical drawing teaches the student only the rudiments, and in so far as it is possible to put into book form the many suggestions and criticisms which are the chief benefit in a course where the student comes in personal contact with the instructor, these suggestions and criticisms have been embodied in this latest book on mechanical drawing. The author has had a number of years' experience as an instructor in a large technical college, and has drawn copiously upon his lecture notes to compile a book which is at once a text book and a reference book. About 140 illustrations are included in the text and they are all uniformly excellent.

*Methods and Costs of Rock Excavation.* By H. P. Gillette. New York: M. C. Clark. Price $3.

The author has endeavored in this book to gather together sufficient data to enable an inexperienced engineer to predict the cost of rock excavation with tolerable accuracy and also to point out how and where savings can be effected in the ordinary methods for this class of work. The book includes within its scope not only quarrying and open cut excavation, but trenching, sub-aqueous excavation and tunneling as well. Many practical hints and actual examples taken from practice of the cost of rock work are given. One chapter deals in particular with the cost of railroad tunnels. As a reference book for those who have occasion to estimate and carry out rock excavation of almost any kind this book should be particularly valuable.

*Per Diem Rates for Car Service.*—The articles by Mr. Arthur Hale, Chairman of the Car Service Committee of the American Railway Association, on the working of the per diem car service rules during the past two years, which were published in the *Railroad Gazette* of October 14 and 21, have been reprinted in pamphlet form, and copies may be had at the office of the *Railroad Gazette* at 25 cents each. On orders for the pamphlets in quantities a discount will be made.

## TRADE CATALOGUES.

*Something Pneumatic* for October contains illustrated articles on "Pneumatic Tools for Eastern Countries," reprinted from the *Indian and Eastern Engineer* for April; "Mechanical Appliances in Modern Shipbuilding," by Waldon Fawcett; "Construction of the Minnesota," the new steamer of the Great Northern R. R. There is also a note of thanks from the Vice-President of the Fifth National Industrial Exhibition of Japan to the Chicago Pneumatic Tool Company, for its exhibit at this exhibition, the original being reproduced, with a translation below.

*Henry R. Worthington*, 114 Liberty street, New York, issues Bulletin No. 114, describing "underwriter" fire pumps designed to meet the specifications of the insurance companies. These pumps have air and vacuum chambers, relief valves, pressure gages and other special devices differing considerably from ordinary trade pumps. The back cover of the pamphlet shows the 14 Worthington fire pumps supplied to the Louisiana Purchase Exposition for the protection of the buildings at the fair.

*The A. S. Cameron Steam Pump Works*, New York, sends a miniature reproduction

of part of its complete catalogue. It contains a few of the many designs of pumps made by this company. A number of illustrations of pumps and their detaills are given as well as a detailed description of the Cameron steam end and water valve chest. It also contains a brief article on Simplex vs. Duplex pumps, and directions for ordering, setting up and running pumps are given.

*The Chicago Pneumatic Tool Company*, Chicago, has issued a new catalogue. It is 6 in. x 9 in. and contains 126 pages. The cover designs are original and appropriate, being engraved from well-executed sepia drawings. The book is printed on enameled paper and is well designed and arranged. It covers completely the large and varied line of products of the company, and is fully illustrated.

*The George F. Blake Manufacturing Company*, New York, has published a new edition of its General Catalogue, the 150 pages of which describe and illustrate steam pumps for every possible service, including boiler feeders, mining pumps, water-works pumping engines, vacuum pumps, air pumps and condensers, etc. This company has recently established a new machine shop and foundry.

*Greenlee Brothers*, Chicago, and Rockford, Ill., is distributing its catalogue. It consists of a number of nicely bound circulars 9 in. x 12 in., which illustrate and describe in detail railroad car shop and other special wood working machines, mortising chisels, machine boring bits, augers, etc.

*The Laidlaw-Dunn-Gordon Company*, New York, is distributing its bulletin L-602. It describes a special steam-head for operating deep well pumps, which is designed for pumping from all classes of wells where it is necessary to place the pump cylinder far below the steam cylinder.

*The Chicago Tool & Supply Company*, Chicago, issues a four-page circular relative to Green pneumatic hammers, Dunlap piston air drills, pneumatic motor hoists, reversible back-geared pneumatic motors, rivet heating forges, air compressor and other specialties which it handles.

# CONTRIBUTIONS

## The Manibill.

Boston, Mass., Nov. 11, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Being much interested in an improved method of manifesting devised by Mr. Felch, I must object to the summary manner in which you dismiss that method in the last paragraph of your otherwise interesting article upon the manibill in your issue of Nov. 4th.

The whole trend of modern accounting is towards the indvidual original record, made in such manner and in sufficient quantity to be arranged and assembled to obtain any desired result; and the railroads will have to come into line as the demand for detail statistics becomes ever more insistent.

The manibill being a step in this direction is worthy of serious attention, but it does not go far enough. When a shipper makes a forwarding order, he makes the original record, which only needs the addition of rate, charges, route, car number, to make it the ideal waybill; ideal, because it prevents all errors in the directory and descriptive parts of the bill due to transcribing, such as billing to wrong name, wrong station, omission of, or misnaming articles, omission of address, omission of expense, or billing prepaids as collect and vice versa. And it is just as practicable to make all the necessary papers at the time the receipt is made as it is to transcribe from that receipt to produce the same result as is done under the manibill system.

Under Mr. Felch's method the following are some of the advantages. The blanks are simple and easily filled out, and being of a convenient size, would be often made by the typewriter; the fact that the consignee gets the identical work of the shipping house, tends to improve the latter's work in legibility and correctness, while all corrections necessary to make order correspond with shipment, showing upon all the papers, fixes the same so that all can understand. The provision for station stamp furnishes the shipper with definite information as to just who handled his consigment and makes tracing and further inquiries easy. No delay on account of the necessity of copying in billing, as the waybill is ready to go, before it would be possible to seal the car and get it into the train. All bills, and accompanying papers can be placed in a pocket with mica front, folded so as to show all route directions. All bills, delivery checks, arrival notices and check out slips, being in the writing of the consignor permits of an accuracy in delivery that cannot be obtained from a recopy of the original. The directory and descriptive parts of the papers being the work of the shipper, the consignee can take up any discrepancies direct instead of working through the railroads as is now necessary, thus saving a mass of correspondence, claims and misunderstandings. Shippers are benefited by a more expeditious and correct handling of shipments; by the customer getting an identical copy of the shipping advice, with all marks and numbers to aid in fixing the particular shipment; both consignor and consignee benefited by relief from errors of incompetent, or careless, bill clerks. The railroad is benefited in it not being possible to make an error in the directory and descriptive parts of the billing; in that it will save all the time and cost of recopying the billing instructions of the shippers.

F. LINCOLN HUTCHINS.

## Steel Cars.*

Metal cars in the Unted States, while comparatively of a late origin, the first of any quantity being built in 1897, are yet older than is generally known. To-day we are sometimes surprised to find in an out-of-the-way corner a car of some queer design that probably made a great stir in its own small world when it was new, but which has long since been forgotten and abandoned, except by those who are unfortunate enough to have to keep it in repair. These types of cars are often pointed to as an example of the ultimate end of the modern product. A short time ago I came across some all-metal box cars in a railroad yard that had been in service about 25 years and are now doing duty as ash cars. These cars bear about as much resemblance to the modern steel car as an old wood burner does to our latest type of locomotive, and were, no doubt, of a weak design, even for the time in which they were built. Using them, therefore, as an argument against our modern designs would be manifestly unfair.

The question of corrosion has been much discussed and there are those who are extreme enough in their views to claim that a car of steel construction would, in the course of time, by the action of weather, etc., entirely disintegrate. It is safe to assume that one portion of a car will fail before the remainder; what that portion is will be due to the individual service of the car in question and to the ability and forethought of the designer. I have only to say that the first cars built by us in 1897 have been running in the coal and ore trade continuously, and do not show evidence of deterioration from any cause. We have records of cars in service on the Eastern Railway of France built in 1869, showing in 28 years of service a loss of only 6 per cent. by corrosion.

The claim that the chemical action of coal from a "wet" mine will eat through a plate in a short time has not as yet been clearly proved by actual results. Take, for example, a locomotive tender; it represents a condition that a car would never meet, yet it has never been suggested to substitute a wooden lining in the coal hoppers. Suppose that a car has been left on a side track for a few years, loaded with soft coal and exposed to all inclement weather. This, of course, is practically an impossible condition in these days of the *per diem* system; but, supposing that this happened and that this car had got in such condition as to need repair. The parts affected could be repaired or cut out and replaced just as easily and as cheaply as similar parts could be replaced on a wooden car. It is much easier to cut out soft-steel rivets with a cutter and a maul than it is to saw through a soggy piece of timber with nails in it.

One of the large railroads operating between 20,000 or 30,000 steel cars, determined, by actual experiment, that the steel plates used in its cars lost about $^1/_{200}$ of an inch in four years by corrosion. This company is not repainting any more of its steel equipment. From an artistic point of view this is not a success, as a train of unpainted cars after several years' use would present a color scheme something akin to a battered tin dinner pail; but when the results show on the right side of the balance sheet, the appearance of equipment is not usually considered.

In New England the tendency has been, with a few exceptions, to adhere to an all-wood construction. The principal reason for this is not prejudice, but a conviction, that steel construction is desirable only when used in connection with a high-capacity car. The service on a majority of the roads in this section does not usually demand a box car of over 60,000 lbs. capacity, and steel construction has been considered unnecessary. The cost of a 60,000 lbs. capacity wooden car, not including a flat car or a car designed for special purposes, is from $18 to $30 per ton of carrying capacity. This price, of course, is governed by the following conditions: The type—a box car costing more than a gondola; the specialties used, including trucks; the ideas and ability of the man designing the car. A 60,000 lbs. capacity box car with the same specialties and trucks and with steel underframe will cost from $2 to $4 more per ton carrying capacity, or from $60 to $125 per car. It will be shown later by comparative figures, based upon the net earnings throughout their assumed life, that this increase in first cost is advisable.

The reasons for building small-capacity box cars should not apply in this section to gondolas and flats. The lading in cars of this type is of such a character that a higher capacity car made of steel could be used to great advantage.

One point in favor of steel construction in a box car is that the underframe being rigid, the posts and braces are called upon to resist only the shocks from horizontal strains

*Extracts from a paper by J. F. MacEnulty, Pressed Steel Car Company, read at the October meeting of the New England Railroad Club.

of the load. A wooden underframe is continually settling, and the superstructure is thus brought in to assist the sills in supporting the vertical load. This results in bulging sides and ends and leaky roofs. By the use of a rigid steel underframe there is also a saving on the flange wear of the wheels. The timber used in wooden car construction is not thoroughly seasoned. It may be bought as seasoned timber, but it is very seldom that it is up to the specification desired. As a result from natural shrinkage, a wooden underframe will in the course of time ride flat on the truck side bearings. This causes an increase in friction on the wheel flanges with corresponding results. A properly constructed steel frame will hold up under any conditions and allow free movement of cars of the same capacity, but it can be readily seen that there would be a marked difference. The constant increase in motive power units and the heavier tonnage being hauled per train is fast bringing about a condition that will necessitate the introduction of steel in the underframe of every new car built. Cars are constantly being hauled in trains of 2,000 tons or over, and they are subjected to severe buffing strains from the shocks of heavy high-capacity cars shifted against them in the classification yards. To construct a wooden frame to successfully meet these conditions and withstand the increasing rough usage would necessitate an outlay of first cost that would be useless, when the comparatively small increase of outlay necessary for a steel car is considered.

a fair average for a car in continual service. The average life of a steel car is assumed at 25 years. None of the modern cars are old enough as yet to accurately determine their life. In those cars first built there are no signs of wear that accurate figures can be based upon. Basing an estimate on cars in service abroad, however, 25 years is a conservative figure. At the end of the 15-year life of the wooden car the cost, earning power, depreciation, etc., of a second wooden car must be introduced in order to equalize the time represented by the longer life of the steel underframe car—the cost of the second car being taken from the sum earned by the first car at the end of 15 years, and the balance of the money being carried forward with a credit of compound interest

Comparative Earning Value of Steel and Wood Under-Framed 80,000-Lb. Capacity Box Cars.

| Framing. | Purchase price. | | Earnings at the end of— 5 years. | 10 years. | 15 years. | 20 years. | 25 years. |
|---|---|---|---|---|---|---|---|
| Steel underframe. | $730 | Earnings at $990.00 per annum for 1st 5 years plus 5 per cent. interest | $5,470.35 | | | | |
| | | " " 961.00 " " " 2d 5 " " 5 " " | ..... | $12,291.81 | | | |
| | | " " 954.00 " " " 3d 5 " " 5 " " | ..... | ..... | $20,959.25 | | |
| | | " " 948.00 " " " 4th 5 " " 5 " " | ..... | ..... | ..... | $31,988.18 | |
| | | " " 940.00 " " " 5th 5 " " 5 " " | ..... | ..... | ..... | ..... | $46,019.98 |
| | | Less :—Depreciation of value of car at 4 per cent. per annum | 129.71 | 235.46 | 321.69 | 392.00 | 421.50 |
| | | Interest on purchase price of car at 5 per cent. per annum | 201.67 | 459.06 | 787.55 | 1,206.90 | 1,540.32 |
| | | Cost of repairs and renewals at $15.00 per annum for 1st 5 years | 75.00 | | | | |
| | | " " " " " 18.00 " " 2d 5 " | ..... | 165.00 | | | |
| | | " " " " " 21.60 " " 3d 5 " | ..... | ..... | 273.00 | | |
| | | " " " " " 25.92 " " 4th 5 " | ..... | ..... | ..... | 402.60 | |
| | | " " " " " 31.10 " " 5th 5 " | ..... | ..... | ..... | ..... | 557.50 |
| | | Interest on cost of repairs and renewals at 5 per cent. per annum | 4.12 | 6.11 | 8.79 | 12.41 | 17.27 |
| | | Total | $410.50 | $865.63 | $1,391.03 | $2,013.91 | $2,536.59 |
| | | Credit by scrap value of car | 189.00 | 189.00 | 189.00 | 189.00 | 189.00 |
| | | Net charge against car | 221.50 | 676.63 | 1,202.03 | 1,824.91 | 2,347.59 |
| | | Net earnings | 5,248.85 | 11,615.18 | 19,755.22 | 30,163.27 | 43,672.39 |
| | | Earnings per $1.00 of purchase cost of car | 7.19 | 15.91 | 27.00 | 41.31 | 59.82 |
| | | Percentage of earnings per $1.00 invested in purchase cost of car as compared with wood-framed cars INCREASE | ..... | ..... | 8 1/10% | ..... | 118 8/10% |
| Wood underframe 1st car. | $660 | Earnings $960.00 per annum for 1st 5 years, plus 5 per cent. interest | $5,304.60 | | | | |
| | | Earnings 864.00 per annum for 2d 5 years, plus 5 per cent. interest | ..... | $11,441.38 | | | |
| | | Earnings 826.00 per annum for 3d 5 years, plus 5 per cent. interest | ..... | ..... | $18,340.35 | | |
| | | Less :—Depreciation of value of car at 6 per cent. per annum | 168.31 | 291.83 | 382.48 | | |
| | | Interest on purchase price of car at 5 per cent. per annum | 182.34 | 415.07 | 712.09 | | |
| | | Cost of repairs and renewals at $35.00 per annum for 1st 5 years | 175.00 | | | | |
| | | " " " " " 57.50 " " 2d " | ..... | 462.50 | | | |
| | | " " " " " 80.00 " " 3d " | ..... | ..... | 862.50 | | |
| | | Interest on cost of repairs and renewals at 5 per cent. per annum | 9.66 | 18.55 | 29.89 | | |
| | | Total | $535.31 | $1,187.95 | $1,986.96 | | |
| | | Credit by scrap value of car | 158.48 | 158.48 | 158.48 | | |
| | | Net charge against car | | | | | |
| | | Net earnings | $376.83 | $929.47 | $1,828.48 | | |
| | | Earnings per $1.00 of purchase cost of car | 4,927.77 | 10,511.91 | 16,511.87 | | |
| | | Percentage of earnings per $1.00 invested in purchase cost of car as compared with steel underframe DECREASE | 7.46 | 15.92 | 25.01 | | |
| Wood underframe 2d car. | $660 | Earnings 1st car at end of 15 years less cost of 2d car at 5 per cent. interest | ..... | ..... | $15,851.87 | $20,231.45 | $25,821.30 |
| | | Earnings at $960.00 per annum for 1st 5 years, plus 5 per cent. interest | ..... | ..... | ..... | 5,304.60 | ..... |
| | | Earnings at 864.00 per annum for 2d 5 years, plus 5 per cent. interest | ..... | ..... | ..... | ..... | 11,441.38 |
| | | Total | ..... | ..... | ..... | $25,536.05 | $37,262.68 |
| | | Less :—Depreciation of value of car at 6 per cent. per annum | ..... | ..... | ..... | 168.31 | 291.83 |
| | | Interest on purchase price of car at 5 per cent. per annum | ..... | ..... | ..... | 182.34 | 415.07 |
| | | Cost of repairs and renewals at $35.00 per annum for 1st 5 years | ..... | ..... | ..... | 175.00 | ..... |
| | | " " " " " 57.50 " " 2d " | ..... | ..... | ..... | ..... | 462.50 |
| | | Interest on cost of repairs and renewals at 5 per cent. per annum | ..... | ..... | ..... | 9.66 | 18.55 |
| | | Total | ..... | ..... | ..... | $535.31 | $1,187.95 |
| | | Credit by scrap value of car | ..... | ..... | ..... | 158.48 | 158.48 |
| | | Net charge against 2d car | ..... | ..... | ..... | 376.83 | 1,029.47 |
| | | Net earnings of 2d car, plus earnings of cash from 1st car | ..... | ..... | ..... | 25,159.22 | 36,233.21 |
| | | Earnings per $1.00 of purchase cost of both cars | ..... | ..... | ..... | 19.04 | 27.37 |
| | | Percentage of earnings per $1 invested in purchase cost of 2 wooden underframe cars as compared with 1 steel underframe car DECREASE | ..... | ..... | ..... | ..... | 54 2/10% |

trucks. The influence of this condition is shown also in drawbar pull of locomotives. It has been determined by two of the large railroad systems that the drawbar pull required to move a ton of freight in a properly constructed car of 100,000 lbs. capacity is 24 per cent. less than is required to move the same amount in an average wooden car of 60,000 lbs. capacity. The locomotive expense affected by this is about 15 cents per mile.

With a yearly mileage of 480 train or locomotive miles at 15 cents per mile the total cost per year would be $72. If the same load is moved in a steel car this saving of 24 per cent. would amount to $17.28 per year. This percentage would, of course, not be so great, comparing steel and wood

Reports from different railroads place the average cost of repairs to wooden cars at from $35 to $80 per car per year—this last figure being from a system that uses more than 100,000 wooden cars over a large territory. The average cost of repairs to steel cars and cars of steel underframe ranges from $9 to $15, and that, too, on cars which have been in service six or seven years.

The comparative cost of maintenance of steel and wooden cars has been carefully worked out by Mr. C. A. Lindstrom. The accompanying table is based upon actual results obtained from roads using steel and wooden cars. The life of a wooden car has been put at 15 years. There are, of course, instances where wooden cars have been in service for a longer time, but this figure is

at the rate of 5 per cent. per annum. While these figures are based upon an 80,000-lbs. capacity car, the proportionate results for other capacities are similar.

It has been calculated (International Railway Congress, Bulletin No. 5) that to haul the additional weight of an 80,000-lbs. car costs $23.10 per year. This can be paid for by hauling seven tons 857 miles. The increase in cost for hauling a 100,000-lb. car at the same proportion can be paid for by hauling seven tons 1,000 miles. A steel underframe for an 80,000-lb. car adds to first cost, approximately from $70 to $150, and for a car of 100,000 lbs. capacity about $175. It can, therefore, be assumed that as this is practically the only additional cost, the saving in repairs would pay for the increase

in first cost in a short time, giving a desirable interest on the first investment. To this, of course, can be added the additional earning power due to loads exceeding the capacity of a 60,000-lb. car. It has been recognized by some of the larger roads of the country that they will get loads of over 60,000 lbs. in a box car often enough to pay, at this rate, for the hauling of the additional weight and realize a comfortable profit be-

carry timbers cut to size for immediate use.

The saving resulting from the use of steel equipment can be stated roughly, as follows:

Reduced number of cars required for any given train load with a resultant loss of friction and atmospheric resistance.

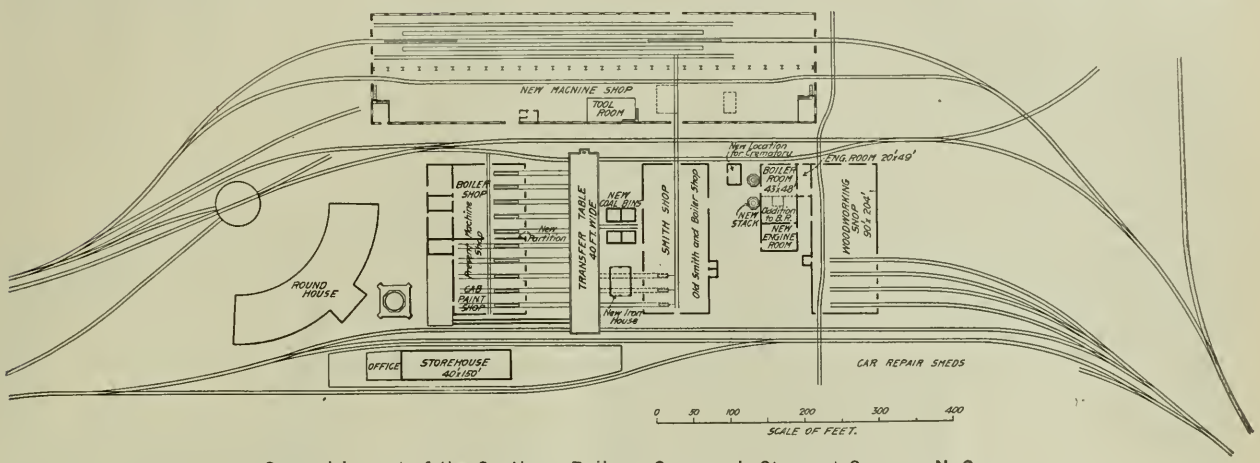
Decreased liability of wreckage and security from loss by total destruction.

Increased tonnage pulled by locomotive.

Increase in mileage due to less time on

## Improvements at the Spencer Shops of the Southern Railway.

The Southern Railway Company has just completed the enlargement of its locomotive repair shops at Spencer, N. C. The work consists essentially of a new locomotive erecting and machine shop together with additions and rearrangements of some of the old buildings. S. Higgins, former Me-




General Layout of the Southern Railway Company's Shops at Spencer, N. C.

sides. This condition would probably be made manifest in New England by actual trial.

When a man who has been used to repairing wooden cars is called upon to patch up steel cars his first wish is that he had spent some years of his apprenticeship in a boiler shop. This is particularly the case on roads which have no steel cars and have made no provision for repairs to that class of cars. A comparatively small outlay will prepare a road, however, for any repairs that are needed. An expenditure of about $1,000 will furnish portable forges, oil burners with air-blast attachments, pneumatic hammers, mauls, formers, drift pins, etc., to keep in repair any reasonable number of steel cars. As for the education of the men for this class of work, a very few days is sufficient to make experts of repair men of average in-

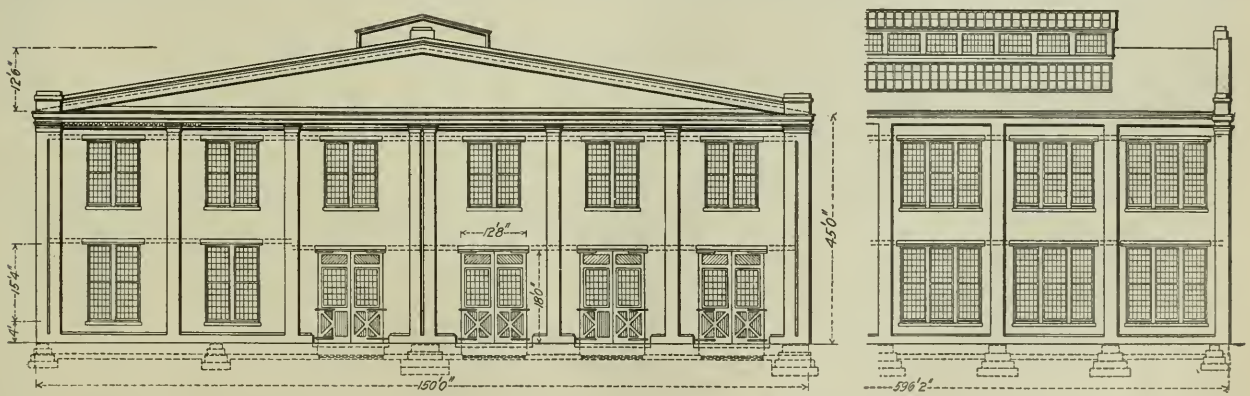
repair track with consequent decrease in cost of inspection.

By way of comparison the following table which was compiled in 1900 is given. In that year there were in actual service in the United States on different railroad systems about 1,500,000 wooden cars, with an average weight of over 14 tons each, making the total weight of all wooden cars in service about 21,000,000 tons.

| | |
|---|---|
| Average capacity of wooden cars, tons | 25 |
| Total capacity of all cars, tons | 37,500,000 |
| Average yearly mileage of loaded car | 3,500 |
| Average yearly mileage of empty car | 3,500 |
| Assumed average gross earnings per ton-mile, mills | 8 |
| Assumed average cost of moving 1 ton 1 mile, mills | 3 |
| Yearly income from assumed gross earnings | $1,050,000,000,000 |
| Yearly cost of hauling load | 394,000,000,000 |
| Yearly cost, hauling dead weight | 441,000,000,000 |
| Total yearly profit | $215,000,000,000 |

If the above-mentioned lading of 37,500,000

chanical Superintendent, was the first to suggest making improvements and to present the subject in a tangible form to the management. He submitted a number of plans, including both longitudinal and transverse layout. Mr. Higgins recommended the longitudinal layout which was finally adopted as submitted by him with but few modifications. S. D. Cushing, Signal and Electrical Engineer, assisted Mr. Higgins in preparing the plans and estimates, and was put in charge of all of the detail work. The buildings were designed in the office of D. W. Lum, Chief Engineer Maintenance of Way and Structures. After the plans were completed and the orders for the tools had been placed, Mr. Higgins resigned to become General Manager of the N. Y., N. H. & H. Railroad. The plans were turned over to his successor, A. Stewart, who carried them




End and Part Side Elevation of Machine and Erecting Shop.

telligence who have formerly worked only on wooden cars.

The majority of roads having steel equipment have educated their repair men to both classes of cars, and the work is now done as easily as though there was but one class of equipment. It is, of course, advisable for a road having in service a number of steel cars to carry in stock such repair parts as would likely be needed, just as they now

tons, representing the entire freight-carrying capacity of cars in the United States, was concentrated in large capacity, light-weight steel cars, the dead weight would be cut down from 21,000,000 tons to 14,000,000 tons, and the resulting saving in cost of transportation would be $147,000,000. This, of course, is a purely speculative calculation but under any local conditions the proportion holds and there is the same ratio of economy.

through as originally designed. The work was done under the supervision of S. R. Richards, Master Mechanic of the shops. The general design of the shops varies from that of other shops of recent design in that the old buildings were used. No addition has been made to the freight car repair department, as this department now has ample facilities for making both light and heavy repairs. All the improvements are for in-

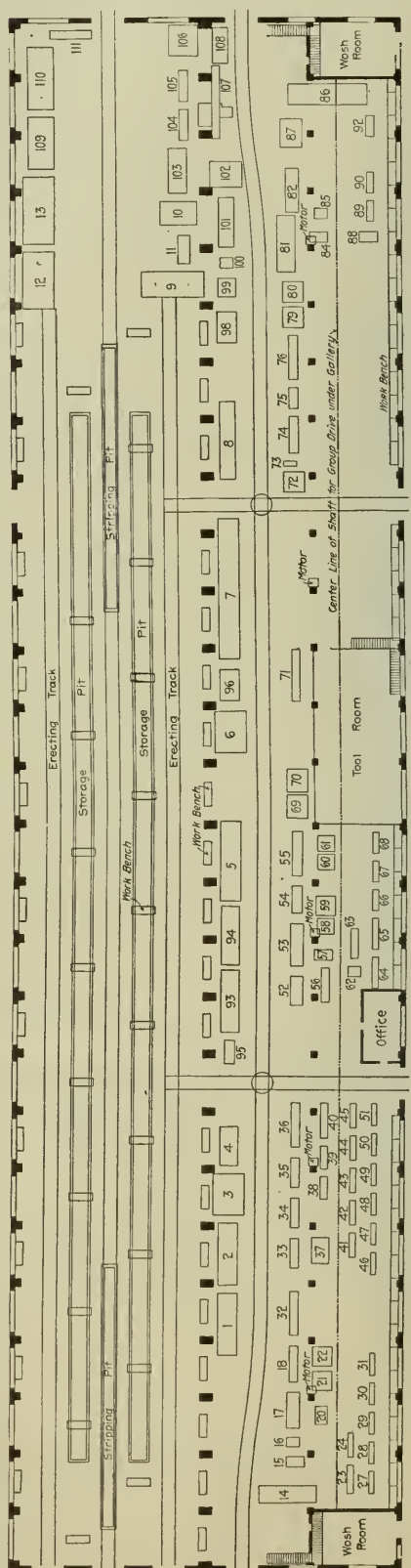
creasing the capacity of the locomotive repair department. It is expected that the shops will be large enough to handle all heavy locomotive work for the eastern district. These shops are the first modern shops built by the Southern.

Ground was first broken in March, 1904, and the contract for the locomotive erecting and machine shop was awarded to J. P. Pettyjohn & Co., Lynchburg, Va. The general layout of the shops is shown in the accompanying illustration. The transfer table pit is 40 ft. wide by 200 ft. long. The smith shop is on one side of the pit and on the other side is the boiler and cab paint shop. The power house is about 50 ft. east of the smith shop. The woodworking shop adjoins the power house, and the two car repair sheds are near the woodworking shop. The new machine and erecting shop is north of the other buildings. The roundhouse has 15 engine pits. It is the intention to increase the capacity of the roundhouse. The coal trestle and coal storage space is south of the roundhouse and is not shown on the general plan. The following table gives the dimensions of the principal shop buildings.

| | |
|---|---|
| Locomotive erecting and machine shop | 150 ft. x 600 ft. |
| Boiler shop | 100 ft. x 102 ft. |
| Smith shop | 90 ft. x 204 ft. |
| Woodworking shop | 90 ft. x 204 ft. |
| Power house | 48 ft. x 115 ft. |
| Store house | 40 ft. x 120 ft. |
| Office | 30 ft. x 40 ft. |

*The Power House.*—The old power plant consisted of a boiler house 43 ft. x 48 ft., which contained four 100 h.p. boilers. These boilers furnished steam for engines which were in the several shop buildings. All the power is now generated electrically in the power house, which has been enlarged by an addition 48 ft. x 72 ft. The addition is of corrugated iron and steel frame construction, built on a concrete foundation. The engine room is 36 ft. x 48 ft. The floor of the power house is heavy concrete. The boiler equipment consists of the four old 100 h.p. boilers which work at 100 lbs. steam pressure and three new 150 h.p. boilers which work at 150 lbs. pressure. The new boilers are made by the Walsh & Weidener Boiler Company, Chattanooga, Tenn. A Stilwell cast-iron open heater, made by the Platt Iron Works Company, Dayton, Ohio, and a Herron pump made by the Herron Pump Company, Chattanooga, Tenn., are also installed in the boiler house. Two brick chimneys 85 ft. high by 6 ft. inside diameter furnish the necessary draft. One of these chimneys is new and was built by the Alphons Custodis Chimney Construction Company, New York. The new and old steam piping is so interconnected with valves that either set of boilers can be used to supply all steam. The pipe and fittings were furnished by the Crane Company, Chicago. The railroad company erected the piping. The engine room equipment consists of two 16 in. and 27 in. x 16 in. Westinghouse compound non-condensing engines. These are direct connected to two 200 k.w. 250 volt direct current Westinghouse generators. Two air compressor made by the Chicago Pneumatic Tool Company furnishes compressed air for the pneumatic tools. No mechanical device has been installed for handling coal and ashes, as colored labor is very cheap in the south. It was thought inadvisable to put in an expensive coal handling system owing to the fact that the plant is relatively small. All the water supply for both the shops and the locomotives at Spencer is procured from the Yadkin river three miles away. The railroad company has a pumping station at the river and from there the water is forced through an 8 in. pipe into a large tank at the shops. The water supply system is to be increased to about double its present capacity.

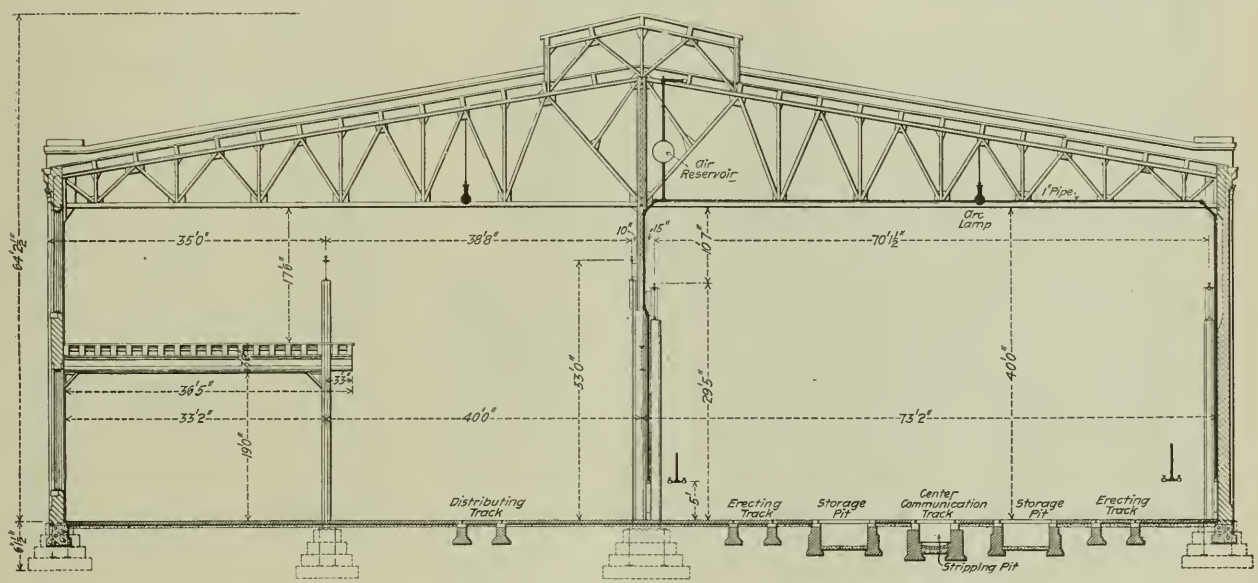
*Locomotive Erecting and Machine Shop.*—This shop is 600 ft. long by 150 ft. wide and cost about $160,000. The walls are brick on concrete foundations. About 40 per cent. of the wall and roof area is glass, thus giving good natural lighting. The columns and roof trusses are steel and were built by the American Bridge Company. The roof is fitted with Paradigm skylights and the floor is made of vitrified brick placed on edge and filled in with concrete grouting. The erecting shop is on one side of the building. It has two longitudinal erecting tracks each 480 ft. long. By allowing 40 ft. per locomotive it is possible to shop 24 engines at one time on these tracks. The number of sq. ft. of floor space in the machine shop per engine is 3,000 and in the erecting shop it is 1,600 sq. ft., making a total for both the machine and erecting shops of 4,600 sq. ft. per engine. This is a larger ratio of floor space to engine pit than found in any other railroad shop that we know of. On the inner side of each erecting track is a concrete storage pit 4 ft. wide x 4 ft. deep. These pits have drains which connect with the sewer. The central communication track is placed between these pits and passes through the entire building. In the middle of this track and near each end of the erecting track is a stripping pit 100 ft. long. An engine coming in for repairs is run over either one of these pits, the motion work is taken off and the wheels are freed. The locomotive is then taken up by the heavy cranes and placed on either of the erecting tracks. The wheels are then removed by the crane and are taken to the wheel repair department at one end of the shop. A standard gage industrial track passes through the shop midway between the outer edge of the gallery and the center columns. The machine tools are placed as shown in the accompanying illustration, and are both direct and group driven by direct current motors, made by the Northern Electrical Manufacturing Company, Madison, Wis. For direct driven tools, that company's two wire variable speed motor is used. The two wire direct current system using 250 volts is used throughout the shops. A novel and effective method of group drive is used for the tools under the gallery. The system of drive consists of five lengths of shaft each 100 ft. long and each driven by a 20 h.p. motor mounted on a bracket. This bracket, which is shown herewith, is attached to a shop column and the motors are belted to the shafts and tools as shown in the accompanying illustration. Normally each shaft runs independently, but in case one or more of the motors fails, the several sections of shaft can be connected by means of crab clutches. This arrangement is also useful in case more power is required in any of the groups. It is hence practicable when necessary to get from 20 to 100 h.p. in any one group of tools. The heavy machine tools such as planers, slotters, heavy lathes, etc., are placed as shown and are direct driven by individual motors. Some of the lighter tools that are not equipped with motors are driven by means of an ingenious arrangement of shafting secured to the center shop column, as shown in the accompanying illustration. On account of softness of the ground over 92 concrete foundations for machine tools were necessary. On the erecting side of the shop are only heavy machine tools, such as wheel lathes and presses. These are in the corner, as shown, and consist of one wheel press, two new wheel lathes, which are direct motor driven, and two old wheel lathes which it was decided not to equip with electric drive, as it would have cost about $1,000 to fit each of these tools with a motor. The method of driving these machines, which is shown in the accompanying illustration, consists of a 10 h.p. back geared motor running at 215 r.p.m. connected to the countershaft pulley, which runs at 70 r.p.m. This arrangement cost about $400 for



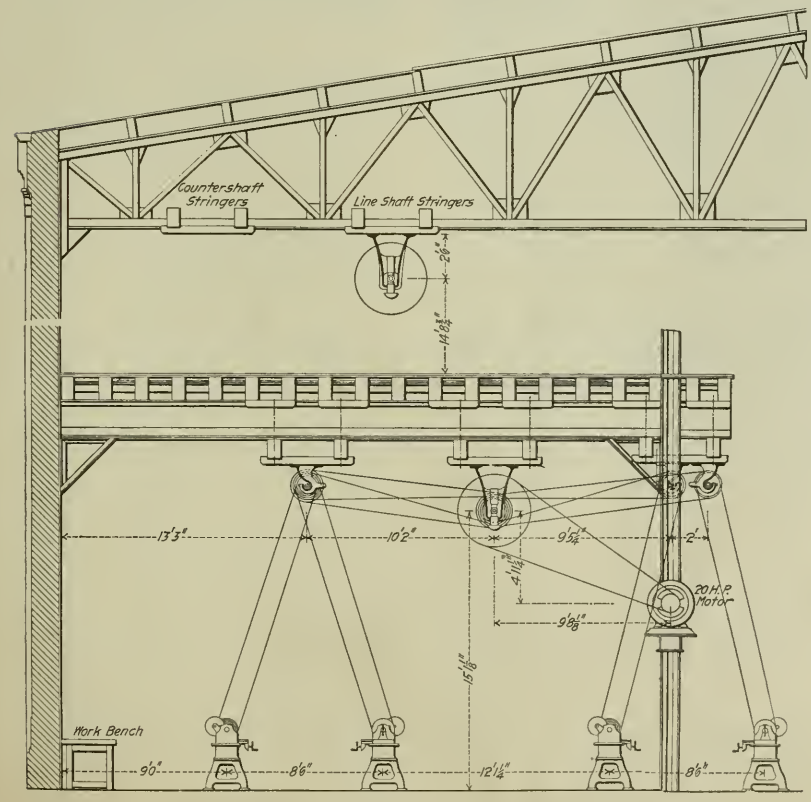

General Plan of Machine and Erecting Shop, Showing Location of Machine Tools.

each tool. Pressed steel pulleys made by the American Pulley Company, Philadelphia, Pa., are used throughout the shop. The accompanying table gives a list of both the direct motor driven tools and the group driven tools in the machine shop and the amount of power required to drive each tool.

The gallery which extends along one side of the shop is 35 ft. wide and has double flooring. The top flooring is ⅞ in. T. G. maple. It has two landing stages for receiving work from the cranes. One end of the gallery is partitioned into two rooms. One of these is used for air-brake repairs and the other for electrical repairs such as motors, electric headlights, etc. On the other portion of the gallery are light machine tools, such as turret lathes, brass working machines, etc., placed in groups electrically driven. The blowers for the Sturtevant heating system are also in the gallery. At each end of the shop and under the gallery is a two-story wash and locker room, 22 ft. x 33 ft., with basins and expanded metal lockers. The tool room is under the gallery, the lower portion of which is enclosed with matched boarding and the upper part is enclosed with expanded metal. Two 70 ft. electric traveling cranes each of 60 tons capacity serve the erecting shop, and two smaller 38 ft. cranes, one of 10 tons capacity and the other of five tons capacity, serve the heavy machine tools on the main floor and also deliver work to the gallery. All four cranes travel the length of the shop. The cranes were furnished by the Shaw Electric Crane Company. Two rows of 13 Toerring arc lights placed midway between the center of the shop and the side walls and spaced 40 ft. between centers are used for lighting the erecting shop. These lights are in line with the bottom of the roof trusses, which is about 40 ft. from the floor. The lights will run 200 hours without attention, and are cleaned from the traveling cranes. Besides these arc lights every machine has a 16 c.p. incandescent lamp enclosed in a wire net. The compressed air for operating the pneumatic tools, etc., is delivered to four air reservoirs supported in the roof trusses. The air is distributed throughout the shop through 1 in. pipes, as shown in the cross section.

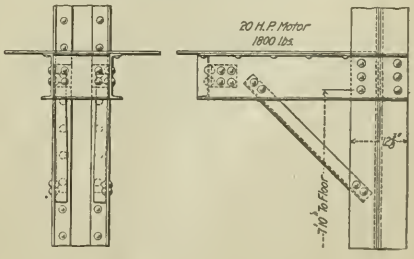



Section Through Machine and Erecting Shop.

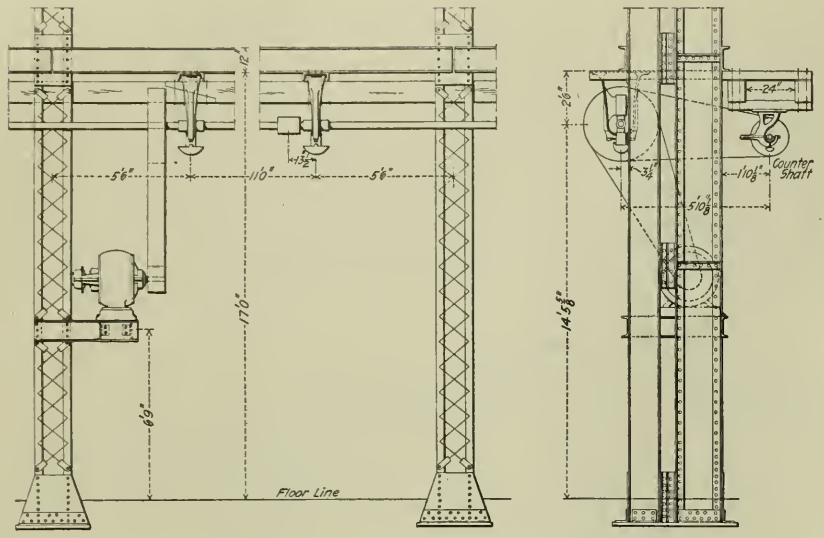



Arrangement of Shafting Under Gallery.

*Boiler and Smith Shop.*—The boiler shop has been moved from its old location in the smith shop to the building which was formerly used for machine work. This building has been partitioned, one side being used for the cab and paint shop, and the other side is for boiler work. There is nothing new or novel about the boiler shop; in fact, it will strike many, especially western railroad men, as being inadequate in size when compared to the machine shop. Owing to the excellent water the Southern has very little trouble with its boilers in this district, and hence boiler troubles are relatively rare. The smith shop is 90 ft. x 204 ft., and is of steel frame and corrugated iron construction. It is equipped with 38 cast iron forges made by the Ross Meehan Foundry Company,




Bracket for Supporting 20-h.p. Motors.




Arrangement of Shafting on Center Columns.

MACHINES DRIVEN BY INDIVIDUAL MOTORS.

| No. of mach. | Kind. | Size. | H.-p. |
|---|---|---|---|
| 1 | Planer | 48-in. x 48-in. x 10-ft. | 15 |
| 2 | Planer | 48-in. x 36-in. x 10-ft. | 15 |
| 3 | Radial drill | 7-ft. arm. | 3 |
| 4 | D'ble-head shaper. | 24-in. | 10 |
| 5 | Planer | 48-in. x 48-in. x 15-ft. | 15 |
| 6 | Radial drill | 7-ft. arm. | 3 |
| 7 | Planer | 48-in. x 48-in. x 26-ft. | 15 |
| 8 | Milling mach. | 30-in. x 30-in. x 14-ft. | 10 |
| 9 | Planer | 60-in. x 60-in. x 10-ft. | 20 |
| 10 | Slotter. | 26-in. | 10 |
| 11 | Lathe | 42-in. x 72-in. | 10 |
| 12 | Driv'g wh'l lathe. | 90-in. | 15 |
| 13 | Driv'g wh'l lathe. | 90-in. | 18 |

MACHINES DRIVEN IN GROUPS.

*Group No. 1.*

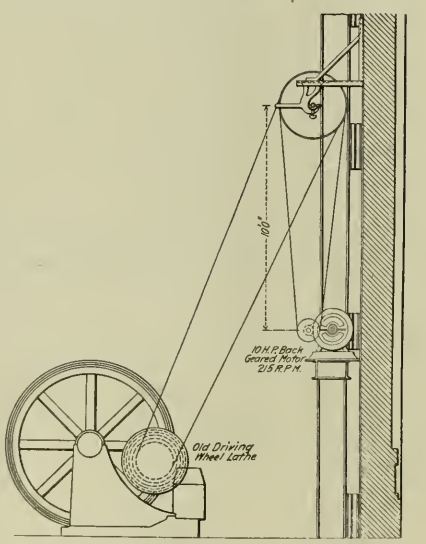
| No. of mach. | Kind. | Size. | H.-p. |
|---|---|---|---|
| 14 | Planer | 36-in. x 36-in. x 10-ft. | 10 |
| 15 | Shaper | 20-in. | 3 |
| 16 | Tool grinder | —— | 2 |
| 17 | Hor. boring mill | 60-in. | 2½ |
| 18 | Lathe | 30-in. x 84-in. | 5 |
| 19 | Turret lathe | 2-in. x 24-in. | 3 |
| 20 | Slotter | 12-in. | 3 |
| 21 | Drill press | 36-in. | 2 |
| 22 | Drill press | 36-in. | 2 |
| 23 | Lathe | 22-in. x 84-in. | 2 |
| 24 | Lathe | 16-in. x 48-in. | 1 |
| 25 | Turret lathe | —— | 3 |
| 27 | Turret lathe | 16-in. x 36-in. | 1 |
| 28 | Turret lathe | 16-in. x 36-in. | 1 |
| 29 | Turret lathe | 16-in. x 36-in. | 1 |
| 30 | Turret lathe | 16-in. x 36-in. | 1 |
| 31 | Turret lathe | 16-in. x 36-in. | 1 |

*Group No. 2.*

| | | | |
|---|---|---|---|
| 32 | Lathe | 30-in. x 132-in. | 5 |
| 33 | " | 30-in. x 72-in. | 5 |
| 34 | " | 30-in. x 72-in. | 5 |
| 35 | " | 30-in. x 72-in. | 5 |
| 36 | " | 30-in. x 132-in. | 5 |
| 37 | Shaper | 20-in. | 3 |
| 38 | Lathe. | 22-in. x 48-in. | 2 |
| 39 | " | 22-in. x 48-in. | 2 |
| 40 | " | 20-in. x 90-in. | 2 |
| 41 | " | 18-in. x 48-in. | 1 |
| 42 | " | 18-in. x 48-in. | 1 |
| 43 | " | 18-in. x 48-in. | 1 |
| 44 | " | 18-in. x 48-in. | 1 |
| 45 | " | 18-in. x 48-in. | 1 |
| 46 | " | 16-in. x 36-in. | 1 |
| 47 | " | 16-in. x 36-in. | 1 |
| 48 | " | 16-in. x 36-in. | 1 |
| 49 | " | 16-in. x 36-in. | 1 |
| 50 | " | 16-in. x 36-in. | 1 |
| 51 | " | 16-in. x 36-in. | 1 |

*Group No. 3.*

| | | | |
|---|---|---|---|
| 52 | Piston rod grinder | —— | 3 |
| 53 | Lathe. | 50-in. x 96-in. | 7½ |
| 54 | " | 36-in. x 72-in. | 5 |
| 55 | " | 36-in. x 132 in. | 5 |
| 56 | " | 24-in. x 102-in. | 2 |
| 57 | Shaper | 20-in. | 3 |
| 58 | Drill press | 40-in. | 2 |
| 59 | " " | 36-in. | 2 |
| 60 | " " | 40-in. | 2 |
| 61 | " " | 40-in. | 2 |
| 62 | Tool grinder | —— | 2 |
| 63 | Lathe | 22-in. x 84-in. | 2 |
| 64 | " | 16-in. x 84-in. | 1 |
| 65 | " | 16 in. x 84-in. | 1 |
| 66 | " | 16-in. x 54-in. | 1 |
| 67 | " | 16-in. x 54-in. | 1 |
| 68 | " | 16-in. x 54-in. | 1 |




Arrangement of Motor and Countershaft for Driving Old Wheel Lathes.

Chattanooga, Tenn. These are arranged in pairs and placed diagonally as shown. A number of these forges are new, as are also a number of the machines, such as steam hammers, shears, bolt cutters, bolt headers, etc. A liberal number of jib cranes, placed as shown in the illustration, facilitate the handling of work from the forges to the steam hammers. The blast for the forges is carried through overhead pipes directly over the center line of the forges. Each pair of forges is connected to these main blast pipes by a smaller branch pipe. The smoke jacks are placed close to the fires and connect with pipes which pass through the roof and into the open air. This keeps the shop comparatively free from smoke and gas. A standard gage track used for deliver-

*Group No. 4.*

| | | | |
|---|---|---|---|
| 69 | Vert. boring mill. | 51-in. | 5 |
| 70 | Vert. boring mill. | 51-in. | 5 |
| 71 | Turret lathe | 4¼-in. x 34-in. | 5 |
| 72 | Drill press | 42-in. | 2 |
| 73 | Rod bushing press. | 2-in. | 5 |
| 74 | Lathe. | 26-in. x 90-in. | 3 |
| 75 | " | 26-in. x 48-in. | 3 |
| 76 | Turret lathe | 4¾-in. x 24-in. | 5 |
| | Machines in tool room | | 10 |

*Group No. 5.*

| | | | |
|---|---|---|---|
| 79 | Drill press | 13-in. | 1 |
| 80 | Drill press. | 42-in. | 2 |
| 81 | Planer | 36-in. x 36-in. x 10-ft. | 10 |
| 82 | Hor. boring mill. | —— | 2½ |
| 84 | Shaper | 20-in. | 3 |
| 85 | Tool grinder | —— | 2 |
| 86 | Planer | 48x36-in. x 14-ft. 6-in. | 15 |
| 87 | Shaper | 18-in. | 3 |
| 88 | Shaper | 20-in. | 3 |
| 89 | Lathe | 18-in. x 54-in. | 1 |
| 90 | " | 18-in. x 54-in. | 1 |
| 91 | " | 26-in. x 48-in. | 3 |
| 92 | Piston rod keyway | —— | —— |
| | Cutter | —— | 1 |

*Group No. 6.*

| | | | |
|---|---|---|---|
| 93 | Planer. | 36-in. x 36-in. x 10-ft. | 10 |
| 94 | Planer | 36-in. x 36-in. x 10-ft. | 10 |
| 95 | Cold saw | —— | 5 |
| 96 | Slotter | 20-in. | 7½ |

*Group No. 7.*

| | | | |
|---|---|---|---|
| 98 | Vert. mill'g mach. | 20-in. | 5 |
| 99 | Vert. bor'g mach. | 37-in. | 3 |
| 100 | Tool grinder. | —— | 2 |
| 101 | Lathe. | 42-in. x 144-in. | 7½ |
| 102 | Radial drill | 5-ft. 6-in. arm. | 2 |
| 103 | Milling machine. | 26-in. x 26-in. x 9-ft. | 10 |

*Group No. 8.*

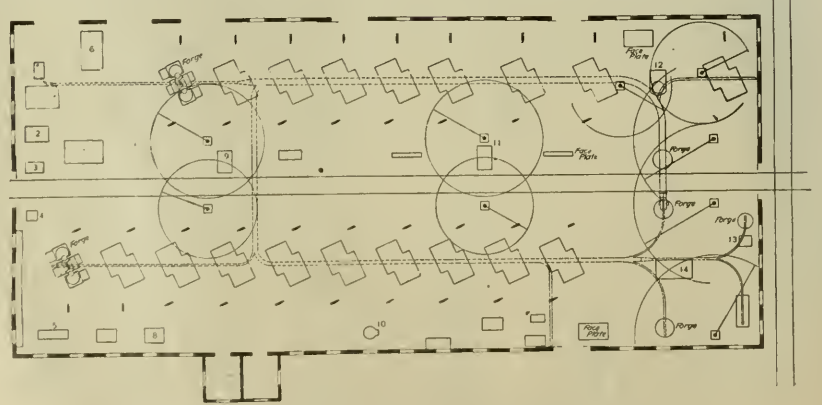
| | | | |
|---|---|---|---|
| 104 | Lathe. | 30-in. x 84-in. | 5 |
| 105 | Lathe | 30-in. x 84-in. | 5 |
| 106 | Vert. bor'g mill. | 84-in. | 7½ |
| 107 | Cylinder planer. | —— | 10 |
| 108 | Cylinder borer | —— | 3 |

*Group No. 9.*

| | | | |
|---|---|---|---|
| 109 | Driving wh'l lathe. | 78-in. | 7½ |
| 110 | Driving wh'l lathe. | 78-in. | 10 |
| 111 | Driving wh'l press. | —— | 10 |

MACHINES IN SMITH SHOP.

| No. of mach. | Kind. |
|---|---|
| 1 | 2-in. bolt header (new). |
| 2 | Bolt cutter, (old). |
| 3 | Bolt cutter (old). |
| 4 | Bolt shear (old). |
| 5 | 6-spindle nut tapper (old). |
| 6 | Punch and shear (new). |
| 7 | 3½-in. bolt shear (new). |
| 8 | 200-lb. Bradley compact hammer (new). |
| 9 | 1,000-lb. steam hammer (new). |
| 10 | Trip hammer (old). |
| 11 | Morgan steam hammer (old). |
| 12 | Beament steam hammer (old). |
| 13 | 75-lb. hammer (new). |
| 14 | 3,000-lb. steam hammer (new). |


Forge
Forge
Forge

ing materials and work passes through the center of the shop as shown.

Owing to the fact that the freight car repair capacity of the Spencer shops is not to be increased it was decided not to make any alterations to the woodworking shop, as its present equipment consists of comparatively modern tools. Practically the only extra work that this shop will be called upon to do is the cab work, and it was not thought that this would be enough to warrant building an addition.

## Comparative Cost of Fast and Slow Freight Service.*

BY W. B. POLAND, SUPERINTENDENT, BALTIMORE & OHIO SOUTHWESTERN RAILROAD.

For many years the relative economy of running slow freight trains with engines loaded to maximum capacity, compared with fast freight trains of less than the maximum capacity of engines, has been under discussion. For the purpose of collecting some data on this subject, records were kept on the Indiana Division of the Baltimore & Ohio Southwestern Railroad for the months of January and February, 1904, as follows:

First.—For common freights scheduled to travel about nine miles an hour, rating being assumed as full capacity of engine for this speed.

Second.—For semi-quick despatch freights, it being intended that this class of freight should make an average schedule speed of 15 miles an hour, rating of engines being assumed at 72 per cent. of rating for common freights.

Third.—Quick despatch freights, it being intended that this class of freights should make an average schedule speed of 19 miles an hour, rating of engine being assumed at 60 per cent. of rating for common freights.

The data collected for each of these classes of trains for separate trips was as follows:

(1) Temperature.
(2) Number of engines.
(3) Number of cars.
(4) Number of 1,000-ton miles, no arbitrary allowance being included.
(5) Running time between terminals.
(6) Rate per hour.
(7) Total time between terminals.
(8) Rate per hour.
(9) Cost of operation.
(10) Cost of fixed charges.
(11) Total cost.
(12) Cost per 1,000 ton miles.
(13) Per cent hauled of the maximum rating for common freight.

The "cost of operation" for each trip was obtained from actual cost of wages, overtime, cost of helper engine and fuel, as shown by records of that trip; the number of engine miles per trip multiplied by the total cost per mile, as shown by monthly records for the following items: Running repairs, classified repairs, oil, sand, waste, miscellaneous engine supplies and roundhouse attendants, which amounts to 14 cents per mile for the 1,500-Class engines and 8 cents per mile for the 100-Class engines.

The writer has estimated the average original value of the 1,500-Class freight engines at $11,000 each and that of the 100-Class engines at $9,000 each. An annual allowance of 5 per cent. on the value should be made for interest and 5 per cent. for depreciation, making a total of 10 per cent. per annum. In order that the use of an engine may be justified, it must earn 10 per cent. per annum on the capital invested, and must for each hour of its time be worth a proportionate amount to the railroad company. For the 1,500-Class engines this would equal about 12 cents an hour and for the 100-Class engines 10 cents an hour. This is the fixed charge made against each train for each engine for each hour in transit. The writer has assumed the average value of a freight car to be $800 and on the same basis a car, in order that its use may be justified, must earn 10 per cent. of its value per annum, which would amount to 1 cent per hour. On this basis the fixed charges for the train equipment for any trip would be 1 cent multiplied by the number of cars in the train, multiplied by the number of hours between terminals; plus $0.12 or $0.10 multiplied by the number of engines, multiplied by the number of hours between terminals.

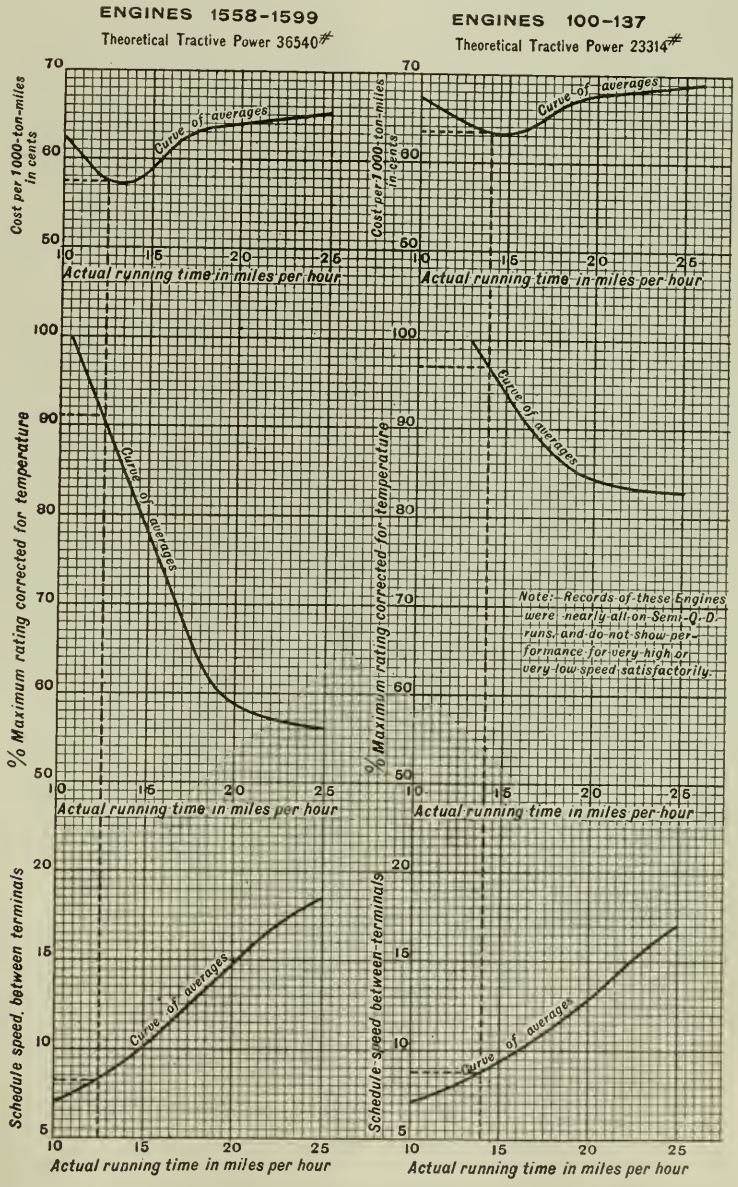
The per cent. of rating handled by each train was obtained from a tonnage statement, by dividing the actual ton-mileage made by the ton-mileage which would have been made had maximum common freight rating, corrected for temperature, been used.

The "total cost" used does not represent the actual cost of handling the train between terminals, but includes only those principal items which vary with, or are dependent upon, each trip. The cost obtained by dividing the total cost by the number of 1,000 ton miles is therefore correct for comparative purposes only.

The above data has been shown graphically on the diagram, as follows:

First.—A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the cost per 1,000 ton miles on the vertical ordinate. The curve of average results indicates the cost per 1,000 ton miles corresponding to given speeds in actual running time.

Second.—A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the percentage of the maximum rating for common freight on the vertical ordinate. The curve of average results indicates the percentage of maximum rating which must be given trains in order that their average speed may


ENGINES 1558-1599
Theoretical Tractive Power 36540#
ENGINES 100-137
Theoretical Tractive Power 23314#
Cost per 1000-ton-miles in cents
% Maximum rating corrected for temperature
Schedule speed, between terminals
Actual running time in miles per hour
Curve of averages
Note:- Records of these Engines were nearly all on Semi-Q.D. runs, and do not show performance for very high or very low speed satisfactorily.

Curves Showing Relative Economy of Train Loading.

*Reprinted from Bulletin No. 56 of the American Railway Engineering and Maintenance of Way Association.

be a certain running time in miles per hour.

Third.—A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the time between terminals in miles per hour on the vertical ordinate. The curve of average results indicates the relation between the actual running time and the schedule speed in miles per hour between terminals.

From these charts we may see graphically the comparative cost of fast and slow freight service and to a certain extent the relative economy of heavy and light motive power. When it is desired to move freight between given points on this division in a fixed time, it will be possible from these diagrams to determine the rating which must be given engines in order that they may make the desired schedule.

For the 1,500-Class compound freight engines the minimum cost is found at a speed of 13 miles an hour, which requires a rating of 88 per cent. of the maximum; but a speed of 12½ miles an hour does not increase the cost of handling appreciably and will allow 91 per cent. of the maximum rating to be hauled. By referring to the third chart it appears that an actual running time of 12½ miles an hour corresponds with a schedule speed of 8¼ miles an hour between terminals.

For the 100-Class engines the minimum cost is shown at a speed of 15 miles an hour, which requires a rating of 94 per cent. of the maximum; but a speed of 14 miles an hour does not increase the cost of handling appreciably and will allow 97 per cent. of the maximum rating to be hauled. It also appears that a running time of 14 miles an hour corresponds to a schedule speed of 8¾ miles an hour.

From the conditions existing when these records were taken, we should conclude that for the 1,500-Class engines the most economical operation will be attained by trains scheduled at 8¼ miles an hour, running 12½ miles an hour and hauling 91 per cent. of maximum common rating. For the 100-Class engines the greatest economy of operation will be attained by trains scheduled at 8¾ miles an hour, running 14 miles an hour and hauling 97 per cent. of maximum common rating.

The records of about 500 trains given above were taken during a period of exceptionally heavy traffic and also during unusually severe weather, with the temperature in the neighborhood of zero for weeks at a time. It is probable that results in warm weather would be different. It would, therefore, be desirable to make the same determinations under summer conditions and this, it is hoped, will be done later. The determination of the most economical tonnage rating by this method is independent of the rating originally assumed.

## The Grand Trunk Pacific.

Recent advices indicate that work on the much talked-of Grand Trunk Pacific will be pushed energetically during the next five or six years, and that possibly an attempt will be made to improve on the record made in hurrying the Canadian Pacific through to the coast. A tremendous task lies ahead of the Canadian Government and the private interests back of the project and the many delays and difficulties encountered in the preliminary work of organization and obtaining government sanction will doubtless fade into insignificance before the innumerable obstacles to be overcome when the actual work of building and equipping the road begins. An editorial in the *Railroad Gazette*, July 17, 1903, pointed out the possibilities of traffic over the proposed line. In the *Quarterly Journal of Economics* for November, Mr. W. L. Mackenzie King has a long article on the new railroad which analyzes in detail the agreement made by the Canadian Government to assist in the construction and comments on the policy of virtual government ownership which is to be tried. We reprint it almost in full below.

The Grand Trunk Pacific Railway Company, the Government of Canada and a private corporation are engaged at the present time in preparing for the joint construction of a railroad which, within the period of a little over seven years, will afford a new highway from the Atlantic ocean to the Pacific, every mile of which will be upon Canadian soil. The original act authorizing this work was passed during the Parliamentary session of 1903, and assented to on October 24 of that year, at the same time that assent was given to the act incorporating the Grand Trunk Pacific Railway Company. The amended act was passed at the session of Parliament held during the present year; and it is under the provisions of the act of 1903 as amended, and an act respecting the Grand Trunk Pacific Railway Company, assented to on July 18, that the work of construction will be carried out.

The Canadian Pacific, begun in 1881 and completed in 1886, is at present the only transcontinental railroad in the Dominion. The construction of any roads south of it for two decades from the time of beginning its construction was prohibited; and in that respect it had a guaranteed monopoly of the trade of the west for this period. In Eastern Canada it is but one of several railroads connecting the more important commercial centers and ports; and, since the completion of the period of its guaranteed monopoly in the west, competitors have entered the field to share with it the increased business of Manitoba and the northwest territories. The competitive lines in the east and the west form in a disjointed way a continuous transcontinental road, connecting the vast, sparsely settled tracts of the west with the more thickly populated commercial and industrial centers of the east. So far, however, as transcontinental traffic is concerned, these railroads operate within an area the commercial requirements of which are served in part by the Canadian Pacific. Neither the Canadian Pacific nor its competitors are so located as to meet the steadily increasing demands of the northward expanding industry, nor so as to be of service in opening up parts of the new territory available for settlement, both in the eastern provinces and in the west, and affording transportation facilities for such territories.

The Canadian Pacific is constructed in part through the United States. That portion from near Agnes in the Province of Quebec to St. Croix in the Province of New Brunswick is in the State of Maine. A perpetual obligation to the Government of the United States, in the nature of a "bonding privilege," is thus incurred. Obligations are a feature odious to the commercial rivalries of nations; and it is felt by many that the friendly political relations between the two countries should not be unnecessarily subjected to a strain which the dictates of a relentless commercialism might render inevitable, should the "bonding privilege" ever become a creature of its caprices.

Political expediency and commercial necessity have therefore been important determining factors in connection with the new national railroad, which is intended to develop commerce through Canadian ports, to secure the most direct and economical interchange of traffic between Eastern Canada and the provinces and territories west of the Great Lakes, and to open new channels of trade from east to west. In the language of the statute creating it, it is to serve as "a new railroad highway across the Dominion of Canada from ocean to ocean," to be directed in its course "with a view to the opening up of new territory to settlement," and to be throughout "wholly within Canadian territory." "It is a work of a national character, necessitated by the status of Canada in the year 1903, just as the Intercolonial Railway was necessitated by the status of Canada at the opening of Confederation, and just as the Canadian Pacific Railway was necessitated by the status of Canada a few years after Confederation."

The prominent feature of the plan of construction of the new transcontinental railroad is the arrangement whereby the government is to construct and own one portion of the road and a private corporation to construct and own the other portion, and, subsequently, subject to certain limitations and payments, to control the operation of the whole. The eastern terminus of the road is the city of Moncton in the Province of New Brunswick; its western terminus, the navigable waters of the Pacific ocean at or near Port Simpson or some other port in British Columbia. The proposed course of the railroad from east to west is to pass through the central part of the Province of New Brunswick and through the Province of Quebec by the shortest available line to the city of Quebec, then through the northern portion of the Province of Quebec and Ontario and through the Province of Manitoba to the city of Winnipeg, from Winnipeg through the Province of Manitoba and Northwest Territories to the Rocky Mountains by a route yet to be determined. It will then pass through the Rocky Mountains to the sea. The portion of the route from Moncton to Winnipeg is known as the Eastern Division, and is to be built by the government. The portion from Winnipeg to the Pacific is known as the Western Division, further divisible, according to the physical features of the district through which it passes into the prairie and mountain sections. This part is to be built by the Grand Trunk Pacific Railway Company, the company incorporated for its construction, and which on its completion will operate the whole road. In its construction of the Western Division the company will be assisted by the State to the extent of certain definite obligations, and some additional liabilities which the government has agreed to accept.

From Moncton to Winnipeg is a distance of 1,800 miles. The work of construction of this part (the Eastern Division, which is the part being built and to be owned by the government) is under the charge and control of four commissioners. The commissioners are empowered to appoint and employ engineers (except the chief engineer, who is appointed by the governor in council), surveyors, officers, servants, agents, and workmen, may appropriate lands required for the purpose, and have, in respect of the division, all the rights, powers, remedies, and immunities conferred upon a railroad company under the Railway Act and its amendments. They may let the work of construction by tender and contract; but members of the House of Commons and Senate are debarred from holding offices of emolument under the commission or from being interested during the period of construction in contracts, on penalty of disqualification. The commissioners have also power to construct such telegraph and telephone lines on the Eastern Division, as may be reasonably required for its operation.

The construction of the Eastern Division is to be commenced at each of the termini, and at Quebec in opposite directions in such a way that the part of the road from Winnipeg to Quebec will be completed as nearly as possible at the time of the completion

of the road from Moncton to Quebec. The commissioners are to issue and deposit debentures with the Minister of Finance in amounts sufficient to pay sums of money for work and services as performed, debentures to be repayable in 50 years from July 1, 1903, and bearing interest at 3 per cent. per annum payable half-yearly, the debentures and the interest thereon to be a first lien and charge upon the Eastern Division, and on all revenue and income after payment of maintenance charges. For the protection of the Grand Trunk Pacific as lessee, a provision is made for the building of this division under the supervision of the company to insure its economical construction.

The commissioners are obliged to render monthly accounts to the Minister of Railways and Canals; to keep books which shall be subject at all times to the inspection of any of the commissioners, the Minister of Railways and Canals, or officers specially appointed by any of these or by the Auditor-General. They are also required to make to the Governor in council, through the Minister of Railways and Canals, an annual report for the information of Parliament. The accounts of the commissioners, in respect of receipts and expenditures, are to be subject to examination and audit by the Auditor-General.

From Winnipeg to the Pacific ocean is a distance of about 1,500 miles. The construction of this Western Division is to be done by the Grand Trunk Pacific; and the work is to be carried on according to plans and specifications to be approved by the government, the work to be completed by Dec. 1, 1911. The construction and equipment of this division is to be on a standard not inferior to the main line of the Grand Trunk between Montreal and Toronto. A deposit of $5,000,000 cash or government securities is required to be made by the company as security for the construction of the division and the first equipment of the whole line, the government to pay 3 per cent. interest on the cash deposit, and transfer the interest on the securities, the deposit to be returned on the completion of construction and equipment.

For the purpose of aiding the company in the construction of this division the government is to guarantee to pay the principal and interest on an issue of bonds to be made by the company for a principal amount equivalent to 75 per cent. of the cost of construction of the division; but such principal amount is not to exceed $13,000 per mile for the prairie section, although 75 per cent. of the cost of construction may exceed this sum per mile. The bonds may be issued in the currency of Canada or sterling money of Great Britain at denominations to be agreed upon, the principal payable in 50 years from the date of issue, which is to be as soon as the Western Division is constructed and equipped ready for operation in accordance with the agreement, provided that the Eastern Division is then also furnished with the equipment required, and that the cash deposit is still unforfeited in the hands of the government. The bonds are to bear interest at the rate of 3 per cent., payable half-yearly. If the company should default in paying interest on the bonds, the government will pay the same, and take up the coupons representing such interest; and the payments so made are to be a charge under the mortgage to be given to secure the guaranteed bonds of the government, which shall be subrogated to all the rights of the holders of the bonds.

On the mountain section, the government is to pay the interest on the bonds, guaranteed for seven years. Thereafter the company is liable for the bonds, principal, and interest, subject to the same conditions in case of default in payment as in the case of the prairie section, with this exception, however, that during the period of three years succeeding the seven, the government shall not be entitled to exercise any rights of foreclosure or sale against the company or take possession of the railroad if the company defaults in payment of interest on guaranteed bonds; but any moneys paid by the government shall be repaid by the company to the government as follows: at the end of the period of three years the whole amount so paid by the goverment to be capitalized and repaid by the company to the government, with interest at the rate of 3 per cent. per annum, or the company may at its option repay the sum in 40 equal instalments with interest or give to the government bonds for the interest so capitalized, payable in 40 years with interest. After the first ten years the government is to guarantee the interest on the bonds until the principal is paid, subject to the same duties and rights in case of default by the company as in the other guarantees.

Upon completion of the construction of the Eastern Division, it is to be leased to the Grand Trunk Pacific Railway Company for a period of 50 years, the company paying therefor a rental of 3 per cent. of the actual cost, and accepting the condition of granting to any other Canadian railroads, running privileges over the line on such terms as may by agreement between the government and the company be deemed reasonable and fair. For the first seven years the government will remit the interest, which is equivalent to granting to the company a cash bonus during that period of time equal to the interest on the cost of construction on a 3 per cent. basis. At the expiration of the lease the government may take possession and operate this part of the road on its own account, or it may lease the line to the Grand Trunk Pacific or other company for a further period of time on terms to be then arranged, subject, however, to the restriction that preference is to be given to the Grand Trunk Pacific in the event of that company agreeing to terms as favorable as those offered by any other company.

The company is to equip both divisions with modern and complete rolling stock, suitable and sufficient for efficient operation and the handling of all classes of traffic to the satisfaction of the government, and at all times during the continuance of the lease of the Eastern Division to maintain efficient service over both divisions of the railroad. The first equipment of the completed road is to be of a value of at least $20,000,000, of which not less than $5,000,000 worth shall be supplied for the operation of the Eastern Division; and this amount of rolling stock, together with all rentals and conditions, is to be marked as assigned to the Eastern Division and held to form part of its equipment for the period of the lease.

Of other features of the agreement between the government and the company, one of the most important is the condition requiring the company to ship all goods consigned to it over Canadian territory to Canadian ocean ports, when not specially directed to forward them by another course, also the condition requiring the company at no time to charge a through rate on export traffic from the point of origin to the point of destination which shall be greater via Canadian ports than via United States ports. The company is also required to provide shipping connections on both the Atlantic and Pacific Ocean ports sufficient in tonnage and number of sailings to take care of and transport all its traffic, both inward and outward; nor is it to permit traffic to be diverted to ports outside of Canada upon the ground that there is not a sufficient amount of shipping to transport such traffic from or to Canadian ocean ports.

The government reserves powers of running and haulage rights over the Eastern Division for the Intercolonial or other lines of railroad and over the Western Division for any lines of railroad, subject to terms of agreement with the company; and the latter is given similar rates over the Intercolonial. The rates to be levied and taken by the company upon any part of the line are to be under the control of the Governor in council or any tribunal authorized by Parliament for the regulation or control of the business of railroads.

The company is required to purchase all materials and supplies for the construction of the Western Division and the equipment of the whole from Canadian producers, where these can be purchased in Canada in the desired quantities and of equal quality upon terms equally advantageous with those procurable elsewhere. The government's guarantee is also made conditional on payment by the company of all just claims of contractors for materials, supplies, and wages incurred in connection with the construction of the road.

The government is to have the right of appointing one director of the company during the term of its lease of the Eastern Division, and so long as the government remains liable for any portion of the bonds issued. Provision is made for arbitrating any points of dispute or differences between the company and the government which may arise, and cannot be otherwise settled between them.

The capital stock of the company is fixed at $45,000,000, of which not more than $20,000,000 is to be preferred, and not less than $25,000,000 common, stock. The Grand Trunk Pacific Railway Company has undertaken that the Grand Trunk Railway Company shall take the full amount of the common stock, except the shares held by directors, which are not to exceed 1,000. But the Grand Trunk is not to be prevented from making any such disposition of the common stock as it may deem expedient, though it is to continue to hold a majority of this stock by such title as shall enable the Grand Trunk to control the policy of the Grand Trunk Pacific during the term of the lease to it of the Eastern Division, and so long as any bonds guaranteed by the government under the terms of the agreement between the government and the Grand Trunk Pacific may remain outstanding.

The Grand Trunk Pacific Railway Company has agreed that the Grand Trunk will guarantee its bonds for the balance required for the construction of the Western Division (exclusive of $20,000,000 required for the first equipment of the road), and the Grand Trunk Pacific is allowed to issue a second series of bonds to be so guaranteed, which are to be a second charge on the property mortgaged to secure the government guarantees.

In case of default by the company a remedy of the government will be in the taking possession of the Western Division through an agent or manager with power to manage and operate the division and to receive the tolls and revenue. It is provided that, in the event of such remedy becoming necessary and being adopted, the manager appointed is to distribute the surplus tolls and revenue after payment of the working expenses *pari passu* between the government or other holders of the bonds secured, in the proportion of 75 per cent. to the holders of the first series and 25 per cent. to the holders of the second series. The right of the government to possession is to terminate if and when the application of the proportion provided of the surplus tolls and revenues shall have paid off all arrears of such interest. There is a further proviso that the

government is not to exercise any of its rights in respect of possession by the company until there has been a default for five years.

A comparison in certain particulars between the terms upon which the new transcontinental line is being constructed with those upon which the construction of the Canadian Pacific was carried out 25 years ago is interesting and instructive. An amount of $25,000,000 in cash, of 25,000,000 acres of public lands, many miles of road already constructed by the government at an estimated cost of $30,000,000, of guaranteed immunity from competition throughout the west by lines to the south for a period of 20 years, extensive taxation exemptions—these are concessions of the earlier undertaking, none of which are to be found in the agreement governing the construction of the present road. To the Grand Trunk Pacific no direct appropriation of public funds has been made, and not an acre of public lands has been granted. The part of the road to be constructed by the government will be retained in its possession and leased. Instead of immunity from competitive rivalry are provisions securing to existing or possible future rivals, running privileges over the company's lines on certain conditions.

No mention is made of taxation, no exemption granted. On the other hand the new road has its bonds guaranteed to the extent of 75 per cent. of their value, receives payment of the interest on the cost of construction of a part of its road for a period of years, and receives also what is virtually a free lease of the government's road for a period of years. Excepting these differences in terms, it would appear that against the uncertainties arising from the limited knowledge of conditions and prospects of a quarter of a century ago, the more certain outlook and probabilities of the present have been weighed. An assured trade with government guarantee would appear to be a present-day substitute for the land and money grants, the monopolies and exemptions, of the past.

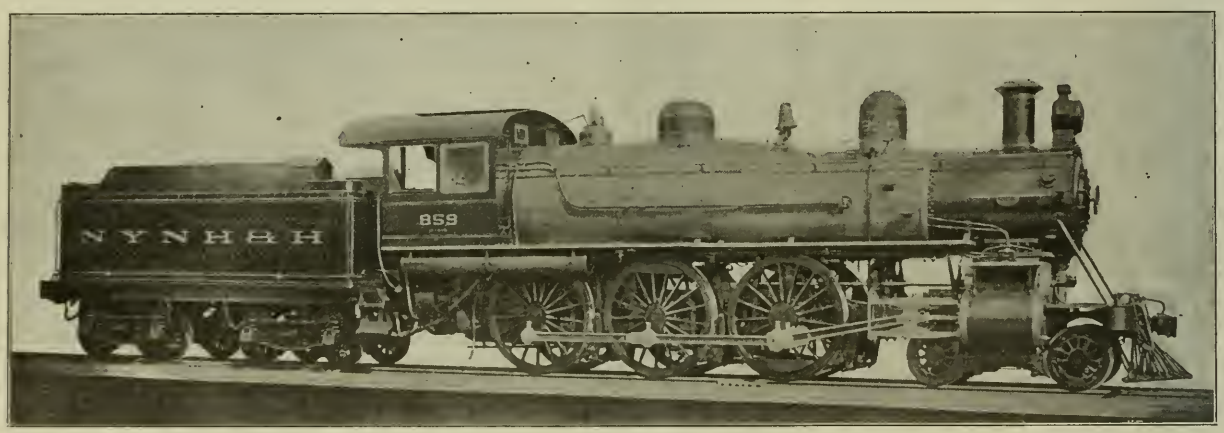
The railroad legislation has been, since the time of its introduction in Parliament, the chief subject of controversy in party politics. The government of the day having created and brought forward the measure, it has found strong indorsement from the ranks of the Liberal party and the Liberal press, though the resignation of his portfolio as Minister of Railways and Canals by the Hon. A. G. Blair at the time the measure was being introduced, on the ground of a difference with his colleagues as to the policy of the government in the matter, was evidence of a conflict of opinion among the government supporters—a difference which has not failed to be made the most of by the opposition (Conservative) leaders and press.

The expediency of immediately proceeding with so vast an enterprise without opportunity being given for obtaining, in fuller detail, particulars as to the country through which the new road is to pass; the advisability of the government undertaking the construction of the less profitable part of the road and undertaking construction at all through a part of the country which is already served by the Intercolonial, a government-owned road; and the greater wisdom of an alternative policy of government ownership of the entire railroad or such parts as it might be deemed advisable to build—are phases of criticism around which the battles of party debate waged while the measure was under discussion in Parliament, and which have been prominent in the electoral contest which has followed its dissolution. Against the policy of delay on the ground of insufficient knowledge of the country through which the road is to pass, the government has argued a possession of ample data on which to base a judgment, the existence of extensive productive areas, valuable alike for settlement and exploration, and the urgency of the need to secure at once a sure interchange of products between the east and west. The inadequacy of present facilities was further urged. As to the construction and ownership of the Moncton to Winnipeg part of the road, it has been maintained that its position affords a means of control over the whole which is most desirable, while business is secured to this division by virtue of its location, without the government being obliged to undertake those additional and supplementary enterprises for which a private corporation is better suited, and which, because also of its location, it will be necessary to have carried out in connection with the Western Division. As to paralleling the Intercolonial, it has been pointed out that the route of the new line will be shorter than that of the Intercolonial between Quebec and Moncton by about 180 miles; that the parts of the Provinces of Quebec and New Brunswick which the two lines will serve are not the same, the lines at no point, save the immediate vicinities of the termini, being less than 30 miles apart. It has been urged, further, that the route of the Intercolonial was determined some 40 years ago on the ground of what was politically expedient at the time, and that the trade of to-day should not be forced to inherit with its faults, a condition of things perhaps wise in the past, but which, commercially considered, may be disastrous at the present time.

Against the policy of government ownership of the entire line have been set forth the superior merits of individual ownership in an undertaking of the kind. It has been pointed out that, whatever the advantages of public ownership may be where favorable conditions exist, they are not certain where conditions precedent to commercial success have largely to be created. The construction of wharves and elevators, the employment of commercial agents and agencies in Asiatic countries, the equipment of an ocean carrying service, the erection and maintenance of hotels, and the thousand and one details necessary and incident to the successful creation of a set of conditions which may attract and establish a profitable business for the railroad—all these, it has been alleged, so essential to the financial success of the undertaking, are matters which private investment and management may be expected to direct with greater efficiency and service, and many of them of a nature which it would be undesirable, if not impossible, for a government to perform.

## Ten-Wheel Locomotives for the New Haven.

The Baldwin Locomotive Works is delivering 22 new ten-wheel (4-6-0) passenger locomotives to the New York, New Haven & Hartford. Twenty of these engines will have simple cylinders and two will be of the Baldwin four-cylinder balanced compound type. The illustration herewith shows one of the balanced compounds. The peculiar feature is that the connecting rods from all four crossheads drive on the first axle but in this respect the locomotive is similar to the 10-wheel balanced compound built by the Baldwin Locomotive Works for the Plant System (see *Railroad Gazette*, Feb. 28, 1902). The principal dimensions of both locomotives are given in the following table:




Four-Cylinder Balanced Compound—New York, New Haven & Hartford.

| | New Haven. | Plant. |
|---|---|---|
| Total weight, lbs. | 160,600 | 176,510 |
| Weight on drivers, lbs. | 123,100 | 127,010 |
| Cylinders, in. | 15 & 25x26 | 15 & 25x26 |
| Diam. of drivers, in. | 72 | 73 |
| Heating surface: | | |
| Fire-box, sq. ft. | 168.5 | 128 |
| Tubes, sq. ft. | 2,497.5 | 2,665 |
| Total, sq. ft. | 2,666 | 2,793 |
| Grate area, sq. ft. | 34.7 | 27.3 |
| Working steam pres, lbs. | 200 | 200 |
| Number of 2-in. tubes | 318 | 341 |
| Length of tubes, ft. & in. | 15—1 | 15—2 |
| Engine wh'l base, ft. & in. | 27—5 | 29—2 |
| Driv'g wh'l base, ft. & in. | 13—6 | 14—1 |
| Tank capacity, gal. | 5,500 | 5,000 |

The use of 10-wheel locomotives for passenger service is a departure from the usual practice of the New Haven, which has heretofore used the eight-wheel locomotive exclusively for such service.

## Passenger Stations of the Duluth, South Shore & Atlantic.

The report of the Railroad Improvement Committee of the American Park and Outdoor Art Association at their St. Louis convention, an abstract of which we published Sept. 23d, made special reference to the stations of the Duluth, South Shore & Atlantic Ry. at Sault Ste. Marie, Marquette and Houghton, Mich. These small-city stations were commended for the fitness of their architecture, and their interior finish and decoration were pronounced harmonious and correct. The condition of the surrounding grounds was also approved. The stations on this road embody the ideas of Mr. W. F. Fitch, President and General Manager, through whose courtesy descriptions have been sent us.

Station at Sault Ste. Marie.

Houghton Station.

So far as possible, native material has entered into their construction, and in each case it has been the aim to provide a station that would meet the particular requirements of the city. For instance, at Sault Ste. Marie, which is a port through which many immigrants annually enter the United States, a commodious and airy waiting room has been provided for their use, while at Marquette the second story of the new building serves as offices for the operating and purchasing departments. These stations are facing the St. Mary's Falls ship canal, through which the Great Lakes passenger and freight traffic passes and along which the United States Government maintains a park. With a neat little park at each end, the station is an interesting and attractive waiting place for travelers. It is 187 ft. long and 44½ ft. wide, and is built of brown sandstone quarried at Rock River, Mich. It is one story high with the exception of the central portion, which is two stories. The upper floor is occupied by the telegraph office, living rooms and the kitchen, serving the dining room below, with which it is connected by a dumb waiter. This kitchen is so situated that waiting passengers are not offended by the odors from it. The platform on all four sides is protected by an overhanging roof.

The interior is particularly well arranged and even the smallest space has been utilized. In the east end is the general waiting room, with ladies' retiring rooms and men's toilet partitioned off at the extreme east. The toilet rooms have tile floors and wainscoting and sanitary fixtures with marble slabs. The waiting room and ladies' rest room are finished in quarter-sawed oak and the walls are tinted olive green. The ceiling is beamed with oak, with electric lights at the intersections. The spaces between the beams are also tinted green. In the northwest and southwest corners respectively, are offices for the superintendent of dining and sleeping cars and the ticket clerk, with an opening into the baggage room between them.

West of the general waiting room is the baggage room, next to which is the lunch room. Beyond that is a transfer room occupied by the express company, and at the west end is the immigrant waiting room, 40 ft. x 56 ft., which is finished in Georgia pine. The walls and ceiling are finished similarly to the general waiting room, and there are toilet rooms for men and women. The station is lighted by 165 incandescent lights and is heated by steam, the plant being situated off to one side. Platforms extend around the whole structure and out between the tracks at the south side, where the trains arrive and depart.

The Marquette station is a two-story building, 105 ft. x 35 ft., and is built of brown sandstone from quarries at Fort Wing, Wis. It was opened to the public Dec. 23, 1901. It stands back a short distance from Marquette's main street, from which it is separated by a greensward maintained by the company. The first floor is devoted to waiting room, ticket office, toilet rooms and baggage room, and the second floor is used for offices. The main portion of the first floor is included in the general waiting room, which is 68 ft. long, with ladies' retiring rooms at the extreme east. It is finished in red birch and the walls and ceiling are finished in green with wainscoting of lincrusta walton in red. The ceiling is beamed with red birch with electric lights at the intersections, and the ladies' rooms are similarly finished. On the south side of the waiting room is the ticket office and on the west side is the men's toilet; also an opening into the baggage and parcel room. West of the waiting room are stairways to the sec-

Marquette Station.

Interior of Waiting Room, Marquette Station.

modifications of one general plan, the general arrangement of the three being similar. Such detail alterations were made as were required by the size of the building and the requirements of the public.

The station at Sault Ste. Marie is the property of the Sainte Marie Union Depot Company, composed of the Minneapolis, St. Paul & Sault Ste. Marie and the Duluth, South Shore & Atlantic. It is also used by the Canadian Pacific as a tenant. It stands

ond floor from both the north and the south side of the building with exterior entrances. The extreme west of the building is used as a baggage room.

The building is heated by steam, from a plant in the basement, which also furnishes steam for the coach yard to the south of the depot. There is a platform about the entire building, which is protected by a veranda supported by brackets, on each of which there is an electric light. In external appearance the building is plain, though there is an immediate impression of utility and convenience in design and arrangement.

In general appearance, the Houghton station is similar to the one at Marquette except for the second story. It is 102 ft. x 22 ft. and is built of red sandstone quarried at Portage Entry, Mich., and was formally opened Nov. 2, 1903. It is steam heated and electric lighted and faces Portage Lake, the space between the two being used by the company for tracks and for park purposes. In the west end of the building are the ladies' rooms. At about the center, on the north side is the ticket office, and at the east end the men's toilet. Beyond that is the baggage room. The center of the building is taken up with the general waiting room, finished in red birch. The walls and ceiling are tinted green, and the ceiling is beamed with red birch with electric lights at the intersections. The platforms are protected by an overhanging roof.

In each of the three buildings the furniture of the waiting room is of the same material as the finish of the room. There are the customary settees, with rocking chairs provided in the ladies' rooms. All floors are hardwood; in fact, all material used and the workmanship have been of the very best. There is nothing unusual or gaudy in either the architecture or the interior finish and therefore nothing to offend the taste of any class of people.

We are indebted to Mr. G. W. Hibbard, General Passenger Agent, for information and illustrations.

## Accidents in the United States in October.[1]

†rc, 2d, Northern Pacific, Driscoll, N. Dak., an eastbound stock train which was standing at a water tank was run into at the rear by a following freight train, wrecking the engine and several cars. Three passengers in the caboose of the standing train were killed and three were injured.

rc, 2d, Nashville, Chattanooga & St. Louis, White Bluff, Tenn., a freight train ran into the rear of a preceding freight, making a bad wreck. A man lying asleep in the caboose was killed and two other trainmen were injured.

unf, 3d, 2 a.m., Chicago, Burlington & Quincy, Altona, Ill., a fast mail train was derailed by the door of a freight car which had fallen upon the track, and four trainmen and one mail clerk were injured.

rc, 4th, Lehigh Valley, Meshoppen, Pa., a local freight train standing at the station was run into at the rear by a following freight, and three trainmen were injured, one of them fatally.

*unf, 5th, Augusta Southern, Mitchell, Ga., passenger train No. 6 broke through a trestle bridge which had been weakened by fire, and the tender and three cars, with the bridge, were burnt up. The baggageman was killed and three trainmen and two passengers were injured.

eq, 5th, Norfolk & Western, Ingleside, W. Va., a freight train was derailed by a broken flange and 22 loaded cars were wrecked. Two trainmen were killed.

o, 5th, Southern Railway, Charlotte, N. C., the caboose of a freight train was crushed by a pushing engine behind it, in consequence of the sudden stoppage of the train by the automatic application of the air-brakes. Three trainmen were killed.

o, 5th, Lake Champlain & Moriah, Mineville, N. Y., a locomotive was wrecked by the explosion of its boiler, and the engineman and fireman were killed.

rc, 7th, Lehigh Valley, Falling Springs, Pa., a passenger train ran into the rear of a preceding freight, wrecking five cars of fruit and overturning the engine; engineman and fireman injured.

bc, 7th, Pittsburg, Cincinnati, Chicago & St. Louis, Hanlins, Pa., butting collision between a passenger train and an empty engine, wrecking both engines. The fireman of the passenger train was killed and three other trainmen were injured. The collision was due to a misunderstanding of instructions by the men in charge of the empty engine, who ran west on the eastbound track and ran past a block signal.

bc, 8th, 10 p.m., Southern Pacific, China, Texas, butting collision between Sunset Limited passenger train No. 9 and eastbound fast mail train No. 8. Eight passengers were injured.

xc, 8th, 9 p.m., Erie road, Port Jervis, N. Y, collision between a work train and a freight, wrecking one engine and 12 cars. Three trainmen and two tramps were injured.

bc, 9th, Northern Pacific, Garrison, Mont., butting collision of freight trains, wrecking both engines and many cars. One fireman was killed and two other trainmen were injured.

†bc, 10th, 4 a.m., Missouri Pacific, Warrensburg, Mo., butting collision between an eastbound passenger train and a westbound freight, wrecking both engines and many cars, and completely crushing the leading coach of the passenger train, which was next to the engine. Twenty-nine passengers and one brakeman were killed and 60 passengers were injured, some of them fatally. Both trains were running at full speed. The freight train had waited at Knobnoster 1 hour, 40 min. for passenger trains No. 10, first No. 30, and No. 50, but for second No. 30 it did not wait, and with this it collided. It appears that the men in charge of the freight did not carefully note the passing passenger trains.

*†eq, 10th. Southern Pacific, New Iberia, La., a freight train was derailed by a brake-beam which became loose and fell to the track, and 14 cars were piled up. The wreck took fire and was mostly burnt up, and a produce dealer who was on the train to take charge of a carload of fruit was killed.

dn, 10th, Southern Railway, Saluda, N. C., a passenger train descending a steep three-mile grade (237 ft. to the mile) became uncontrollable and was run upon one of the "catch points," or safety switches, with which this line was recently fitted; but the speed of the train was so great that the engine went off the end of the track, although at the far end it rises at the rate of 11 ft. in 100 ft. No person was injured.

xc, 11th, Pennsylvania road, Bordentown, N. J., a passenger train ran into the side of a freight train, and the engine was overturned. Six passengers and three employees were injured.

unx, 13th, Southern Railway, Lancaster, S. C., a freight train broke through a trestle bridge and the engineman and fireman were injured.

xc, 14th, 7 p.m., New York Central & Hudson River, Rensselaer, N. Y., the Empire State express, eastbound, collided with an empty engine, and the fireman of the latter was killed.

bc, 15th, Denver & Rio Grande, Beaver Creek, Colo., butting collision of passenger trains; two trainmen injured.

unx, 15th, Southern Pacific, West Fork, Ore., the rear car of a passenger train, which was a sleeping car, was derailed and fell down a bank. Three passengers were injured.

xc, 17th, Erie road, Binghamton, N. Y., collision of freight trains in the yard, making a bad wreck. Three trainmen were injured.

bc, 18th, Southern Railway, Bird's Eye, Ind., butting collision of freight trains, wrecking both engines and several cars and knocking down the station building. One engineman was killed.

dr, 18th, Atlanta, Knoxville & Northern, Talona, Ga., a freight train was derailed and four cars were ditched. The engineman was fatally scalded and the fireman seriously injured. It is said that the derailment was due to a defective rail.

eq, 18th, Lake Erie & Western, Gilman, Ind., a freight train was derailed by the breaking of a wheel, and a brakeman was killed.

rc, 19th, Cleveland & Pittsburg, Beech Creek, Ohio, rear collision of freight trains, wrecking 10 cars. The fireman and one brakeman were killed and another trainman was injured. There was a dense fog at the time.

dr, 19th, 5 a.m., Georgia Railroad, Decatur, Ga., passenger train No. 3 was derailed at a point where track repairs were in progress, every car going off the track and some of them being ditched; but one passenger and the mail agent are the only persons reported hurt.

*rc, 20th, Southern Pacific, Yuba Pass, Cal., westbound passenger train No. 3 ran into the rear of freight train No. 115 in a snowshed, wrecking the caboose and several freight cars and knocking down parts of the shed. The wreck took fire at once and four carloads of cattle and several other freight cars, with 2,000 ft. of the shed, were burnt up. Superintendent R. J. Laws dropped dead during the clearing up of the wreck.

bc, 21st, New York Central & Hudson River, Geneva, N. Y., butting collision of freight trains, wrecking three engines and several cars. One engineman, one fireman and an apprentice fireman were killed. The southbound train ran past a block signal set against it.

bc, 21st, Missouri Pacific, Chetopa, Kan., butting collision of passenger trains; 17 persons were slightly injured.

xc, 21st, 10 p.m., Central of New Jersey, White House, N. J., collision between a coal train and a milk train, wrecking both engines and 30 cars. One fireman was killed. The collision is said to have been due to one of the trains becoming uncontrollable on a steep descending grade.

bc, 23rd, 1.22 a.m., Yazoo & Mississippi Valley, Stampley, Miss., butting collision between a northbound passenger train and a southbound freight, making a bad wreck. Three trainmen were killed and one was injured. The collision was due to the failure of the passenger train to obey an order to wait at Stampley until 1.30 a.m. for the freight.

unx, 25th, 1 a.m., Missouri Pacific, Neal, Kan., passenger train No. 42 was derailed and the first three cars were overturned. The express messenger and 15 passengers were injured, most of the passengers slightly.

unx, 25th, Augusta Southern, Warthen, Ga., a freight train was derailed and the caboose was ditched. The conductor was killed and a brakeman injured.

xc, 25th, Cleveland, Cincinnati, Chicago & St. Louis, Anderson, Ind., a freight train collided with a switching engine in the yard, wrecking both engines and 12 cars. One brakeman was injured. It is said that the collision was due to the failure of the light in a lantern with which a brakeman of the

[1] Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in *The Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments: defects of roadway. |
| eq | Derailments: defect of equipment. |
| dn | Derailments: negligence in operating. |
| unf | Derailments: unforeseen obstruction. |
| unx | Derailments: unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

switching engine was trying to stop the freight.

unx, 26th, Wabash road, Sadorus, Ill., a freight train was derailed and wrecked and five tramps were killed.

xc, 26th, Cleveland, Cincinnati, Chicago & St. Louis, Jonesboro, Ind., a freight train collided with some freight cars which were on a side track but not clear of the main line; one brakeman was killed and two other trainmen were injured.

*xc, 26th, 4 a.m., Erie road, Tuxedo, N. Y., a freight train just starting from the station was run into at the rear by a following freight and 15 cars were wrecked. The wreck took fire and was partly burnt up.

rc, 27th, Chicago, Milwaukee & St. Paul, Minneiska, Minn., a passenger train collided with the rear of a preceding freight, wrecking the engine and several cars. The express messenger was injured and two tramps were killed.

o, 27th, Chicago, Burlington & Quincy, Lincoln, Neb., a passenger train ran into and demolished a wagon containing oil, which was crossing the line at a grade crossing, damaging the engine. The engine and first two cars were at once drenched with oil, which took fire from the fire in the engine, and the engineman and fireman were burned to death.

eq, 28th, Erie road, New Hampton, N. Y., an excursion train was derailed by the breaking of one of the axles of the tender. Three persons were injured.

dn, 29th, 9 a.m., Northern Pacific, Lind, Wash., eastbound passenger train No. 2 was derailed and all of the cars except two sleeping cars fell down a bank. It is thought that insecure rails at a point where the track was undergoing repair were the cause of the derailment. Eight passengers were injured.

†rc, 30th, Missouri Pacific, Tipton, Mo., a passenger train which was standing at a tank was run into at the rear by a following passenger train, crushing the rear car of the leading train. Three passengers were killed and 10 others were injured. It is said that the second train was running at 25 miles an hour, in violation of the rule to keep speed under control at this point.

dn, 30th, Nashville, Chattanooga & St. Louis, Murfreesboro, Tenn., passenger train No. 5 was derailed at a misplaced switch and the engine was overturned. The engineman was badly scalded and an express messenger was injured.

## Factors Affecting the Vision of Enginemen and Firemen.*

Controlling trains by block signals requires, in the daytime, the determination of the position of a semaphore arm, about 4 ft. long by 6 in. wide, or distinguishing the color of a disk about 17 in. in diameter, displayed on a pole about 26 ft. high. At night the color of a 6-in. lens, lighted by a kerosene lamp, must be observed. This must be determined by the enginemen at sufficient distance in which to control their trains. On a train at speed a signal must be read at not much less than one-half mile. The writer rode considerably over 5,000 miles in the cabs of engines on various roads, at all times of day and night, and in all kinds of weather, to obtain data as to visual requirements of enginemen and firemen, and arrived at the conclusion that the best known standard of binocular single vision and color perception is none too good, and it must be quick vision. There are so many conditions that severely test the best vision and color sense that a person with these faculties diminished to even a small extent is a great source of danger. Escaping steam often completely envelops the engine and cab. Steam and soot from the smoke-stack is blown back against the cab windows, covering them with steam and dirt and making it next to impossible to see through them, to say nothing of obtaining a view of anything through the condensed steam and smoke. This is especially true in passing under the viaducts or bridges entering the railroad yards of large cities, where there are many moving engines and trains, and signals must be closely watched for. In freezing weather the escaping steam is especially bad, as the windows are coated with ice, and seeing through them is out of the question. The escape of steam inside the cab in cold weather often coats the side windows with frost and ice, but rarely the front ones, as the rush of cold air against them while in motion keeps them clear. Double glass is also used, with an air space between, which prevents their freezing. The dust raised by passing trains often coats the windows, especially if they are damp from escaping steam; the engineman's position, being on the right side, escapes most of this, however, on roads which run their trains right-handed on double tracks. The cloud raised from ploughing through snow drifts shuts off all vision for the time. Some considerable complaint is made of the drivers throwing mud and dirt on the front windows in moist weather.

The glare from the furnace door when the engine is stoked makes the reading of signals much more difficult. There is an iron shield above the furnace door on the engineman's side, which protects him somewhat. Many enginemen have their seat curtained off to relieve them of this glare. After looking into this glow from the position of a fireman during the time required to shovel in five or six shovels of coal, it is an utter impossibility for a novice to read a signal. There was a black scotoma before my eyes, the size of the furnace door, for fully 10 minutes, and I could distinguish nothing except eccentrically. Firemen have told me they could not even see their steam gage for several minutes after a stoking, and when one takes into consideration that from three to ten tons of coal are handled in a two to five hours' run, there is not much let-up from looking into the fire-box, and when this is done daily for five or six years, or even longer, before a fireman can expect to become an engineman, it must be a good pair of eyes that can stand it and pass the required standard examination for promotion, without a rest or change.

The divergent rays from the headlight make it more difficult to read signals if there is fog, snow or mist in the air; with the electric headlights, while they are of the greatest advantage in all other ways, this is much more aggravated; an immense disk of reflecting and refracting particles is directly before one, and it is almost impossible to distinguish signals through it. If these headlights were built on the same principle as the searchlights of the navy, so that they would throw parallel rays and could be deflected to strike the track at say 100 yds. distance in front of the engine, they would be greatly improved. This effect was obtained on the Burlington by Mr. J. A. Carney, Master Mechanic, by making an extension to cut off the divergent rays and stopping the light down with a diaphragm. An 18-in. extension with the light stopped down to a pencil about 9 in. in diameter made a perfect light.

It is impossible to estimate distances accurately behind an electric headlight, or to tell how far off an oncoming train lighted with one is. The effect on the eyes of looking into an approaching electric headlight on double tracks is very much the same as looking into a searchlight, but it is unnecessary for enginemen to look directly into the source of light. In fog, snow, mist and rain night signals are seen at a greater distance than day. The foreground and background of day signals make a great difference with their being easily seen. A sky background is the ideal; the kind of day does not seem to make much difference. Signals displayed on roads running through mountainous country, and especially where there are many curves in valleys, are very hard to distinguish from the elevated position on either side. Woods stripped of their leaves or in full foliage, the proximity to buildings and bridges, all tend to make the position signals less distinct, while the cross-bars of telegraph poles are very confusing. Undoubtedly night signals are much easier read, as the contrast is so much greater, but as to their being seen any further, or so far, atmospheric conditions being the same, is questionable. The reflection from snow, from a body of water, from the solid green of foliage, running toward the sun when near the horizon, the shimmer in the atmosphere on hot summer days, all are features which add much to the difficulty of seeing signals.

Lenses of various colors were experimented with in looking into the fire-box from the fireman's position, and then trying to read day and night signals. Red, blue, green and smoked glasses were useless or worse, but a light amber lens gives a perfect result. I could look into the fire-box of the large type engines, see all parts distinctly, relieved of the blinding glare, see about the cab perfectly, climb on the seat with no spot before my eyes, and the signal lights maintain their clear definition of color, white being tinged a slight yellowish. The green light cannot be seen at so great a distance as with the naked eye, but red and white can be seen an equal distance and with equal distinctness.

Men exposed to the heat and glare of furnaces or of molten metal suffer some diminution in vision of the eye most exposed, i.e., the left in right-handed men, and vice versa, but this is very rarely permanent, as a change and rest usually brings about complete restoration of sight. A number of firemen have volunteered the information that they had passed their entrance examination all right, but when they were re-examined after four or five years' service their left eye was not so good as the right, which is the one next to the fire-box in stoking.

Protection of some kind is the only method of overcoming the effect produced by the impact of snow, mist, rain and wind against the eye, and all sorts of devices are resorted to. Fully 90 per cent. of the men questioned admitted they carried some form of protection glass for such an emergency. With lenses before my eyes I found no difficulty in facing the worst storms; the glasses did not become dimmed enough to prevent sufficient vision to read signals at any distance they could be made out with prevailing weather conditions, and the condition of the eyes were infinitely better. The larger the lenses the more perfect the protection. Fogging only occurs when going from a cold air into a warm one, and within five seconds after contact with cold air the lenses are clear again. This point, however, is one small factor against the use of glasses by trainmen, as the engineer is unable to see distinctly about his cab for the few moments his glasses are fogged, after contact with cold, but he is equally unable to see for the same length of time as a result of coming in contact with snow, rain and wind with the naked eye. The lenses also protect the eyes from the flying coal dust in the cab. The reflection from snow, from a body of water, the sun near the horizon, and the shimmer on hot days, was best overcome with the amber lenses. The difference in the care taken of the lamps is very marked over 40 or 50 miles of road.

Comparative tests were made of different

*Abstract of a paper presented at the November meeting of the Western Railway Club by Dr. Nelson M. Black, of Milwaukee.

makes of roundels used in signal work. It was found that the difference in intensity of color of a signal was due in a great many cases, not to the care taken of the lamp, etc., but to the poor quality of the roundels themselves, there being a difference of 77 per cent. in the amount of the original illumination transmitted by the poorest and best; spectroscopically, the difference between 17.4 per cent. and 73.1 per cent. of pure red light transmitted by the red roundels, and 13.2 per cent. and 30.2 per cent. of pure green light by the green roundels. (These tests have been reported in the *Railroad Gazette.*)

Following this part of the paper is a discussion of the reports which have been adopted by representative medical societies as to standard vision and hearing required by trainmen, there being four such reports. These reports vary little in essential features and the author advocates the adoption of a uniform report, in order that uniformity in examination among the different roads be arrived at. The more important sections are then discussed singly. The section referring to the minimum requirements for acuteness of vision is declared to be the most important and all the reports agree that 20/20 (6/VI) vision in each eye without glasses shall be required for entrance into service or promotion.

Dr. Black then goes on to tell of the studies and investigations which have been made of this subject by Doctors William Thomson, of Philadelphia; Charles H. Williams, of Boston, and others. With this part of Doctor Black's subject readers of the *Railroad Gazette* are already familiar.

Continuing the speaker said: If the vision of men examined for promotion after five years' service and those re-examined in service falls below the standard required, and such vision could be brought up to the required standard by glasses, they may safely be promoted or retained in service. Glasses must be worn if they are necessary to secure adequate vision. Protection to the eyes by lenses, more especially if needed to correct any refractive error, is of great benefit.

Some of Dr. Black's conclusions are: The best known standard of visual acuity and color perception should be required of men concerned in the active operation of trains.

The signal systems now in vogue, while they are not perfect, are sufficiently adequate for the standard of vision required and the present speed of trains. . . .

Glasses are not a hindrance to enginemen, and their use should be allowed when required to protect the eyes or to bring the vision up to required standard, but no person should be accepted into service requiring them or who will accept a plus lens of 1½ or 2 D. . . .

A suggested uniform code of tests and requirements is appended to the paper.

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A very large proportion of the administrative officers of the Prussian State Railroads (and of other State administration corps) are lawyers, or rather, are graduates of the law departments of the universities; for very few of them have ever "practiced law," as we understand it; and most of them contemplated an administrative career when they studied. Naturally, something more than strictly legal knowledge is desirable for railroad service; and something more seems to be required; for the deans of the law faculties of the universities have given notice to the students that henceforth the Minister of Public Works will not consider any applications of law graduates to enter the railroad service unless they can show that they have thoroughly studied political economy, the science of finance, social political legislation and technology.

## Railroad Commissioners' Convention.

The sixteenth annual convention of the National Association of Railroad Commissioners was held at Birmingham, Ala., November 15 and 16. The President of the Association, Commissioner John V. Smith, of Alabama, in his opening address presented an argument against State railroad ownership. The association, after listening to the report of the executive committee, which dealt with the question of damages for personal injuries, voted to instruct the executive committee to prepare a bill to be presented in the various State Legislatures defining the rights of each party in such cases. The association also favored the proposition that legislation should be enacted in each State to restrict the building of unnecessary competitive railroads.

The committee on uniform classification and simplification of tariffs reviewed the subject in the light of what has been said upon it in past years, and declared that the people still demand uniform classification of freight; and it was recommended that the Interstate Commerce Commission be asked to again investigate the whole subject. Professor B. H. Meyer read a paper on the valuation of railroads in the United States, discussing the different methods adopted by different public authorities in estimating the value of railroad property. He said that a compilation is now being made of statistics relating to each railroad, which it is hoped will throw light on the problem of making a satisfactory general rule for valuation.

The committee on legislation reviewed the general conditions of Federal legislation and declared that the need of Federal control over rates is just as important as is the similar need in 20 or more States which have met the problem by empowering their railroad commissions to regulate rates.

The committee on safety appliances made a report endorsing the arguments presented to Congress by the Interstate Commerce Commission in its last annual report, and recommending the passage of the bill for the compulsory use of the block system which the commission presented at that time. The essential parts of the report follow:

The existing situation, taking the country as a whole, may be described in a few words. Most of the principal railroad companies have the block system in use on parts of their lines, but the aggregate mileage of road block signaled is less than one-fifth of the total in the country. Collisions continue to occur with painful frequency, and the use of the block system is extended but slowly. Some few roads have made considerable extensions during the past year, but on others, and in all parts of the country, important lines remain without block signals.

As to the best method of block signaling it would be out of place for this committee to express an opinion. Any of the different arrangements used could be recommended as immeasurably better than the continuance of the old methods—time-table, time interval, flagging and torpedoes. As between the different automatic devices, the question of excellencies or defects is a delicate one, because in many features the apparatuses of rival manufacturers or patentees differ from one another chiefly in details; in those details of construction or operation which are understood only by men intimately acquainted with them—the inspectors and maintainers employed by the railroad companies. The testimony of these inspectors and maintainers has not been collated in available form. Wherever block-signaling methods or apparatus are at all unsatisfactory the fault is much more likely to be found in the methods of administration or of care taking and inspection than in the mechanical construction of the devices or the principles laid down for their operation. Much of the non-automatic block signaling in this country is carried on with an insufficient equipment of apparatus. While it is possible by constant care to carry on the work with a degree of success in spite of this deficiency, it would be manifestly wrong to recommend for adoption any arrangement not provided with all of the generally approved signals, distant signals and accessories.

In the matter of legislation this committee can do no better than recommend that this convention give its unqualified indorsement to the proposition made by the Interstate Commerce Commission to Congress in its seventeenth annual report, presented last December. That proposition embraced a draft of a proposed law, a copy of which is appended hereto. The Commission based its recommendations on well-settled experience in England, where the block system has been universal for many years, while at the same time the conditions in this country were at every step fully considered. It is much to be desired that a statute like that proposed to Congress be proposed and adopted in each State; but in view of the fact that public opinion on the subject has not yet become thoroughly crystallized, it would seem best to concentrate attention and effort on the national legislature, at least for the present.

. . . We may summarize our conclusions by saying that only a small part of the railroad mileage of the country which ought to be block-signaled is block-signaled, the railroads themselves being judges; that simple unpatented methods and apparatus are available, and that the strong arm of the law is needed to bring about a satisfactory degree of progress in this greatly needed improvement. The suggestion that the railroads themselves will admit the need of extension is based on the fact that some railroads make plans for new block signaling, but postpone their execution. But this admission of the need is limited to lines with considerable traffic. A true view of the situation is more comprehensive than this. The block system is needed and is economically feasible on lines of both light and heavy traffic. But on lines or branches which do not yield a satisfactory profit railroad companies are usually very reluctant to make even a small expenditure for improving the service, and therefore it behooves the public to see that legislative action is taken.

## Railroad Shop Tools.

*(Continued.)*

### MUD RING DRILL.

The six-spindle mud-ring drill shown in Fig. 1 is made by the Niles-Bement-Pond Company, New York. The spindles of the machine have independent drive and feed clutches and are adjusted along the cross rail by a rack and pinion. The distance between the housings is 12 ft. 1 in. The minimum distance between the spindles is 8 in. and the maximum distance from the end of the spindles to the table is 14 in. The table has no vertical adjustment, but it has a cross traverse of 2 ft. 2 in., which is adjustable by hand. The countershaft has two sets of pulleys, 24 in. and 30 in. in diameter. These take a 5-in belt and should run at 175 and 225 r.p.m. respectively.

### LOCOMOTIVE FRAME DRILLS.

This type of machine is designed for drilling, reaming and tapping the sides and edges

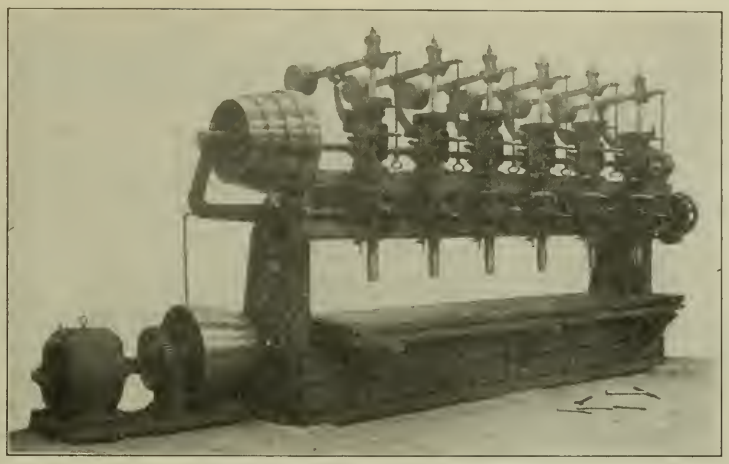


Fig. 1—Niles-Bement-Pond Mud Ring Drill.

of locomotive frames, but may be used to advantage for many other purposes. The machine shown in Fig. 2 is made by the Bickford Drill & Tool Company, Cincinnati, Ohio.

The arms, one of which is made to rotate through an angle of 30 deg., are made of pipe section and are adjustable on the rail, either by hand or by power. The spindles have eight changes of speed, ranging in geometrical progression from 49 to 120 revolutions per minute, and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gage and hand-lever reverse.

The back gears are on the heads, which arrangement brings the power direct to the work, and the gears may be engaged, disengaged or thrown out of service while the machine is running; the operator does not have to reach the shifter in order to stop the spindles. The depth gage, besides enabling the operator to read all depths from zero, supplies a convenient means for setting the automatic trip, the graduation showing where each dog should be set in order to disengage the feed at the desired points.

The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work; in addition it leaves the spindle free, after any intermediate tripping, to be advanced, or raised and advanced, or traversed its full length, without disturbing the setting of dogs; it also throws out the feed when the spindle reaches its limit of movement. There are eight changes of feed, ranging in geometrical progression from .007 to .064 in. per revolution of the spindle. The tapping mechanisms are on the heads and are fitted with friction clutches operated by levers, the handles of which extend around under the arms within convenient reach of the operator. The general dimensions of this machine are as follows:

| | |
|---|---|
| Diameter of spindles, least section | 2⅛ in. |
| Spindles bored to fit Morse taper | No. 5 |
| Vertical traverse of spindle | 17 in. |
| Max. distance under spindles over table | 30 in. |
| Min. distance from center of spindles on plain arms to face of housings | 16 in. |
| Min. distance from center of spindle on universal arm to face of housings | 18 in. |
| Maximum distance from center of spindles to face of housings | 40 in. |
| Maximum distance between end spindles | 27 ft. 4 in. |
| Traverse of head on plain arms | 24 in. |
| Traverse of head on universal arm | 22 in. |
| Length of rail | 29 ft. |
| Distance from floor to extreme height of spindles | 10 ft. 2 in. |
| Largest diameter of driving cone | 24 in. |
| Width of belt for cone | 5 in. |
| Size of tight and loose pulleys | 6¼ in. x 24 in. |
| Speed of countershaft | 450 r.p.m. |
| Floor space required | 7 ft. 4 in. x 33 ft. |
| Weight, complete | 49,000 lbs. |

LOCOMOTIVE FRAME DRILLS.

The locomotive frame drill shown in Fig. 3 is made by Foote, Burt & Company, Cleveland, Ohio. The maximum distance between the outside centers of this tool is 23 ft. 6 in. The length of the table is 24 ft. 6 in., and it has a vertical power adjustment of 2 ft. 6 in. on the uprights. The drill has three heads as shown, the head nearest the driving cone being universal in its motion. The middle head has an in-and-out adjustment of 6 in. and the third head has a vertical adjustment. All of the heads are adjustable along the rail. The heads have three

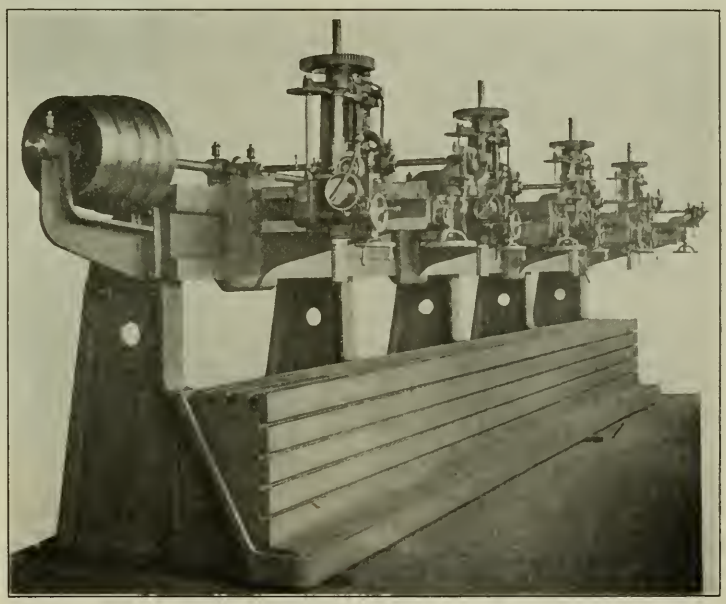


Fig. 2—The Bickford Locomotive Frame Drill.

Fig. 3—Foote, Burt & Company's Locomotive Frame Drill.

changes of power feed obtained by means of a pull pin. The power feed has a range of 16 in. The machine will drill holes up to 1½ in. in diameter. The width of the face of the cross rail is 14 in. and the width of the face of the column is 8 in. The weight of the machine complete is about 24,000 lbs.

## Creeping Rails.

In a written discussion of Mr. Samuel T. Wagner's paper on this subject presented before the American Society of Civil Engineers Sept. 7 and reprinted almost in full in the *Railroad Gazette*, Sept. 23, Mr. F. S. Stevens, Division Superintendent, Philadelphia & Reading, and a member of the society, mentions one or two remarkable cases which came under his observation. He says:

The term "creeping" should be applied only to those cases in which the rails are moved by external forces; and movement

which is due to expansion and contraction should not be considered. The only force, then, that can produce the trouble is the moving train, and, as the friction or adhesion will hold the rails in place on the ties, it follows that this movement must occur when the rail is not loaded and is practically free from contact with the ties. Therefore, it is due to the wave motion caused by the weight of the train passing over a roadbed which yields more or less to the compression and is somewhat elastic. The movement, then, must precede the train, and will increase directly with the elasticity of the roadbed and the condition of the track as to surface. The writer has had charge of track over ground which, apparently at some time, had been swamp, and the soft alluvial formation, of great depth, carried the embankment of gravel, not exceeding 6 to 8 ft. high; but this comparatively thin layer of gravel was subjected to great vibration under passing trains, and the wave in front of the engine was very perceptible. The result was that frequently the splice-plates were broken at the center, and the rails separated from 6 to 12 in., the splice-plates evidently having cracked some time before, and the joint parted in this way. If there were no cracked plates to part and thus relieve the strain, the bolts were sheared off and the same opening appeared. The strange fact, in connection with the parting of these splices, was that the joints in the track on the hard ground adjoining did not close, but remained open for a distance of half a mile or more from the old swamp, and there the rails ran close together and showed a tendency to buckle. The movement was in the direction of the heavier traffic and up grade.

Similar conditions have been found where new ties have been "spotted" in at intervals and have not received proper attention within reasonable time afterward. These, becoming loose, hung by the spikes and gave the rails so little support that violent wave motion was set up and the consequent creeping took place. The effect of loose ties is more noticeable where the tracks are curved, for where the traffic is heavy and slow, and trains are long, and where the track is surfaced for high speed, the load shifts to the low rail and the wheels that travel on the high rail must slip. In addition to the wave motion, there is the dragging effect of the sliding wheels, with the result that the outer rail of the curves creeps and the inner rail does not.

Loose splice-plates also affect the creeping of rails, and, where other conditions are good, loose splices alone will cause some movement. The remedy is to prevent, as far as possible, all wave movement by using rails of sufficient weight to carry the loads without appreciable deflection, build firm and unyielding roadbeds, and use enough good ballast to distribute the load properly and see that it is kept open, so that all water may escape quickly and without saturating and softening the roadbed; then keep all ties tamped to a true and uniform bearing, each tie carrying its proper proportion of the load. The rails in such track will creep very little, and no trouble will be found in keeping the proper expansion allowance at the joints, if the splices are kept uniformly tight.

On the Chicago & Alton rails 133 ft. long are being used, and it is understood that there is no trouble with them. The only question, in this matter of length of rail, is that of handling, and that should not cause much trouble to roads close to their source of supply. The writer does not believe that there has ever yet been any trouble with tracks which could be traced to excessive length of rail, but there has been a great deal of trouble caused by creeping rails which crept because they were neglected, or the ties were loose, the joints were loose, the surface poor, or the men in charge incompetent. When engines and cars ride smoothly, without jolt, jar, sway, or lurch, the rails are not creeping to any great extent. It is poor track which does the creeping, unless the trouble lies below the bottom of the roadbed. Drainage is the "whole thing" in making and maintaining good track which will hold its surface and stay where it is placed, and the cost of maintenance varies, as to rail and labor, very nearly in proportion to the tonnage moved. Eliminate the wave motion by thorough drainage, sufficient weight of rail, good ties, and good surface, with tight joints, and no fear need be entertained on account of trouble caused by creeping rails.

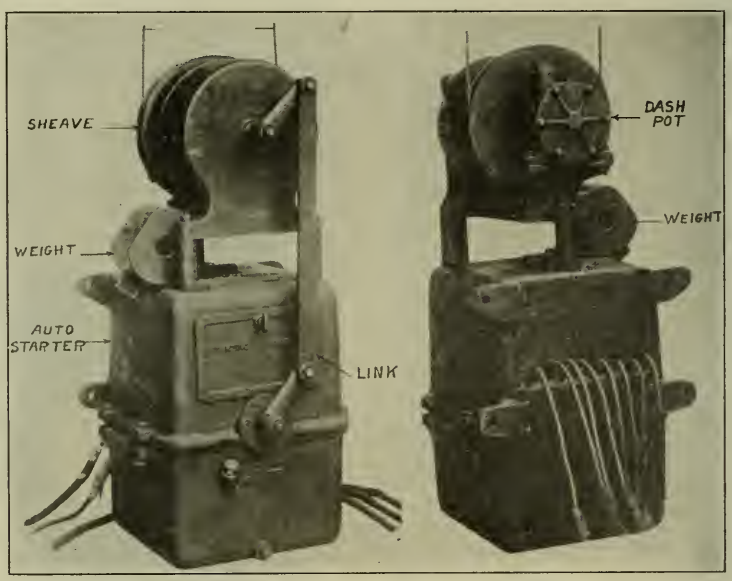
## A New Automatic Pump Controller.

The accompanying illustrations show an automatic pump controller designed by the Westinghouse Electric & Manufacturing Company for use with its Type C polyphase motors, from 5 to 50 h.p. capacity. By its use, the pump is automatically started when the water in the tank falls below a predetermined level and is again automatically stopped when the water reaches a certain depth. The actuating power is a single combination of ropes and levers as shown in the accompanying diagram, connected with a float in the tank, and with the starting lever of the device. It is reliable in action, and no constant attendance is necessary.

In principle this controller consists of a Westinghouse oil immersed auto-starter, with a starting and stopping mechanism connected by a link and governed by a weighted lever. This lever moves freely through an arc of 138 deg. in a slot in the drum of the automatic device, falling this distance when the action of the float has turned the drum sufficiently to lift the weight just past a perpendicular position. As the water level is lowered, the drum is turned by the falling float and the weight is slowly lifted until it reaches and passes an upright position and falls through 138 deg., throwing the handle to a full running position and starting the pump. As the water rises, the rising float turns the drum in the opposite direction, and the weight is lifted until it falls to its original position, throwing the handle in the opposite direction to the off position and stopping the pump.

In order to secure an even and gradual action of the auto-starter, the impetus of the falling weight is checked by the action of a dash pot, which can be adjusted to regulate the speed of the movement. The weight arm or lever moves loosely upon the shaft, and as it falls it compresses two spiral springs. These are coiled loosely around the shaft and press against a casting which is keyed to the shaft, but which is prevented from turning by a pawl, held by notches in the main casting. The weight arm compresses the springs and then trips the pawl, which the springs move quickly to the next notch. The pawl is tripped three times in the downward movement of the weight. Each time it is tripped, it allows the shaft to be turned a certain distance by the compressed springs, and the auto-starter is thrown through the three notches, starting or stopping the motor.

The attachment for operating the controller shown in the diagram is designed for use when the controller is placed below the tank. If desired, the controller may be mounted above the tank, a rod attached to the float and passed through the end of the lever replacing the rope illustrated, and the stop balls being attached to this rod. Owing to the many different conditions of installation, and the simplicity of the float mechanism, the Westinghouse Electric & Manufacturing Company does not furnish this portion of the outfit, but simply the controller as illustrated.




*Front View.* *Rear View.*

**Westinghouse Float Mechanism for Automatic Pump Controller.**

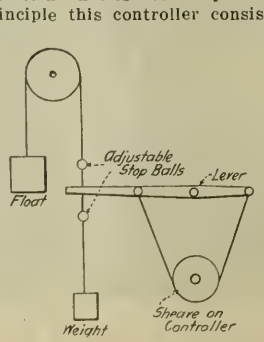



Diagram of Float Mechanism.

RAILROAD GAZETTE

In the obituary notice of Mr. Gustave Bouscaren printed November 11 the statement was made that he had charge of the reconstruction of the Covington & Cincinnati suspension bridge. This is incorrect. The engineer in charge of the work was Mr. Wilhelm Hildenbrand, as is well known to readers of the *Railroad Gazette*. Mr. Bouscaren's work in connection with the rebuilding of the bridge was the remodeling of the anchorages and the repairing of the cable ends where they had been somewhat damaged.

## SUBURBAN TRAFFIC.

A considerable extract from the report on suburban traffic prepared by Mr. A. W. Sullivan for discussion at the International Railway Congress and printed in the bulletin of the congress will be found on another page. Mr. Sullivan's method of inquiry was to send a circular containing 100 questions to the railroads concerned with suburban traffic. Of these railroads 129 replied, but only 32 gave the information which forms the basis of the report; yet a casual glance at the list of cities represented shows that the data collected covers all of the most important suburban districts in the country. Including all cities of first magnitude, the report covers 28 suburban services within the United States, one in Canada and three in South America, and it is interesting as a statistical curiosity that the number of passenger rides per year in these 28 United States services is given as 135,802,000, nearly 60 per cent. more than the total population of the United States. The questions which were submitted to the railroads to furnish data for the report are most minute, as may be gathered from the fact that many of the 100 topics are subdivided into four or five parts. It has not seemed advisable to reprint the general discussion of American suburban traffic, for the majority of the information there given is quite familiar to all who know American railroads, and is evidently intended chiefly for the delegates from foreign countries. But, at the risk of repeating familiar figures, the table showing the number of seats per car and the principal dimensions and characteristics of the suburban cars of each of the lines reporting has been given in full, because, although the subject matter is not new to the readers of the *Railroad Gazette*, it is very valuable for purposes of reference.

The table of suburban fares, forming part of the report, is not shown, because the question (No. 9) which was asked regarding suburban rates of fare, single and return, to the chief terminal stations from eight stations distant respectively five to 12 miles from the terminals, was answered by the railroad companies in such a way that the results are misleading. The rates of fare quoted seem in almost every case to be the simple round trip rate that would be accorded to the transient traveler; consequently, the figures shown are so high that they do not at all represent one of the characteristic features of American suburban travel—the low rate for commutation tickets. It is to be regretted that this question could not have been worded somewhat differently, so that this most full and comprehensive report would have had the minimum commutation fare instead of that of the ordinary traveler's ticket, the price of which is not specially important from the standpoint either of the railroad or of the traveler. It is the transportation which must be used twice a day every week day in the year which interests the suburban resident and builds up or keeps back the growth of "commuter" territory.

With the same fundamental necessities of providing rapid transit from a central location in a crowded city to the suburban residential territory and of providing it cheaply, there are interesting differences in the way the problem is worked out in England and in the United States, the two countries where it is perhaps most strongly felt. The great burden of the British railroads supplying large industrial centers is the requirement that workingmen's trains should be run at certain hours of the day, carrying workmen at a greatly reduced rate. As an example of the attitude of the British railroads toward these trains, it is interesting to see that every little while some one gets arrested for traveling on a workingmen's train under false pretences, is punished, and the fact of his arrest and conviction is widely advertised by the railroads. In short, they regard the traffic as oppressive and are desirous of doing as little of it as possible, although it is done at rates which compare pretty closely with American commutation rates in the vicinity of the largest cities. But the British workingmen's trains run for short distances only, so that the average passenger mile rate must bear a much larger terminal charge than is the case with us. On the ordinary suburban services of the English roads the tendency seems to be rather to give second class accommodations at a rate somewhat less than the regular third class than to greatly increase third class business at a lower rate. The traveler who is unfortunate enough to find himself in a third class car during the morning rush hours can understand the reason for this. Yet, as a matter of fact, it frequently happens that the second class cars in the suburban service are less comfortable than the third class cars found elsewhere, so that the traveler's only gain is in comparative seclusion, and this is chiefly a theoretical consideration in rush hours. In fact, so large a proportion of the British suburban travelers decide every year that they cannot stand third class for their regular trips every day, that on many of the trains second class cars are in the majority during rush hours. The average of British suburban fares is brought down by the sale of workingmen's tickets, but there is little doubt that the ordinary British suburban resident pays considerably more for his transportation than does the American. It is unfortunate that the question relative to fares did not call for the minimum, so that the subsequent report dealing with Great Britain could have furnished material for an interesting comparison.

Mr. Sullivan, as is well-known, designed the Illinois Central suburban cars of the side door type, and it is evident throughout the report that he believes them to be the best car possible for this work. He makes mention of the fact in his report that 100 passengers have been discharged from a car at a terminal station in four seconds, and that ordinary stops at intermediate stations where many passengers leave and enter the trains are made in six to eight seconds. This is certainly a most creditable record. The ordinary British type of car with side doors and transverse partitions, unprovided with an aisle, can discharge passengers with great rapidity, but time is lost in taking them up because of the tendency of the traveler to walk along the car in search of a compartment where he can find a seat. The Illinois Central cars combine the advantage of side doors at frequent intervals with that of the aisle, which enables the passenger to enter wherever he happens to be, and look for a seat while the train is in motion. The following points are among the author's conclusions of the methods to be employed in the working of a suburban service of the most successful type: The arrangements for passengers to go to and from the trains must be short and direct and the station platforms level with the floor of the cars; cars must be of large capacity, with side doors to get the greatest freedom of movement for entrance and exit; provision must be made for the distribution of passengers throughout the train while in motion; the car, as the vehicle of transportation and the primary unit, is the factor to which everything else must conform; in the case of new lines to be built the type of car should first be determined and the railroad then designed to fit the car; the locomotive should be proportioned to handle trains of maximum size at the speed demanded by the train schedule; the greatest train movement and the highest degree of speed and economy in operation are to be obtained by schedules which provide for the movement of trains at uniform speed and stopping at all stations on the same track; separate tracks should be provided upon lines of heavy traffic for trains which are run at high speed and do not stop at all stations.

## THE EARNING VALUE OF RAILROAD IMPROVEMENTS.

The enormous sums of money that have been or are being expended by some of the trunk-line railroads, for extensions and improvements in the last few years, has attracted very general attention, and the question is often asked, Will it pay? The benefits and profits resulting from extensions to secure new business, from reduced grades and curvature, from cut-offs to shorten through lines, and from improved track and machinery are usually obvious enough. But this cannot always be said of the very large expenditures often made, the objects of which seem to be the insuring of greater safety of operation, the expediting of travel and business, and the promotion of the comfort and convenience of the public. A noteworthy example is the complete rearrangement and rebuilding by the Pennsylvania railroad of its yards at West Philadelphia, particularly with reference to its passenger traffic. With its many lines entering and leaving Philadelphia through the West Philadelphia yard, including the very crowded tracks of the main lines to New York, to Washington and to the West, the situation had become greatly complicated, particularly

at the grade crossings and points of switching to diverging tracks.

With great ingenuity and engineering skill, the West Philadelphia system of tracks has been reconstructed so that there are no grade crossings either on passenger or freight tracks, each main line having its entrance and its exit unbroken and independent of the others. How this has been accomplished was briefly described in the *Railroad Gazette* of March 27, 1903. While exact figures are not at hand it is safe to say that the aggregate cost of this feature of the West Philadelphia improvements has been in the neighborhood of a million dollars; and a correspondent writes to inquire on what basis the officers of the road can make calculations which will justify such an enormous outlay. Doubtless in planning these improvements, there were in the minds of the officials of the road reasons for incurring this large expense other than those dictated by mere physical utility.

Improvements designed to prevent accidents and to avoid delays to trains, have a tangible value which the engineer and statistician can formulate and estimate with approximate exactness. If it be known from experience that an accident is likely to occur at a given grade crossing once in so many years, and that each such accident is likely to involve damages to life and property amounting to a given sum, it is easy enough to capitalize the value of those losses and to figure what expenditure will be justified in making such accidents impossible. In the case also of train delays, the reduction of grade and curvature, the saving of distance, and numerous other items, their value is capable of more or less exact computation. But the wise modern railroad manager does not stop within the limits of such estimates. He must be more than an engineer and statistician. He must have that rare business judgment or instinct which lies at the bottom of all commercial success, joined with faith and courage in his convictions. In effect this faculty amounts to a correct foresight of what the public, present and future, wants and will buy, whether it be in the matter of calico or of transportation. Improvements of the character referred to, while their physical value receives full recognition, have another value that may be of even greater importance. If the American traveler attaches undue importance to the elements of quick time, punctuality of trains and physical comfort, the railroad manager may deplore, but he cannot ignore it. While to the average railroad passenger the fact that his train is delayed for a few minutes, or that he arrives at his destination half an hour late may be a matter of no practical importance, he will resent it deeply, and may for no better reason transfer his patronage and influence to a rival line. The unavoidable publicity of an accident on any road will prejudice the public against that road to a greater or less degree. Not a few persons have been known to forswear a road because their car was not properly ventilated; or, more frequently, because their meals in the dining car were not satisfactory. On the other hand they may stick like bosom friends to the road that meets their exalted expectations and work like beavers for it. Influences of this character, while apparently trivial, may, in the aggregate, have an important influence upon the business of a railroad. Knowing this, the wise manager may be amply justified in expenditures which neither arithmetic nor engineering would alone dictate. While money invested to put a road in the best physical condition, to avoid the possibility of accidents, and to prevent delays, may not always be warranted by prospective reduction of operating expense, such investments may be amply justified by increase in net earnings. The wideawake railroad manager understands this and shapes his policy accordingly; and what manager has ever so shaped his policy and not been vindicated?

## GROWTH OF RAILROAD BONDING.

Poor's railroad statistics for 1903, recently published, contain two entries of exceptional significance. The total capital stock of American railroad companies is given at $6,355,207,335, and their bonded debt at $6,722,216,517, or an excess of bonds over stock of $367,009,182. Taking the same authority the excess of bonds over stock in 1902 was 387 millions. In 1901 stock and bonds were nearly equal with $5,978,796,249 for the former and $6,035,469,741 for the latter. In 1900 stock exceeded bonds by $45,753,496, and in the year preceding by $97,323,154. But for the twelve years preceding, except in a single year, we find bonded debt predominating and usually by several hundred million dollars—in 1892 the highest disparity being reached when stock stood at $4,863,119,073 and bonds at $5,406,955,004. When we extend the comparison for a period of thirteen years still further back to 1874 inclusive we find for that period no significant disparity in the two sets of securities.

If the figures for issues of railroad bonds for 1904 were available there is little doubt that they would show the ratio of bonds to stocks still mounting higher. "Collateral trust" bonds, "convertible" bonds, debenture bonds and various issues of junior bonds, some with and some without mortgage security, have come out abundantly, to say nothing of the "short note" device so common a few months ago and representing a class of security sooner or later, in many cases, to be refunded into bonds. On the face of the situation it seems extremely probable that the railroads of the country, after a temporary reaction in the direction of stock issues extending over three years beginning in 1899, have again entered a period when bonds will be predominant, and, it may be, predominant in a remarkable degree. Such a situation is worth its brief study both as to causes and results.

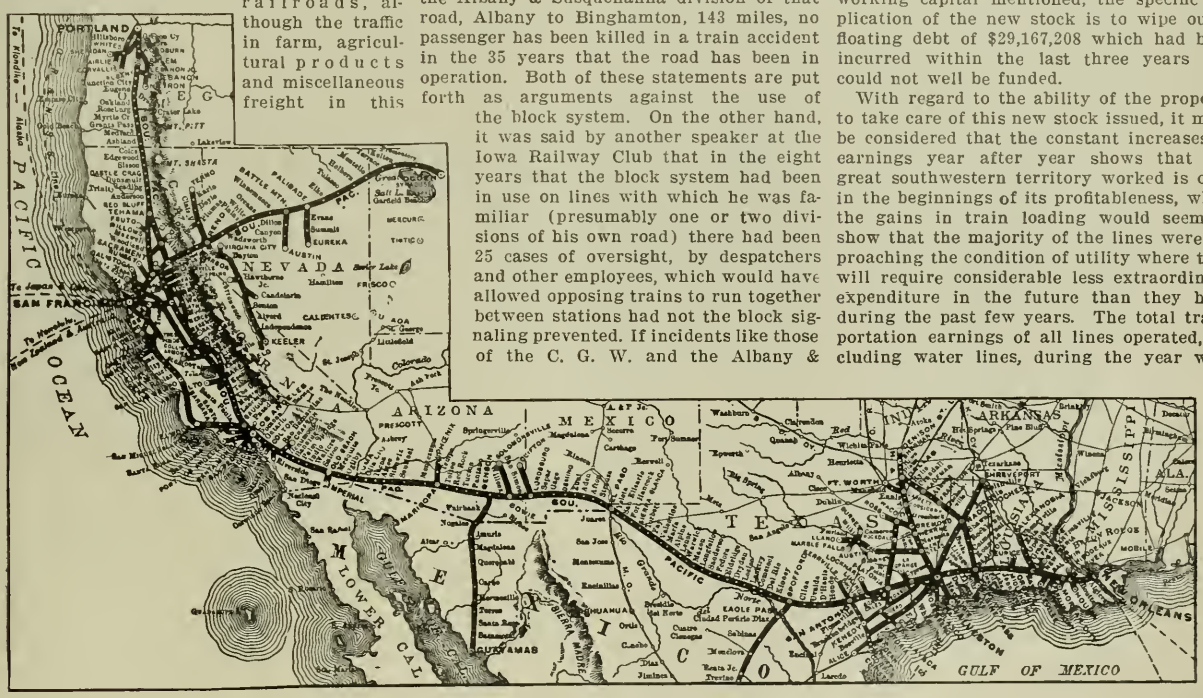
Its causes are not hard to find. In the first place a period of railroad consolidation has been attended with extensive issues of new bonds to buy up stocks for control. The process has assumed a number of different forms, but there may be mentioned specifically the "holding" company, sometimes conservative in aims and results, but more often attended with speculative facts or perils. Again, the marketing of new railroad securities, particularly stocks, has had to meet sharp rivalry of other securities pressed for sale. The "industrial" bond with its alluring high return for income has competed sharply with the railroad security. So have the street railway corporations in their effort to secure the funds for fresh enterprise. Finally, not to mention minor causes, the average investor, as distinguished from the mere speculator, has grown keener in his discriminations. While there will always be lambs for "the street" to shear, many of them have grown to be wise sheep and the mere variety and number of the forms of investment pressed upon the man who has the money to buy has educated him in values—an education that has measurably turned him from the railroad share and toward the higher security of the railroad bond. As an illustration of this new attitude of the investor, it will be recalled that the prospective cutting of a "melon" by a railroad company a few years ago lifted the market price of the stock; nowadays it is more likely to depress it. Among intelligent investors the "melon" is not the popular fruit that it was in earlier days of railroad gardening.

Apart from the precedent supplied by the long and, on the whole, decided dominance of bonds over stocks during the period of 20 years before 1899 the forecast suggests a pretty protracted "bond period" in the immediate future. While the funded debts of our railroads have greatly increased it is not to be forgotten that they cover greatly enlarged plants and that a railroad system carries the same amount of debt at from one-half to two-thirds the fixed charge represented by the old 7 and 6 per cent. bonds now almost extinguished by refunding. Consolidation has gone on swiftly but it is by no means ended and the new bonds that purchase control are one of its most familiar marks. Again, the new electric ventures of the great steam lines whether for electric lines or for electric equipment of steam roads, carry the bond theory of the future into large spaces. And it is a forecast to be welcomed rather than feared. While a "bond period" may have its abuses it does not lend itself to them as readily as a time of stock expansion, distribution and bonus; it connotes more conservative financing and a saner form of investment; and, as a token of railroad prosperity, if one looks over the returns of railroad capitalization for almost a third of a century, he will find that, as a general proposition, good times have been coincident with the larger ratios of bonded debt to share capital—albeit panics and crises have betimes played considerable havoc with both.

### Gross Earnings for October.

Railroad gross earnings, which first began to show gains in the month of August, still continue to show substantial increases over last year. For the first few months of 1904, owing to strikes and bad weather throughout all sections of the country, railroad earnings received a severe set-back and were, as a whole, far below those reported in the corresponding period of 1903. During the last three months, however, aided by favorable weather and a general revival in business, most of the railroads have been able to show good increases in gross. For the month of October, 87 railroads show a gain of $2,456,913 over the same month in 1903. This compares with a gain on 91 roads in September of $2,589,768, and on 87 roads in August of $1,551,206. Of 65 of the more important railroads reporting earnings for October, 42 show increases and 23 decreases; but the losses, with only a few exceptions, are small.

The increase in traffic during October seems to have been more or less general throughout the country, but the heaviest traffic has been in the Middle and Middle West and trunk line territory. It is rather an unusual state of affairs that the trunk lines should be the first to show the effect of the larger movement of traffic, as the Northwest and Southwest are generally the first to respond to either good or bad influences in traffic. It is undoubtedly a fact that the travel to and from the Louisiana Purchase Exposition has aided materially in increasing the traffic receipts of the east and west trunk lines and of the railroads in the Middle and Middle West. Among the southern roads, the earlier movement and size of the cotton crop has been favorable to larger earnings. In the Northwest, the movement of grain has not been up to what it should be at this season of the year owing to unusually high prices in the grain market at Chicago. These prices have resulted in a large decrease in grain exports to England and have affected adversely the grain traffic of the northwestern railroads, although the traffic in farm, agricultural products and miscellaneous freight in this section of the country is better than it was at this time last year.




Southern Pacific.

Earnings when divided geographically show general increases throughout all sections, although the gains are larger in those parts of the country where traffic has been influenced by the favorable circumstances mentioned above. The largest increase is in the anthracite group, where five railroads report a gain of $1,002,824. Other returns may be summarized as follows: Middle and Middle Western group (13 railroads), increase $528,429; trunk line group (six railroads), increase $455,260; Southern group (11 railroads), increase $743,167; Northwestern and North Pacific group (12 railroads), increase $105,873; Southwestern group (11 railroads), decrease $455,416.

Among the separate railroads showing increases in gross, the Reading heads the list, with a gain of $404,931. Other increases are: Lehigh Valley, $448,362; Missouri, Kansas & Texas, $386,511; Wabash, $336,871; Canadian Pacific, $255,698; Southern, $215,670; Pere Marquette, $191,058; St. Louis Southwestern, $176,209; Baltimore & Ohio, $156,647, and the Central of Georgia, $147,709. The heaviest loss in receipts was made by the Atchison, Topeka & Santa Fe, which shows a decrease of $1,026,646 for the month. This was due to the extremely severe floods which occurred during October and which interrupted the traffic of this road for several weeks. Other decreases in earnings reported were: Great Northern, $224,436; Chicago & North Western, $175,608; Colorado & Southern, $78,248; Central Branch (Missouri Pacific), $55,000, and the Grand Trunk, $48,313.

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At the meeting of the Iowa Railroad Club in October, when the subject of block signaling (reported in the *Railroad Gazette* of Nov. 11) was continued from the September meeting, an officer of the Chicago Great Western said that on one division of that road 360 miles long, no paying passenger had been killed by a train accident in the 18 years since the road was built. The President of the Delaware & Hudson Company has lately published a statement to the effect that on the Albany & Susquehanna division of that road, Albany to Binghamton, 143 miles, no passenger has been killed in a train accident in the 35 years that the road has been in operation. Both of these statements are put forth as arguments against the use of the block system. On the other hand, it was said by another speaker at the Iowa Railway Club that in the eight years that the block system had been in use on lines with which he was familiar (presumably one or two divisions of his own road) there had been 25 cases of oversight, by despatchers and other employees, which would have allowed opposing trains to run together between stations had not the block signaling prevented. If incidents like those of the C. G. W. and the Albany & Susquehanna were common they would have a tendency to make block-signal inventors feel like going out of business; but in candor we must say that we have not as yet observed any such tendency, particularly among those inventors who have not yet secured all the capital that they want.

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## Southern Pacific.

The report for the year ending June 30, 1904, which appears in the admirably full form that has characterized these documents as prepared by Mr. Mahl, shows a property of great strength. It will be recalled that the system has been undergoing a thorough regeneration for a period of several years, involving a vast amount of construction and betterment work entirely apart from the development and strengthening of the water connections. Throughout the recent profitable years the net income has been applied for this rebuilding and re-equipping of the system, and it was pointed out last year that the amount of surplus income which had in this way been turned back into the property since the commencement of operations in 1885 aggregated over $100,000,000, as representing the total expenditure for which no securities had been issued. But the complex organization of the Southern Pacific system, with the constant additions and extensions to the proprietary companies' lines, for which the Southern Pacific Company furnishes funds as a suspended asset pending the completion of the work and awaiting a favorable opportunity when the securities so issued in payment for such construction or equipment of other property can be sold at satisfactory prices, creates a need for an exceedingly large working capital. Hence it was resolved last June that the capital stock be increased $100,000,000, the increase to be of preferred stock subject to non-cumulative dividends not to exceed 7 per cent. per year, the stock being convertible into common stock, share for share, at the option of the holders. Forty millions of this new preferred stock was offered to shareholders on July 28. Besides the general need for working capital mentioned, the specific application of the new stock is to wipe out a floating debt of $29,167,208 which had been incurred within the last three years and could not well be funded.

With regard to the ability of the property to take care of this new stock issued, it must be considered that the constant increases in earnings year after year shows that the great southwestern territory worked is only in the beginnings of its profitableness, while the gains in train loading would seem to show that the majority of the lines were approaching the condition of utility where they will require considerable less extraordinary expenditure in the future than they have during the past few years. The total transportation earnings of all lines operated, including water lines, during the year were $92,933,231, an increase of $4,612,895. Operating expenses during the same period were $63,179,593, an increase of only $2,878,333; so it will be seen that the disproportionate increase in operating expenses, which last year made the net earnings smaller than they were in 1902, in spite of the large increase in gross, no longer exists. Receipts over operating expenses in 1903 were $630,047 less than in 1902; receipts over operating expenses in 1904 were $1,734,562 greater than in 1903, and $1,104,515 greater than in 1902. The gains this year were well distributed, but those of the passenger traffic are the most significant. Passenger earnings for the year were $25,201,488. Five years ago they were $13,041,860. Since 1899, that is to say, freight earnings have increased 63 per cent. and passenger earnings have increased 93 per cent. The water lines also show a good gain, and the Southern Pacific Terminal Company has developed during the year a business of $226,301 as compared with less than $70,000 last year. As regards operating expenses, high wages and new train services have pushed up somewhat the item of

conducting transportation, as was to have been expected, and also that of maintenance of equipment. Maintenance of way and structures cost three-quarters of a million less than last year, owing mainly to the favorable progress which has been made in the betterment work and also to certain abnormal charges on the 1903 account. To the total operating expenses of both rail and water lines, maintenance of way and structures contributed $12,315,562, maintenance of equipment $12,050,081, conducting transportation $32,006,932, and operating expenses of the water lines $4,818,149. The number of passengers carried, in spite of the gains in earnings, was actually less than last year, but passenger miles increased nearly 81⅓ millions, the average journey having increased from 77.1 miles to 82.8 miles.

With an average mileage of rail lines of 9,024 as against 8,842 last year, freight tonnage increased from 22,230,367 tons, including company freight, to 23,684,348 tons, and the receipts per revenue train mile increased from $2.77 to $2.82, in spite of a slightly less average rate. The increase in train and car loading (the figures including company freight) occurred both on the lines east and west of El Paso, although the most important gain was on the lines west. In 1903 the average train load east of El Paso was 296.9, the average train load west was 335.4, and the average for the system, 320.3. These loadings increased, respectively, to 297.1, 344.2, and 325.5, this year. Per loaded car, the general average was 19.31; last year it was 18.67. The percentage of loaded freight car miles to total freight car miles decreased somewhat, however, the average being 68 per cent. as against 70. This is attributed to the increase in commodities such as oil, where there is no back haul. At the close of the year, 1,555 locomotives were owned, as against 1,468 in 1903; 43,756 freight cars of all types, as against 44,922, and 1,527 passenger cars, as against 1,345. For new equipment, $2,898,146 was charged against income during the year, to cover 95 locomotives, 120 passenger train cars, 77 freight train cars and 12 road service cars. During the year 251 locomotives were changed to burn oil, making a total of 888 thus equipped.

The following are the principal statistics of the year's operation:

| | 1904. | 1903. |
|---|---|---|
| Average mileage | 9,025 | 8,842 |
| Gross earnings.* | $92,933,231 | $88,320,335 |
| Water lines | 5,796,423 | 5,395 048 |
| Passenger earnings | 25,201,488 | 23,558,047 |
| Freight earnings | 56,602,651 | 54,290,659 |
| Total operating expenses.* | 63,179,594 | 60,301,260 |
| Water lines | 4,818,149 | 4,503,241 |
| Conducting transportation. | 32,006,932 | 30 056,041 |
| Maint.-of-way & structures | 12,315,562 | 13,064,454 |
| Maintenance of equipment. | 12,050,081 | 10,803,788 |
| Net earnings.* | 29,753,637 | 28,019,075 |

*Including water lines.

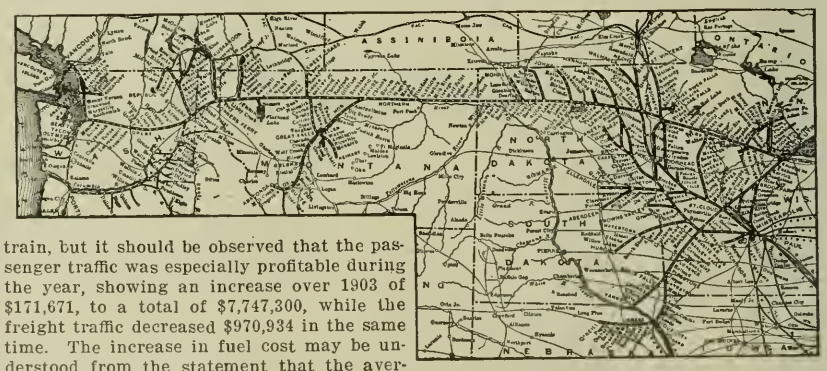
## Great Northern.

The increase of operating expenses in proportion to gross earnings, which was so prominent a feature of almost all railroad reports a year ago, reached the Great Northern somewhat later than it did the rest of the country. In 1903 the operating ratio on this line, always small, was less than it had been in several years previous. Gross earnings showed a large increase and there was a noteworthy gain in the train load, but for the current year a slight reduction in gross earnings as compared with 1903 was accompanied by an increase in operating expenses, so that the net showing is not quite so good as it was last year, although net earnings are larger than for any previous year except 1903. With an average mileage worked of 5,623 as compared with 5,490 last year, gross earnings were $40,057,353, as against $40,785,647 in 1903. Operating expenses were $20,594,363 as against $20,076,829, and net earnings were $19,462,991 as against $20,708,818, giving an operating ratio of 51.41 this year and of 49.23 last year. The fallacy of depending on the operating ratio as the measure of a road's efficiency has often been pointed out, but where a given property is conducted in the same way for a series of years the figure has some comparative interest.

The disproportionate increase in operating expenses, as has been almost universally the case within the last year or so, occurred chiefly under the head of conducting transportation, and was primarily due to wage increases, additional passenger train service and higher price of coal. The first of these items, that of wage increase, cannot be analyzed because the report does not reduce the conducting transportation charge into its component parts; but the accounts for this year show for the first time the effects throughout a full working year of the increase in wages which the Great Northern, in common with practically all the railroads, made during 1902 and 1903. The item of increased cost owing to train service is principally due to the establishment of an additional daily trans-continental passenger train, but it should be observed that the passenger traffic was especially profitable during the year, showing an increase over 1903 of $171,671, to a total of $7,747,300, while the freight traffic decreased $970,934 in the same time. The increase in fuel cost may be understood from the statement that the average cost per ton of coal for locomotive fuel was slightly over 17 cents greater this year than in 1903. The other classified items of operating expenses were kept well in hand, although there is nothing to indicate that too little was charged for maintenance. Maintenance of equipment cost $3,138,693 as against $3,109,469 the year previous, while maintenance of way and structures, aggregating $5,083,264, cost nearly $190,000 less than in 1903. One specific cause for this economy was the fact that a large amount of permanent bridge work has been done in previous years, so that the annual charge for renewals of bridges and culverts for 1904 was $230,035 less than the amount charged in 1903. All replacements, renewals, etc., were charged to operating expenses during the year, and the amount placed against maintenance of way and structures as the cost of extraordinary improvements for the year was $1,410,097. In addition to these maintenance charges it has been customary for several years to set aside a substantial sum out of income as a fund for permanent improvements and renewals, and $2,000,000 was again appropriated for this purpose, as a direct charge against income, subsequent to the charge for rentals but prior to dividends.

This liberal financing of improvement work out of income has enabled the capital account to be kept well down, and there has been no increase in the amount of stock authorized since the increase of $25,000,000 voted in 1901 to acquire the securities of seven companies worked in connection with the system. Since that time the authorized capital stock has remained at $125,000,000, although the purchases have been made as planned, to an amount close to the present limit. In fact, up to June 30, 1904, the amount paid out on account of the purchase of the securities for which this stock was authorized aggregated $25,745,053, or $745,053 more than the proceeds from the issue. The total capital liabilities showed a net increase of $6,822,726 during the year, the increase consisting principally of £1,500,000 sterling, collateral notes, to provide funds to pay for equipment ordered and construction of new lines contracted for and under way. As against this increase the capital assets show an increase of $14,569,603.

Train loading, which showed such a marked increase last year, when it was raised from 417 tons to slightly under 447 tons, again shows an increase to 447.4, although the loading per car was slightly smaller. The chief characteristic of the traffic was a serious decrease in wheat and iron ore and a considerable though less important decrease in live stock, lumber and other bulky freight, accompanied by an increase in merchandise and miscellaneous freight. In the face of this fact the increased train load is a particularly good showing. As might have been expected under the circumstances, ton mile revenue was somewhat




Great Northern.

higher, amounting to .893 cents as against .857 cents last year. It is interesting to see that with an increase of 8,759,114 bushels of wheat hauled to eastern terminals from stations east of Minot, N. Dak., and north of Garretson, S. Dak., and with a decrease of 1,715,499 tons of iron ore transported, the organization was so flexible that the general freight traffic was handled with a train mileage 581,211 smaller than in 1903, and the revenue train load was actually increased.

The chief operating statistics for the year are tabulated below:

| | 1904. | 1903. |
|---|---|---|
| Average mileage worked | 5,623 | 5,490 |
| Rev. train-load: | | |
| Gross earnings | $40,057,353 | $40,785,647 |
| Freight earnings | 29,944,300 | 30,915,234 |
| Passenger earnings | 7,747,300 | 7,575,629 |
| Operating expenses | 20,594,363 | 20,076,829 |
| Conducting transportation. | 10,740,242 | 10,161,884 |
| Maintenance of equip. | 3,138,693 | 3,109,469 |
| Maint.-of-way & structures | 5,083,264 | 5,273,099 |
| Net earnings.* | 19,462,991 | 20,708,818 |
| Gross earnings, per mile | 7,124 | 7,429 |
| Operating exp. per mile | 3,663 | 3,657 |
| Net, per mile | 3,461 | 3,772 |

*Taxes, $1,417,980 in 1904, and $1,474,126 in 1903, not deducted

## NEW PUBLICATIONS.

*Elements of General Drafting.* By C. E. Coolidge, Assistant Professor, and H. L. Freeman, Instructor of Machine Design, Sibley College, Cornell University. 51 pages and 21 plates, 9 in. x 12 in. John Wiley & Sons, New York. Price $2.50.

This book is intended for students in manual training schools, trade schools and technical colleges as well as for the amateur drafts-

man. It describes the selection, use and care of drawing instruments and materials. This is followed by directions for making both detail and assembly drawings. The authors evidently assume that the student is already familiar with elementary practice as the basic operations of drafting are not fully explained. The book is illustrated with line cuts only, and not with line cuts and half-tones, as is stated in the preface. The 21 plates in the back of the book show copies of commercial drawings.

*Self-Propelled Vehicles*, by J. E. Homans, A. M. 672 pages, 5 in. x 8 in., bound in black vellum, gilt top. Theo. Audel & Co., New York. Price $2.00.

This book gives much practical information in regard to the principles of automobile construction and operation. The theory, construction and operation of the gas engine is clearly discussed in detail, as is also the steam engine and electric motor.

The details of the transmission and controling apparatus is described as well as different steering devices, under frames, tires, bearings, lubricators, etc. The principle of the storage battery, its construction and care, are also outlined. The last chapter is devoted to "Gasoline Vehicle Management," and it contains practical information and many useful hints valuable to both owner and chauffeur. The volume is liberally illustrated throughout and closes with a complete index.

## TRADE CATALOGUES.

*The Richards Chair-Panel Company*, Chicago, has issued a new catalogue entitled "Backs." The Richards "Fit-the-Back" panel chair was described in the *Railroad Gazette* Dec. 12, 1902. The panel-back feature is applicable to practically any style of chair, 18 of which are illustrated in the catalogue by half-tone engravings. The Pullman Company has used the device in parlor cars since its introduction in 1893, and the Chicago & Alton and the Santa Fe have been using it on limited trains for several years. Besides the illustrations and descriptive matter, the catalogue contains a large number of testimonials from railroad officers and other users of the chairs. A net price list is included.

*The Little Blue Flag* for November, the magazine of The Lowe Brothers Company, Dayton, Ohio, contains some interesting letters and articles on paint from the salesman's and user's standpoint. There are also illustrations of houses, the exteriors and interiors of which are painted with Lowe Brothers product, and of some effective window displays.

*The Standard Paint Company*, New York, sends its November issue of "The Exchange." It contains an interesting article on "Valuable Hints to the Roofer." Illustrations of a number of buildings at the Louisiana Purchase Exposition covered with Ruberoid roofing are also shown.

*The Stannard & White Company*, Racine Junction, Wis., sends its catalogue D. It is devoted principally to locomotive cab seats. The large number and variety of styles of cab seats made by this company are illustrated and described and detailed parts are shown.

*The Columbus Machine Company*, Columbus, Ohio, sends its special catalogue of gas and gasoline engines in which are described stationary, portable, traction, pumping and hoisting engines. Detailed descriptions of these engines as well as illustrations of their different parts are also given.

# CONTRIBUTIONS

### Automatic Signals, Speed Recorders, and Other Things.

Chicago, Nov. 17, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

A dramatic derailment which occurred in a large western city not more than a thousand miles from Chicago a few days ago illustrates one advantage of automatic block signals, over non-automatic, that perhaps has not been noticed by all of your readers. A heavy passenger train, while running at high speed through a curve, was derailed, and the engine tumbled over on the adjacent main track; and, as this obstruction short-circuited the signal current through the rails of this track, it set the signal at danger ahead of the train; that is to say, so as to stop trains coming from the opposite direction. As the train was, of course, already protected in the rear (on its own track) by the automatic signals, it was thus instantly protected in both directions. The danger of damage to trains coming from the opposite direction is thus obviated, unless such trains happen to be in the block before the derailment occurs.

This accident also illustrated the usefulness of a speed recorder. On the rear end of the train was the private car of a railroad officer, and in it a speed recorder; this showed, a few moments before the derailment, a speed of 60 miles an hour. As the point where the train ran off the track is on a 10 deg. curve, with super-elevation suitable for moderate speed, the cause of the disaster is not a matter of doubt to those who have looked into the case. We see here plainly the value of an officer's car at the rear of every train, and you will doubtless hear from some daily newspaper editor a recommendation that such an adjunct be regularly required. As everybody knows, the use of a speed recorder on the locomotive is of no value, unless there be a man on the engine detailed to watch it, for the engineman and fireman are always interested, in the case of an accident, in showing that the speed had been very moderate. In the present case, it is safe to say that the engineer would swear that 25 or 30 miles an hour was about the rate at which he had been running.

Whether or not this brilliant (?) exhibition of high speed was the result of an endeavor to add one more to the list of the "unconscious exhibits," for the benefit of foreign visitors to the World's Fair, which have been referred to in your columns, I do not know; but there were numerous passengers on this train returning from the World's Fair and it is safe to say that if any of them were foreigners they were impressed by this little object lesson in American enterprise. Possibly there is not much, after all, in exhibits of this kind, to warrant one in calling them "unconscious." It is hard to believe that an engineer of experience, running over the same road day after day, does not know with considerable accuracy how near the limit of safety he is going when he speeds his engine up to a high rate on a sharp curve. In fact, cases of this kind may fairly be looked upon as furnishing testimony in support of the cynical assertion, lately published very widely in England and America, that our notorious railroad-accident record is due largely to the propensity of the whole nation to do everything too fast. In the last three notable cases of fast trains being derailed on sharp curves recorded by the Interstate Commerce Commission, the train in each case carried no passengers; it was a "fast mail" or a fast newspaper train. It will be generally agreed, I think, that if this experiment of running at high speed around sharp curves is to be often repeated, to the extent of making it a "test to destruction," the public may fairly demand that the experiments be confined to fast mail trains. If they are to be tried on passenger trains the general passenger agent ought in all fairness to make the situation and conditions clear in his advertisements.

M. G. C.

### The Cole Four-Cylinder Balanced Compound.

Urbana, Ill., Nov. 19, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

On a recent visit to the World's Fair the writer observed some things about the New York Central locomotive No. 3,000 which he thinks may be of interest to your readers. This engine is the Cole balanced compound, regarding which the claim is made, in print, that the "four cylinders are so arranged in relation to each other that the horizontal moving or reciprocating parts balance each other without the use of the customary counterweights for these parts in the driving wheels."

The wheel and cylinder arrangement is as follows: Two high-pressure inside cylinders connected to the front crank axle, quartering with each other, and two low-pressure outside cylinders connected to the back drivers as usual in the Atlantic type, set quartering with each other and opposite the cranks on the front axle. The customary counterweights are omitted in the wheels except enough to balance the side-rods and a portion of the cranks on the cranked front axle, which are all rotating parts, hence easily balanced.

As regards forces in a horizontal plane through both axles, the locomotive is balanced; but consider for a moment the vertical forces upon the back pair of drivers alone, when rolling on the track. The conditions here are exactly the same as in an ordinary locomotive; for the vertical forces exerted by the reciprocating parts connected to the front drivers cannot interpose between the back drivers and the rail to balance the vertical forces exerted upon the back drivers by the reciprocating parts connected therewith. It must follow then that the reciprocating parts connected to the back drivers, being unbalanced, and quartering or at 90 deg. with each other, must produce a very severe hammer-blow upon the rails at every revolution. The same reasoning, of course, holds with the front drivers.

If all these cranks were on one axle, or if the two cranks on each axle could be opposite, and similar parts had the same weight, the engine would of necessity be exactly balanced. But the splitting up of the cranks, as done in this engine, between the front and rear drivers, must necessarily result in unbalancing the vertical forces upon each axle. These forces are the ones of importance so far as destructive action upon the rails is concerned.

L. E. MOORE,
*Instructor in Mechanics, University of Illinois.*

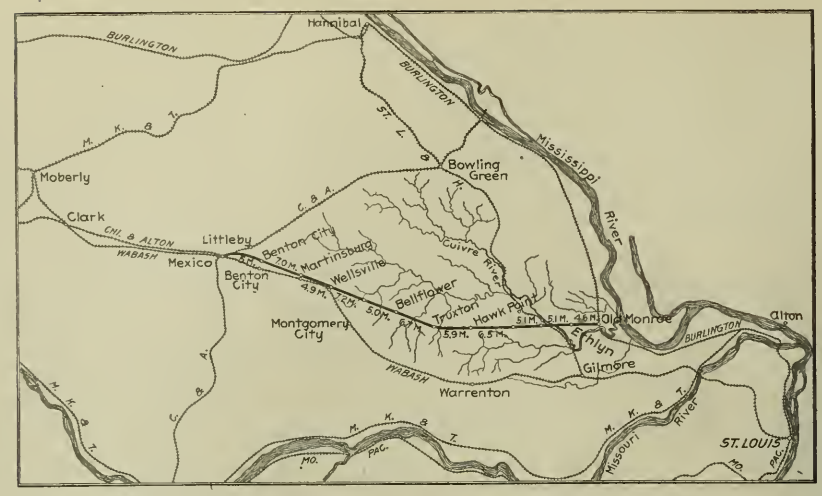
The car-works in Riga are building a number of armored passenger cars for the Chinese Eastern Railroad. With their immense superiority in cavalry, the Russians ought to be able to keep the enemy out of gun-shot of any part of the railroad which they operate. But perhaps these are for use when they invade Japan.

## The Old Monroe-Mexico Branch of the Burlington.

BY A. W. NEWTON.*

In the competition for control of the rapidly increasing traffic between St. Louis and Kansas City, two of the interested roads have been so seriously handicapped because of the lengths of their respective lines as to make them only secondary factors in that service. The Wabash with 277 miles, the Missouri Pacific with 284 miles, and the Rock Island (just completed) with 296 miles, left the Chicago & Alton, with 322 miles, and the Burlington, with 346 miles, the alternative of either abandoning all effort towards securing their fair share of this business, or of building a short line that would put them on a competitive basis.

A study of the map of Missouri with its various railroad systems showed the possibility of a connecting line for the Burlington and the Alton between Old Monroe and Mexico that would give them the advantages of a short route, and also the benefits to be derived from a road already built and in perfect condition, requiring the construction of only 63 miles of new line. The building of this connecting line meant a saving in distance to the Alton of 43 miles and the elimination of that portion of the road having its heaviest grades and greatest curvature; and for the Burlington a saving of 67 miles and also a large amount of heavy grades and sharp curvature.




Map of Burlington Cut-Off between Old Monroe and Mexico.

Erecting Camp Creek Bridge on Falsework.

*Location and General Plan.*—In August, 1902, a reconnoissance of the country between Old Monroe and Mexico was made covering a territory some 30 miles in width, having in view a location that would be as near an air line as practicable. On October 7, 1902, the preliminary location was begun, which was governed by the following conditions: The projected line should not be longer than 63 miles, the maximum grade should be .5 per cent., the maximum curvature should not be more than 2 deg. and should not be more than 10 per cent. of the total length of the line to be constructed, thus insuring a low-grade and practically an air line. On Dec. 23, 1902, the preliminary surveys were completed and an estimate of the cost was made at $42,000 per mile. On March 27, 1903, the final location of the line was begun under the direction of Chief Engineer Breckenridge, of the C., B. & Q., which road was to construct, own and operate the cut-off. The line of preliminary location was abandoned and a new line established that effected a considerable saving in grading and bridge construction, and yet did not materially add to its length. This location gave a total length of 63.18 miles.

The location decided upon required a long maximum grade extending from the Cuivre river west for seven miles through a deep cut, also the construction of large bridges at Cuivre river, Camp creek and Bear creek. At the Cuivre river the entire drainage of the line is concentrated as all waterways along the road eventually empty into this river. For the first nine miles an undulating grade line was laid out on which borrowing and wasting was avoided except on mile 9, where considerable borrow was necessary through the Cuivre bottoms. Then followed the seven miles of ascending grade above mentioned, necessitating deep cuts and the wasting of many thousand yards of excavation. Miles 18 to 27 are through a rolling country where cuts and fills could be readily balanced. Miles 27 to 32 presented the most serious difficulties on the entire line. Crossings for Clear branch, Camp creek and Bear creek had to be located and

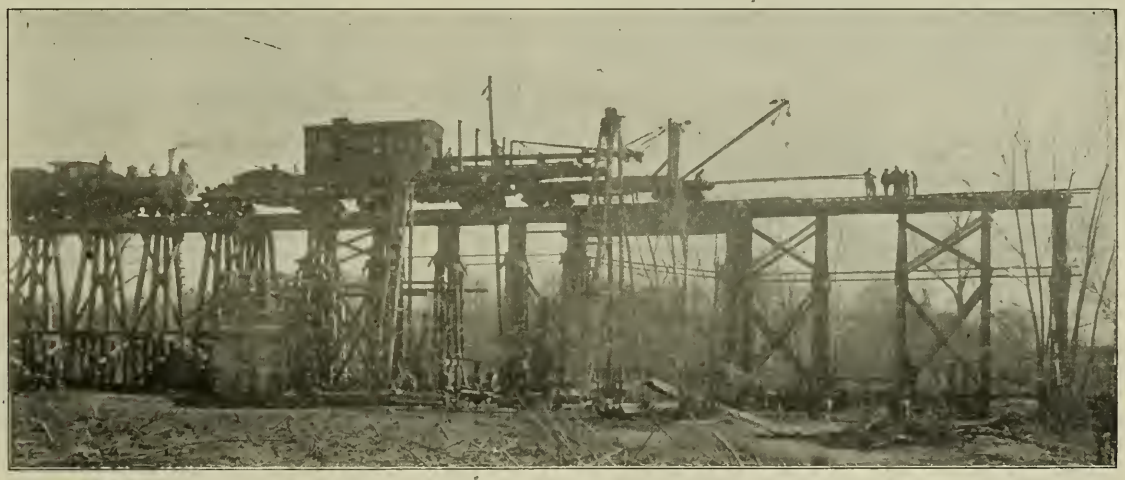
Erecting 105-ft. Plate Girder over Cuivre River.

*Superintendent of Construction.

each presented an obstacle in itself. Here a careful study of the topography of the country showed a physical condition which was most fortunate. High grade crossings were necessary in order to maintain a low-grade line and also to avoid as much excavation as possible. It was, therefore, necessary to find the narrowest places in the valleys of the three streams mentioned. These points were located and found to be not far from the general line of location so that with the introduction of a very little curvature the line as originally laid out could be carried across these narrow places. From mile post 32 to mile post 63 but little difficult work was encountered and the line was located as a tangent the whole distance with the exception of one short 1-deg. curve on mile 45.

The final location was determined by April 28, 1903, and orders were given to have the line in operation by June, 1904, in order to participate in the expected large traffic to and from St. Louis for the World's Fair. The first right-of-way was purchased in May, 1903, and the contract for the grading was let by Chief Engineer Breckenridge to the Stubbs, Flick & Johnson Construction Company, of Kansas City, on May 22, 1903. On June 8, 1903, the first work of construction

Excavating Rock Cut near Camp Creek with Steam Shovel.



Pile Driver Derrick Car Erecting Falsework for 105-ft. Girder over Cuivre River.

Completed Plate Girder Bridge over the Cuivre River.

began. In 12 months time this company undertook to complete 3,200,000 yds. of excavation, haul overland from two to 20 miles and lay 756 tons of cast-iron pipe, construct 11,500 yds. of standard concrete-steel box culverts, erect 650,000 ft. (board measure) of pile and frame bent bridges, erect eight steel bridges and lay and ballast 63 miles of track, besides construction of terminals, reservoirs for water supply and the erection of depots and station buildings. At the end of the 12 months, after having experienced extremely unfavorable weather, the work was 92 per cent. completed.

A force of nine steam shovels and 33 subcontractors having each from one to eight miles to grade, was put upon the work as rapidly as the outfits could be secured. From a total of 18,500 yds. in June, 1903, the excavation was increased to 509,000 yds. in October and 520,000 yds. in November, while at the same time large forces were at work on pipe culverts, putting in concrete and erecting bridges so as to avoid delays to grading.

*Construction.*—The low-grade line and minimum amount of curvature, and the rolling nature of the country, made deep cuts and heavy fills a necessity. As already stated, nine steam shovels, which varied in size from 35 tons to 65 tons, were placed on the

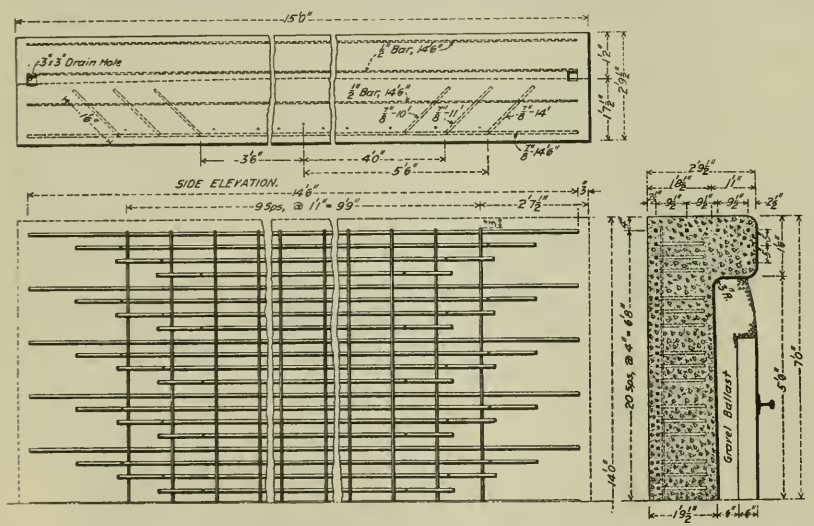
West Approach to Camp Creek Bridge, 87-ft. Fill.

cer tion of the connection with the St. Louis, Keokuk & Northwestern at Old Monroe, where a 2-deg. curve was used, all curves on the line are either 1-deg. or 30 minutes, and the percentage of curvature is less than 10 per cent. of the whole line.

Momentum grades were introduced at four points on the line, based on a train velocity of 30 m.p.h. at foot of grade. The introduction of these grades saved a large amount of heavy filling. Trains are being operated over these momentum grades with loads based on a maximum of .5 per cent. grade.

*Provision for Drainage.*—Cast-iron pipe was used in sizes up to 48 in., both single and double strings, and under fills not exceeding 20 ft. In all cases requiring more opening than would be afforded by a double string of 48-in. cast-iron pipe, or where fills were higher than 20 ft., concrete-steel box culverts were built. These boxes were designed by the bridge department of the Burlington, and the corrugated bars of the St. Louis Expanded Metal Fireproofing Company were used with excellent results. No cracks in the concrete due to settlement or other causes have appeared. These boxes varied in size from 4 ft. x 5 ft. to 14 ft. x 14 ft., the largest being built at Clear branch under a bank 65 ft. high. The drawings of this culvert are reproduced herewith. It rests on a concrete gravel foundation, no extra excavaton being necessary. The box is 213 ft. long and was built in two sections. It has been subjected not only to the strain of having a very large fill built over it but also to the shearing and crushing effect of an immense slide on the north end, without showing any signs of weakness, and after having sustained the weight of the finished roadbed for about six months is in perfect condition. Excellent conditions exist along the entire line for foundations, which in a measure accounts for the exceptional results in concrete and concrete-steel structures, not one of which shows a crack or sign of settlement.

*Bridges.*—Besides three girder bridges for

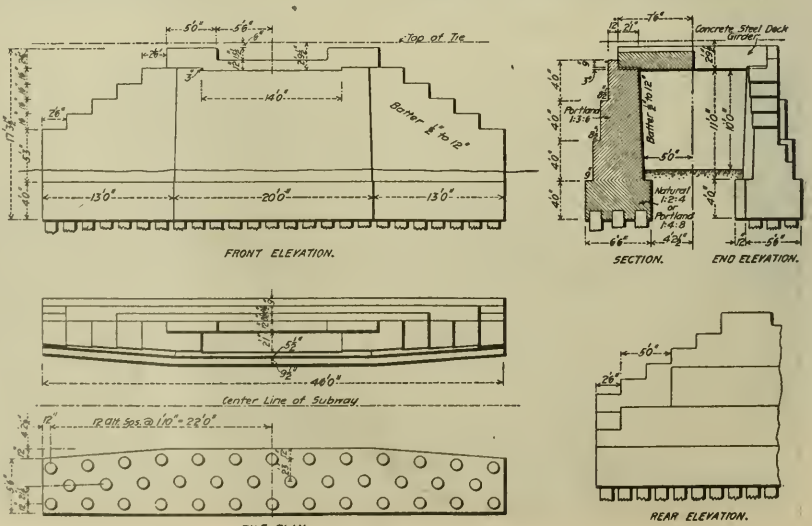



Reinforced Concrete Deck Girder Slab.

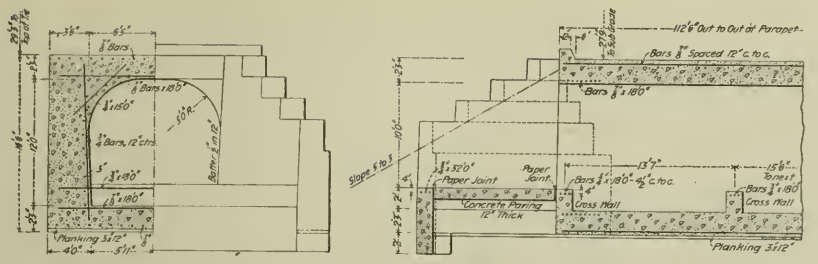
work. Five of these shovels were transported overland an average of 14 miles, and this movement was greatly facilitated by the use of Michael's patent device for handling track on which to move the shovels. This improvement, which is owned by Mr. Johnson, of the Stubbs, Flick & Johnson Construction Company, proved itself to be an excellent labor and time-saving device for steam shovel contractors.

The general plan outlined for the completion of the line was for grading to be done on the east nine miles by Jan. 1, 1904, and the west 18 miles by Nov. 1, 1903, so that tracklaying and ballasting could be carried on while grading was being completed on the remainder of the line. Material for bridges and tracklaying was divided between the two terminal points and forces organized to work from each end. A Harris tracklaying machine was used on the entire line with an average force of 75 men. One mile of track per day was the average amount laid.

A reference to the accompanying map of the line will give an idea of the alinement and also show how nearly an air line was obtained in the final location. With the ex-




Concrete Girder Bridge for Highway Subway.



Reinforced Concrete Box Culvert, 10 ft. x 12 ft.

highway subways, bridges for waterways were erected at Cuivre river, Camp creek, Bear creek, Wolf creek and Elkhorn creek, the last two being 50 and 75-ft. deck plate girders respectively. Bear creek and Camp creek bridges are composed of deck plate girders supported on steel towers, the height of the structures prohibiting the erection of concrete piers.

The erection of the Cuivre river bridge was attended with a continued succession of difficulties incident to the sudden and frequent high waters for which the Cuivre is noted. The bridge is composed of three 105-ft. and two 70-ft. deck plate girders supported on concrete piers carried down to bed rock. The erection of this bridge was begun in November, 1903, and was not completed until June, 1904. The concrete work was done by the Foundation & Contracting Company of New York. With a record of fourteen high waters and overflows to contend with, each of which caused work to be entirely suspended, it is easy to understand why so much time was consumed in building this bridge. Falsework used by the contractors, and also that erected by the railroad company for placing the steel girders, was wrecked and washed away four times.

Soundings for the piers showed a stratum of gravel below the bed of the river, 25 ft. thick, and extending to solid rock. Friestedt interlocking steel sheet piling was used in sinking the caissons and very little pumping was necessary to keep the caissons free from water. The sheet piling was driven with a heavy steam hammer, about four minutes being required to drive each pile after being set in position.

In excavating for foundations a good quality of angular creek gravel was encountered, which when washed was used in the footing courses of the concrete, effecting a saving of several hundred yards of crushed rock. One of the illustrations shows this bridge during erection.

*Track.*—The track is laid with 33-ft., 85-lb. steel rails and 20 ties to the rail. Oak and cypress ties were used, the majority being oak. About seven miles of cypress ties were laid, on all of which tie plates were used.

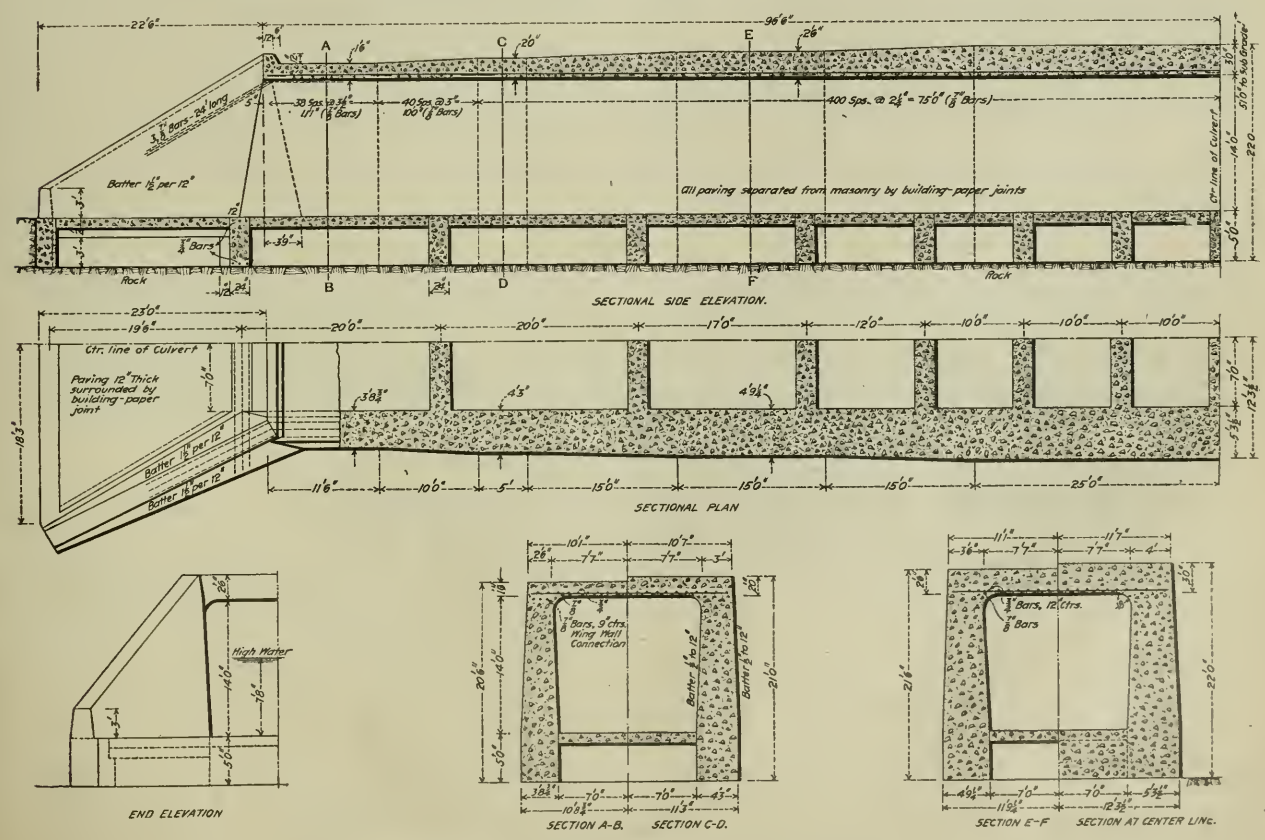
*Terminal Yards.*—At Felton, two miles east of Mexico, about 60 acres of land adjoining the Chicago & Alton were purchased for terminal uses. The plans at this point called for yards 4,000 ft. long, and a roundhouse, coaling station, water station, and other structures necessary for a terminal to be used by two roads where interchange of crews is made in a joint service. The water supply at Felton was increased from 27,000,000 gallons to 64,000,000 gallons by building a second reservoir so that there is now an ample quantity available.

Interlocking plants are being installed at Old Monroe, where connection is made with the St. Louis, Keokuk & Northwestern, and at Felton, where connection is made with the Alton. A standard design of depot has been erected at each of the ten stations along the line. They are both substantial and attractive and convey some idea of the thorough manner in which the entire road is built.

*Ballast.*—As a temporary ballast to be used until the roadbed is sufficiently settled, gravel and burnt mine refuse has been put in with satisfactory results. It is possible to raise and surface the track rapidly with this material and line and surface are easily maintained. On top of this sub-ballast a finishing coat of 8 in. of crushed rock is to be laid during the coming winter so as to have the roadbed in better condition to stand the service during the wet weather of next spring.

Owing to the peculiar nature of the soil on which the line is constructed it was decided that the slope in cuts as well as on fills should be made 1½ to 1; the roadbed to be 20 ft. wide at sub-grade and the total width in bottoms of cuts to be 27 ft. This is in excess of Burlington standards but was deemed necessary in this case.

On October 1, last, the road was turned



Reinforced Concrete Box Culvert over Clear Branch.

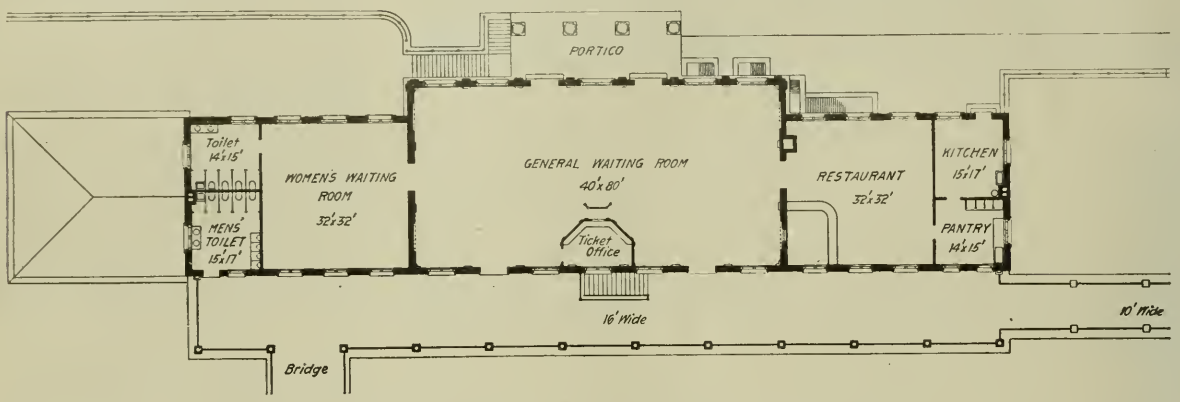
over to the operating department ready for service on a 30-m.p.h. basis, which has been maintained since then, all trains of the Burlington and the Alton between Kansas City and St. Louis running over this cut-off.

## Norfolk & Western Station at Roanoke.

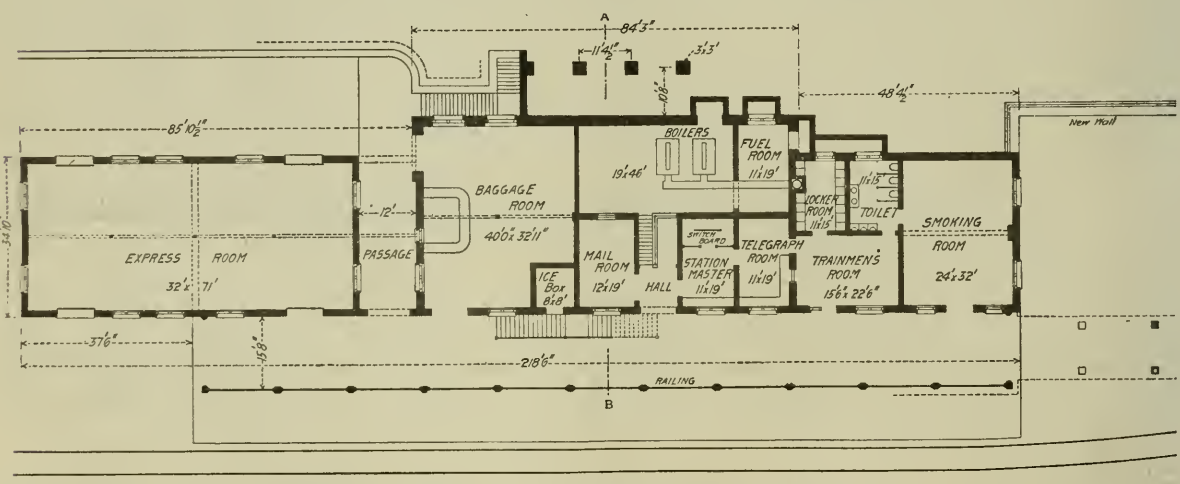
In addition to the extensive freight terminal and shop improvements which the Norfolk & Western has recently completed at Roanoke, Va., it is also building at that city a new passenger station which when completed will be one of the most handsome buildings of its kind in the South. The new station will stand on the site of the old station at the intersection of Shenandoah avenue and Randolph street, and will face north on a wide plaza opposite the large park and grounds of the Hotel Roanoke. The tracks in front of the station run in a cut from 15 to 20 ft. deep and the new building will be two stories high on the track side but only one story above ground on the back side. It is a fine example of Colonial architecture as will be seen from the accompanying illustrations from the architects' drawings.

The top floor is level with the new grade of the plaza which has been established, and is 181 ft. long. The main waiting room occupies the center of this floor and is flanked by low wings on each side, in one of which is the women's room and in the other the restaurant and kitchen. A wide Colonial portico, the full height of the building, and supported by four massive fluted stone columns forms the main entrance to the general waiting room. A stairway running up from the paved court around the west wing of the station at the track level leads into the side of the portico and a wide granolithic walk along the eastern end of the building at the street level opens into the other side. The main waiting room is 40 ft. x 80 ft. and is finished with paneled wainscoting, plaster walls and fluted wooden pillars flanking the doors and windows. It is 22 ft. high from the floor to the paneled ceiling, which is supported on the bottom members of the steel roof trusses. Skylights in the roof over light wells closed at the bottom with ceiling lights provide for ventilation and top lighting. The ticket office is directly opposite the main entrance against the wall.

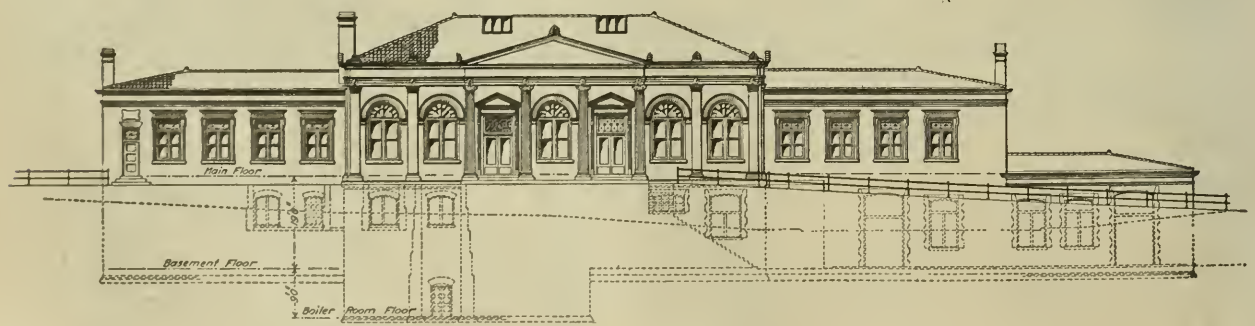
At the western end of the waiting room is the women's rest room, 32 ft. x 32 ft., and toilet rooms for men and




Ground Floor Plan of Norfolk & Western Station at Roanoke, Va.




Floor Plan at Track Level, Roanoke Station, Norfolk & Western.




North Front Elevation of Roanoke Station, Norfolk & Western.

women. The women's toilet opens off from the rest room and the men's toilet opens from the gallery leading along the outside of the building on the track side. At the east end of the building is the restaurant, 32 ft. x 32 ft., and the kitchen and pantry are next to the east wall, where there will be no trouble from odors. Both the women's room and restaurant are finished with a low wood wainscot and plaster walls with ceilings 15 ft. high.

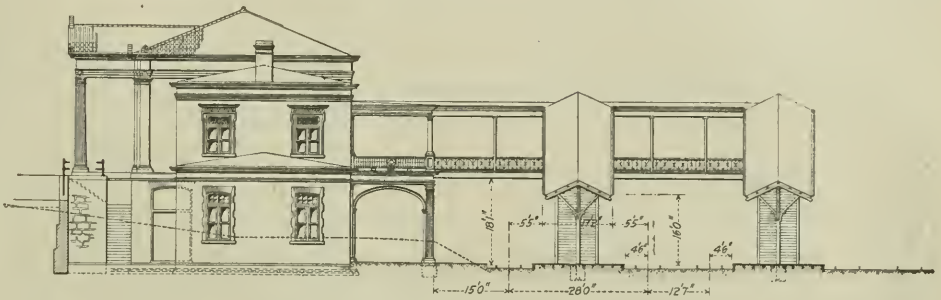
On the lower floor, which is about at the level of the tracks, are the express room, 32 ft. x 71 ft.; baggage room, 40 ft. x 32 ft. 11 in.; mail room, 12 ft. x 19 ft.; boiler room, 19 ft. x 46 ft.; station master's office, telegraph office, trainmen's room, fuel room, smoking and another men's lavatory. The express room extends out beyond the west wing 37 ft. 6 in., and is covered with a low roof that comes a little above the parapet of the retaining wall of the excavation in which the station stands. It is separated from the other rooms on this floor by a passageway 12 ft. wide running through the building from the train platform to the foot of the stairs leading down from the portico. The checking counter in the baggage room is reached from this corridor. Double swinging doors lead out from the baggage and express rooms to the inside train platform and runways for trucks over the tracks will be provided to reach the other platforms. The paved court or driveway in the rear of the express room connects with the street beyond the station where the ground slopes off.

The train platforms, of which there are three, are 19 ft. wide. The single platform next to the building is granolithic paving, but the double platforms are wood laid on stringers bedded in cinders. They are 780 ft. long and the two double platforms are covered with umbrella sheds 17 ft. 2 in. wide at eaves, sloping from the ridge down to the sides. The inside platform is protected only for the length of the station building by the gallery 16 ft. wide next to the wall.

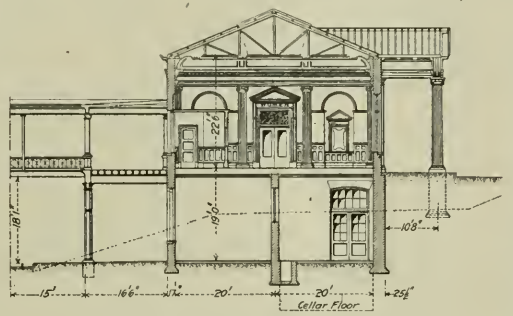
The trains can be reached from the main waiting room on the upper floor through the two double swinging doors opening out on the covered gallery and over the bridge at the west end to the stairs leading down to the platforms below. Or, the inner platform can be reached from the upper gallery by the stairs along the wall between the doors leading out from the main waiting room. The passageway between the baggage and express rooms also forms another entrance and exit.

The walls of the building are pressed brick with stucco, stone and terra cotta ornamentation around the windows, and the roof is fluted tile. The bridge over the tracks and the covered gallery are wood, supported on metal columns. It is expected to have the station in use by next February.

Frye & Chesterman, Lynchburg, Va., were the architects, and the contract for all of the work has been let to John P. Pettyjohn & Co., of the same place. We are indebted to Mr. C. S. Churchill, Chief Engineer of the Norfolk & Western, for the drawings and information.



West End Elevation, Roanoke Station.



Section through Center of Building.

## The Quebec Bridge.

The illustration shown herewith is from a photograph of a model of the bridge of the Quebec Bridge and Railway Company across the St. Lawrence river near Quebec, Canada, now under construction. This bridge, it will be remembered, is the longest span steel bridge in the world. It has a central span of 1,800 ft., two anchor spans of 500 ft. each, and two approach spans of 210 ft. each. The width is 80 ft. between centers of outside railings, and it will carry a double-track railroad, two lines of trolley tracks, two highways and two sidewalks. The clear height at high water is 150 ft. The weight of the structure is 35,000 tons.

The bridge was of such magnitude and contains so many new features that the Phœnix Bridge Company, which designed and is building it, found it desirable to make a model in order to design the traveler. This traveler is built of steel and weighs 450 tons. It is 217 ft. high over all. Contrary to usual practice no steam hoisting engines will be used on the job, electricity being used instead throughout. The Lidgerwood Manufacturing Company has made special electric hoisting engines, weighing about 35 tons, for use with the traveler. The traveler will be carried on steel falsework, the first ever used, so far as we know. Another point which will differ from usual practice is that the traveler will be outside of the trusses instead of inside. When it reaches the main pier it will be necessary to provide special cantilever floor-beams to carry it. There will be three lines of stringers under the traveler, and these same stringers will later be used under the railroad tracks in the permanent structure.

At the present time the masonry piers and the two approach spans of the bridge are done, and practically all of the falsework for one anchor arm is in place. A considerable part of the anchor arm has been shipped and has been stored at the site ready for use. The steel falsework for the traveler has all been shipped and is mostly in place. This steel weighs 1,100 tons. Owing to climatic conditions, it is only possible to work on the bridge about seven months in the year, work for 1904 having ceased at the end of October. It is expected to complete the bridge in four more seasons.

In order to accommodate the material for one-half of the bridge a storage yard 3,000 ft. long and spanned by a 70-ft. crane is required. An idea of the size of some of the members of the bridge may be gained from the statement that the main posts are 325 ft. high and each one weighs more than five ordinary 150-ft. single-track railroad spans. The bridge was designed by Mr. P. L. Szlapka, Designing Engineer of the Phœnix Bridge Company.

The model from which the photograph was made is on a scale of 1 in. to 40 ft. and is 9 ft. long over all. It is made of paper and formed part of the exhibit of the Phœnix Bridge Company at the World's Fair, for which the company was awarded the grand prize.

Bridge of the Quebec Bridge & Railway Company over the St. Lawrence River.

## Rebuilding the Oregon Railroad & Navigation.

The Oregon Railroad & Navigation Company, with headquarters at Portland, Ore., has 1,128 miles of track in Oregon, Washington, and Idaho, on which, since the company was reorganized in 1896, large expenditures have been made for improvements and betterments, consisting of radical changes of line, elimination of trestle bridges by filling or throwing out by change of line, substitution of steel for wooden bridges, replacing wooden culverts with cast-iron pipe, relaying with heavy rail, and ballasting. The following information briefly covering

this work has been received from Mr. E. E. Calvin, General Manager.

The main line of the O. R. & N. extends from Portland to Umatilla, Ore., where it forks, the line running east terminating at Huntington, Ore., and forming a junction with the Oregon Short Line; the line running north terminating at Spokane, Wash., forming connection with the Great Northern. An important branch line extends from Tekoa, Wash., to Wallace, Idaho, handling

Map of Oregon Railroad & Navigation Company's Lines.
*Full lines show main line; dotted lines show branches.*

the output of the Coeur d'Alene mines. A number of other branch lines tap the agricultural and mining districts of Oregon, Washington and Idaho.

The number and magnitude of waterways crossed can be appreciated by the statement that there are in all 68 iron and steel bridges, aggregating 8,697 lineal feet, 35 Howe truss bridges, aggregating 3,928 lineal feet, and 860 pile and frame trestle bridges, aggregating 110,899 lineal feet. The most important structures are the steel drawbridge crossing the Willamette River at Portland and a similar bridge crossing the Snake River at Riparia. Several large streams are crossed a number of times. Between Umatilla and Huntington there are seven crossings of the Umatilla River, 18 crossings of Meacham Creek, two crossings of the Grande Ronde River, three crossings of Powder River, and 33 crossings of Burnt River. Between Colfax and Spokane there are two crossings of Palouse River and four crossings of Latah Creek. On the branch line between Colfax and Moscow there are 18 crossings of the South Palouse River, and on the branch line between Tekoa and Wallace there are four crossings of the Coeur d'Alene River.

Some small amount of bridge filling was done before the present owners acquired the property, but since the date of reorganization the policy has been to eliminate trestle bridges by filling and to substitute steel for wooden bridges at stream crossings, as fast as the revenues would admit.

The following is a brief summary of improvements made during the fiscal year ending June 30, 1904:

There were erected 19 steel bridges (designed to carry modern heavy loads) consisting in all of 25 spans, varying from 20 ft. to 200 ft., with an aggregate length of 1,986 ft., all supported by concrete abutments and piers in which 8,920 cu. yds. of concrete masonry were required for their construction.

The most important bridge erected during the year is known as A 206, crossing the Spokane River at Spokane, Wash. It consists of three 150-ft. through lattice truss spans, and one 35-ft. and one 65-ft. through plate girder, resting on two abutments and four piers. Another important bridge, known as E 45, was erected at Cataldo, Idaho, crossing the south fork of the Coeur d'Alene River. It consists of one 200-ft. through pin-connected truss and one 50-ft. through plate girder, resting on one abutment and two piers. There were also erected two 125-ft. through lattice truss spans, known as bridges E 52 and E 85, crossing the south fork of the Coeur d'Alene River. One 125-ft. through lattice truss, known as bridge R 155, was erected on Meacham Creek. Five through plate girders of 80-ft. span were erected on Burnt River.

Eighty-three cast-iron pipe culverts have been placed transverse to the track under filled bridges or through worn out wooden culverts, aggregating 3,840 ft. in length. One arch culvert was built, its length being 41 ft., and requiring 143 cu. yds. of concrete masonry.

The improvements to track during the fiscal year consisted of laying 48.03 miles of 80-lb. rail, replacing rail of lighter weight, and ballasting 32.22 miles of roadbed. Many permanent improvements have been made since 1896, the summary of which is as follows: There have been eliminated by filling, or thrown out by change of line, 373 bridges, aggregating 58,108 ft., equal to about 11 miles. It required 2,161,921 cu. yds. of embankment for the new roadbed so created. Seven hundred and twenty cast-iron pipe culverts were placed under filled bridges or through worn out wooden culverts, with an aggregate length of 38,255 ft. transverse to the roadbed, equal to 7.2 miles. Fifteen concrete arch culverts were built, with a total length of 1,333 ft., requiring 5,431 cu. yds. of concrete masonry in their construction. Sixty-one steel bridges were erected, with an aggregate length of 5,394 ft., requiring 27,477 cu. yds. of concrete masonry in the construction of abutments and piers, and 4,509 tons of metal in the superstructures.

Twenty-six separate changes of line were made, the length of original line changed being 48.57 miles, and the amount the line was shortened being 1.34 miles. The curvature eliminated consisted of 196 curves, aggregating 5,891 deg., or over 16¼ complete circles.

During the same period light rail was replaced with rail of heavier weight as follows: 152.20 miles of 75-lb. steel rail; 204.49 miles of 80-lb. steel rail; 38.13 miles of 85-lb. steel rail; 13.22 miles of 90-lb. steel rail. Ballasting done during the same period consisted of 25.46 miles.

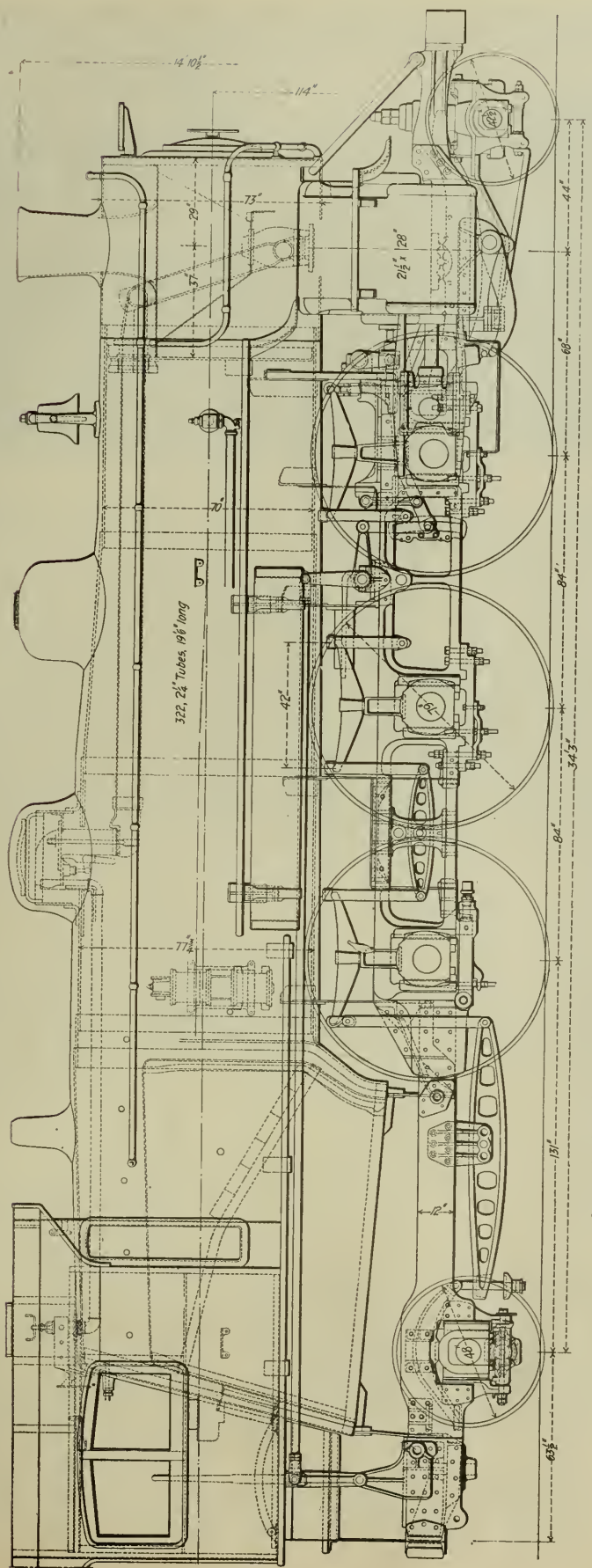
The management intends to continue making improvements to its roadbed as fast as it is practicable to do so, having under consideration for 1905 the erection of several steel spans, the elimination of a number of trestle bridges, and extensive ballasting of track.

Since receiving the foregoing from Mr. Calvin press despatches have stated that work has begun on a new branch from Arlington to Condon in Gilliam County, Ore., 46 miles. The contract, it is said, stipulates that all of the bridge and track work shall be completed by December 31.

## New Passenger Locomotives for the Lake Shore.

The Lake Shore & Michigan Southern has just put into service ten new Prairie (2-6-2) type passenger locomotives built by the Brooks Works of the American Locomotive Company. These new engines are heavier and more powerful than any heretofore used by the Lake Shore in passenger service. Train loads and speeds on this road have increased at such a rate that the class J

Prairie (2-6-2) Type Locomotive for the Lake Shore & Michigan Southern.




General Elevation of the Lake Shore & Michigan Southern Prairie (2-6-2) Type Passenger Locomotive.

locomotives (see *Railroad Gazette* March 20, 1901,) which were designed only about four years ago, have become inadequate, the result being, that the expensive expedient of "double-heading" was often necessary. The new class K locomotives have been designed to haul the heavy 13, 14 and 15-car trains and make time. These locomotives are the heaviest ever built for passenger service anywhere. The principal dimensions of the new class K, the class J, and the Chicago & Alton* 4-6-2 locomotives are given in the following table:

| | Class K. | Class J. | Chicago & Alton. |
|---|---|---|---|
| Total weight, lbs. | 233,000 | 174,500 | 219,000 |
| Wt. on drivers, lbs. | 166,000 | 130,000 | 142,000 |
| Cylinders, in. | 21½x28 | 20½x28 | 22x28 |
| Diam. of drivers, in. | 79 | 80 | 73 |
| Heating surface: | | | |
| Fire-box, sq. ft. | 227 | 174 | 230 |
| Tubes, sq. ft | 3,678 | 3,169 | 3,848 |
| Total, sq. ft. | 3,905 | 3,343 | 4,078 |
| Number of tubes | 322 | 285 | 330 |
| Length tubes, ft. & in. | 19—6 | 19—0 | 20—0 |
| Diam. of tubes, in | 2¼ | 2¼ | 2¼ |
| Grate area, sq. ft. | 55 | 48.5 | 54.0 |

It will be seen that the class K locomotive is 58,500 lbs. heavier than the class J and that this additional weight, with the exception of 22,500 lbs., is on the drivers. The Chicago & Alton engine weighs less than the class K, but the boiler is larger. The class K has 562 sq. ft. more heating surface than the class J, the additional heating surface being due to the larger fire-box and the greater number of tubes and their greater length. The class K locomotive has 55,333 lbs. on each driving axle and the maximum tractive effort is 27,850 lbs. The ratio of weight on drivers to maximum tractive effort is 5.96, which is higher than that for any American passenger locomotive built in recent years. It is interesting to note that the class K locomotive weighs 14,000 lbs. more than the Chicago & Alton locomotive, notwithstanding the fact that the C. & A. engine has a four-wheel leading truck and a slightly larger boiler than the class K. The principal dimensions of the class K follow:

*General Dimensions.*

| | |
|---|---|
| Gage | 4 ft. 8½ in. |
| Fuel | Bituminous coal |
| Weight on working order | 233,000 lbs. |
| Weight on drivers | 166,000 " |
| Wheel base, driving | 14 ft. 0 in. |
| Wheel base, total | 34 ft. 3 in. |
| Wheel base, total engine and tender | 62 ft. 4½ in. |
| Tractive power | 27,850 lbs. |

*Cylinders.*

| | |
|---|---|
| Diameter of cylinders | 21½ in. |
| Stroke of piston | 28 " |
| Diameter of piston rod | 4 " |
| Kind of piston packing | Dunbar |

*Valves.*

| | |
|---|---|
| Kind | Piston, 12 in. diameter |
| Greatest travel | 5½ in. |
| Outside lap | 1¼ " |
| Inside clearance | ⅛ " |
| Lead in full gear | 1-16 " |

*Wheels, Etc.*

| | |
|---|---|
| Number of driving wheels | 6 |
| Diam. of driving wheels, outside of tire | 79 in. |
| Material of driving wheel, centers | 72 " |
| Thickness of tire | 3½ " |
| Diam. of trailing wheels, outside tire | 48 " |
| Diam. and length of driving journals | 9½x12 " |
| Diam. and length of trailing journals | 8x14 " |
| Diam. and length of main crank-pin jrnls. | 7x6½ " |
| Diam. and length of side rod journals | 7½x4¾ " |
| Diam. and length of front journals | 5x4 " |
| Diam. and length of back journals | 5x4½ " |
| Engine truck, kind | 2-wheeled swing center |
| Engine truck; journals | 6½x12 " |
| Diameter of engine truck wheels | 42½ " |

*Boiler.*

| | |
|---|---|
| Style | Extended wagon-top, radial stay |
| Outside diameter of first ring | 70 in. |
| Working pressure | 200 lbs. |
| Thickness of plates in barrel and outside of fire-box | 11-16 in., ¾ in. 25-32 in., 9-16 in., 9-16 in., 9-16 in. |
| Fire-box length | 109 in. |
| Fire-box, width | 74 " |
| Fire-box, depth | Front, 80½ in.; back, 68 in. |
| Fire-box plates, thickness | sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in. |
| Fire-box, water space | 4½ in. front, 4½ in. sides, 4 in. back |
| Tubes, number | 322 |
| Tubes, spacing | ¾ in. front, 13-16 in. back |
| Tubes, diameter | 2¼ in. |
| Tubes, length over tube sheets | 19 ft. 6 in. |
| Fire brick, supported on | (4) 3-in. tubes |
| Heating surface, tubes | 3,678 sq. in. |
| Heating surface, water tubes | 29 sq. ft. |
| Heating surface, fire-box | 198 " |

*See *Railroad Gazette*, Nov. 7, 1902.

| | |
|---|---|
| Heating surface, total | 3,905 sq. ft. |
| Grate surface | 55 " |
| Grate, style | Rocking |
| Ash pan, style | Hopper |
| Exhaust pipes | Single |
| Exhaust nozzles | 5½ and 5¾ in. diameter |
| Smokestack, inside diameter | 18 and 21¾ in. |
| Smokestack, top above rail | 14 ft. 10½ " |
| Cab material | Steel |

*Tender.*

| | |
|---|---|
| Style | Water bottom, gravity slides |
| Wheels, number | 8 |
| Wheels, diameter | 36 in. |
| Journals, diam. and length, 5½ in. diam. x 10 in. | |
| Wheel base | 18 ft. 0 in. |
| Tender frame | 13-in. channels |
| Tender trucks | Arch bar, cast-steel bolster |
| Water capacity | 7,800 U. S. gallons |
| Coal capacity | 15 tons |

## Concrete Abutment on the Ulster & Delaware.

BY M. H. McGEE.*

The accompanying illustrations show a concrete abutment and long wing wall for a plate girder skew bridge on the Ulster & Delaware which was built last year. The bridge crosses a stream which frequently becomes a rushing torrent of water coming down from the mountains after a heavy rainfall and along with other structures over similar streams, was washed out a number of times before the present abutments were built. A long wing wall was therefore essential to prevent the banks washing out. The particularly interesting feature of this piece of work, however, is the construction of the parapet wall, and, incidentally, the date plate which was used. The abutments and wing walls are 12 ft. high above the foundation and are battered 1 to 12 on the face. On the upstream side the wing walls are 32 ft. 6 in. long, and on the downstream side 24 ft. 3 in. long. The superstructure is a through plate girder carrying a single track and crossing the stream at an angle of 67 deg. 30 min. The parapet wall is 2 ft. 1⅝ in. high and 12 in wide. at the top, and is reinforced with eight pieces of old rail about

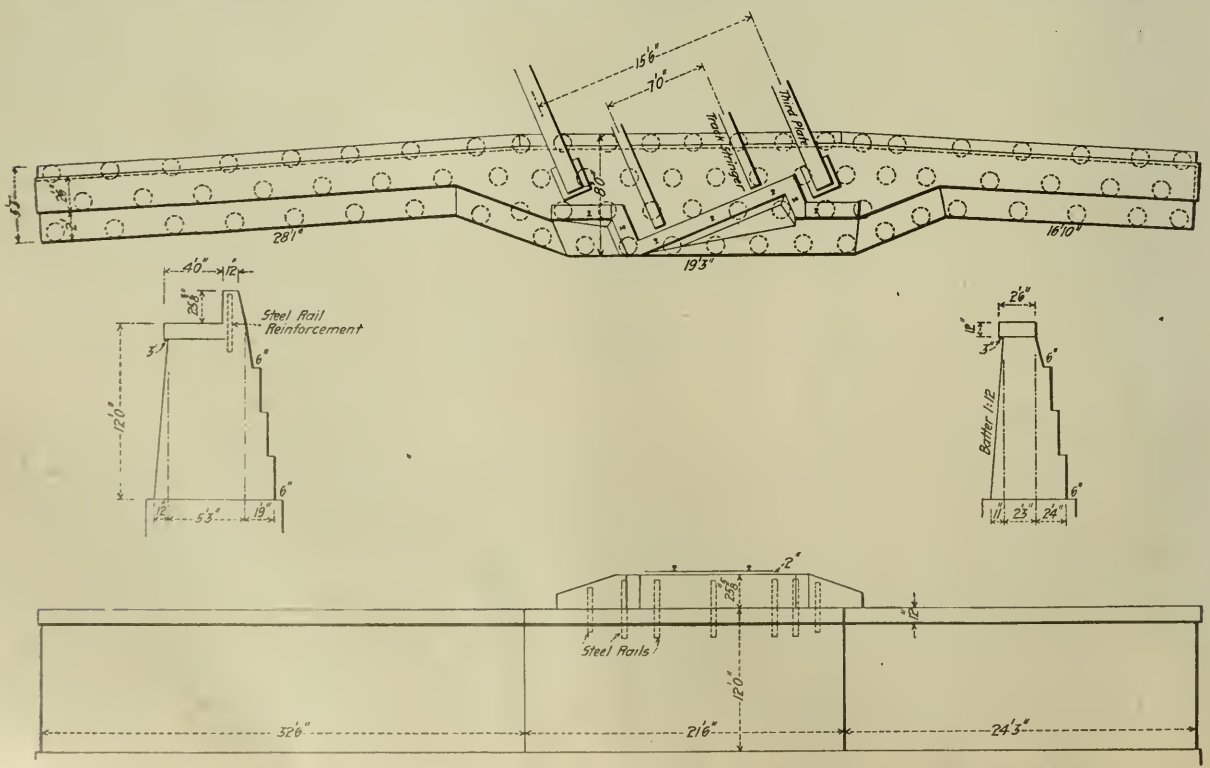
*Assistant Engineer, Ulster & Delaware.

Finished Wing Wall Showing Date Plate.

4 ft. long, which are bedded half in the abutment and half in the parapet. This effectually prevents the parapet from becoming loosened from the bridge seat and protects it from the heaving action of frost in the fill behind which might crowd it forward.

The foundations rest on piles and a 1:4:7½ mixture of concrete was used in them. The proportions used for other parts of the structure were 1:3:6 for the body of the abutment, 1:2:4 for the bridge seat, 1:1:2 for the parapet wall, and 1:2 for the mortar facing. Portland cement and 1½-in. crushed limestone were used and the concrete was mixed in a cubical box mixer run by a small steam engine. The proportion of one barrel of cement, three of sand and six of stone made a batch of one cubic yard, and after a batch was thoroughly mixed it was dumped from the mixing box into special skip shown in one of the illustrations. This skip held one cubic yard, or the entire contents of the mixer, and when filled was hoisted with a derrick, swung around over the forms and dumped all in one place. With the mechanical mixer it was possible to mix and lay more than three times as much concrete a day as had been laid on other similar jobs with the same force of men mixing by hand.

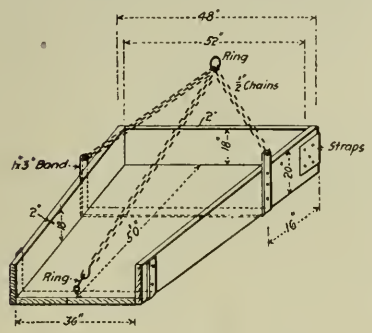
The use of a date plate adds greatly to the appearance of a piece of work of this kind. The one used on this bridge was 18 in. high, 36 in. long and ½ in. deep with beveled edges. The figures are 10 in. high and 1 in. deep. Both the panel and the figures were made of wood, well shellaced and fastened together with wood screws. The




Concrete Abutment and Wing Wall for Skew Bridge, Ulster & Delaware.

Completed Bridge Showing Top of Parapet Wall.

panel with the figures was fastened to the inside of the forms in a conspicuous place slightly below the coping, and the concrete deposited next to them when the work reached that height in the forms. After the concrete had set and the forms were removed it was found that the wooden figures had swelled by absorbing moisture from the surrounding concrete so that they could not be removed without damaging the surface of the concrete and it was necessary to chip out the wood with a carpenter's chisel. There was no serious objection to this except that the date plate was destroyed and could not be used again on another job. On another abutment built later, the figures were also made of wood, but they were beveled with considerable draft so that they could be removed more easily. This, however, proved no more successful than the first attempt, and the wood was again cut out with a chisel. The cast iron date plate described in the *Railroad Gazette*, August 19, in which the figures were beveled, is probably much more satisfactory than the wooden plates used here, but it would seem to be absolutely necessary to coat the iron plate with paraffin or some other waterproofing so as to prevent rust stains on the cement facing of the wall.




Skip Bucket for Placing Concrete.

The scarcity of box cars in Russia is such that flat cars are used this fall for carrying grain in sacks. The draft of cars and locomotives for the long line to the seat of war has left most of the railroads short; and when rolling stock is returned to them from the Siberian Railroad it is likely to need extensive repairs, which cannot easily be made in the Manchurian or Siberian shops. The grain crop suffered from drouth in southwestern Russia, but in the southeast it was abundant, and this is just the part of Russia most distant from market.

## Suburban Traffic.

The following extracts are taken from the report on suburban traffic prepared by A. W. Sullivan for discussion at the International Railway Congress, and printed in the Bulletin of the congress:

In response to the circular of inquiry, replies were received from 129 railroads, of which 97 stated that they had no suburban traffic, and 32 gave information which forms the basis of this report. Of these railroads, 28 are in the United States, one in Canada, two in the Argentine Republic and one in Brazil.

The districts served by the 32 railroads reporting service include 16 cities, having an aggregate population of 11,797,000. The principal cities enumerated, with their populations, are as follows:

| | |
|---|---|
| Boston | 600,000 |
| New York | 3,500,000 |
| Jersey City | 206,000 |
| Newark | 300,000 |
| Philadelphia | 1,300,000 |
| Pittsburg | 354,000 |
| Cincinnati | 330,000 |
| Atlanta | 100,000 |
| St. Louis | 600,000 |
| Chicago | 2,000,000 |
| St. Paul | 163,000 |
| Minneapolis | 203,000 |
| San Francisco | 350,000 |
| Total in the United States | 10,006,000 |
| Montreal | 268,000 |
| Total in Canada | 268,000 |
| Buenos Aires | 1,000,000 |
| Rio Janeiro | 523,000 |
| Total in South America | 1,523,000 |
| Total of all countries | 11,797,000 |

The range of travel seldom exceeds 25 miles, and the average distance traveled is about seven miles. In nearly all cases an effective road competition is found to exist, principally in the form of electric street railways running more or less closely parallel with the steam railroad lines. The total number of suburban passengers transported per annum by each railroad within the districts covered by this report, is shown in the following statement:

| Name of railroad. | District. | Passengers per year. |
|---|---|---|
| Atlanta & West Point | Atlanta | 146,000 |
| Baltimore & Ohio | New York | 5,600,000 |
| Balt. & O. Southwestern | Cincinnati | 250,000 |
| Boston & Albany | Boston | 6,000,000 |
| Boston & Maine | Boston | 12,500 000 |
| Central of Georgia | Atlanta | 130,000 |
| Central of New Jersey | Jersey City & Newark | 3,150,000 |
| Chic., Burl. & Quincy | Chicago | 1,280,000 |
| Chic. & East. Illinois | Chicago | 2,300,000 |
| Chic. & North Western | Chicago | 8,300,000 |
| Chic. Terminal Transfer | Chicago | 800,000 |
| Cin., Ham. & Dayton | Cincinnati | 900,000 |
| Cin., N. Orl. & Tex. Pac. | Cincinnati | 233,000 |
| Del., Lack. & Western | New York | 11,300,000 |
| Erie | New York | 6,000,000 |
| Georgia | Atlanta | 186,000 |
| Grand Trunk | Chicago | 810,000 |
| Illinois Central | Chicago | 15,000.000 |
| Long Island | New York | 930,000 |
| Minn. & St. Louis | St. Paul and Minneapolis | 420,000 |
| N. Y. Cen. & Hud. River | New York | 7,000,000 |
| N. Y., N. H. & Hartford | Boston | 13,200,000 |
| Pennsylvania Railroad. | New York | 2,350.000 |
| Pennsylvania Railroad. | Philadelphia. | 4,000,000 |
| Pennsylvania Company | Pittsburg | 3,240.000 |
| Phila. & Reading | Philadelphia. | 11,000,000 |
| St. Louis & S. Francisco | St. Louis | 600,000 |
| Southern Pacific | S. Francisco. | *18,177,000 |
| Total in the United States | | 135,802,000 |
| *Canada.* | | |
| Grand Trunk | Montreal | 1,110,000 |
| Total in Canada | | 1,110,000 |
| *South America.* | | |
| Argentine Republic | | |
| Buenos Aires, Rosario & Central Argentine | Buenos Aires | 4,456,000 |
| Ferrocarril del Sud | Buenos Aires | 6,232,000 |
| Brazil | | |
| Central Brazil | Rio Janeiro | 9,000,000 |
| Total in South America | | 19,688,000 |
| Total of all countries | | 156,600,000 |

*Includes ferries.

In the United States and Canada block signals are in general use upon the suburban lines of 25 of the railroads reporting; only four lines in the United States, with very light suburban traffic, reported that they handled it without the use of the block system. The use of block signals for suburban traffic is also well established in Argentina and Brazil.

Of the block systems in use in the United States and Canada, 15 are automatic, being operated either electrically or pneumatically; six are manual; three are combined automatic and manual; and one road uses an automatic system in combination with the electric staff. In Argentina and Brazil, the manual block system is used.

The total number of blocks within the suburban districts of all the railroads which reported is 2,337. The minimum length of blocks varies from 300 to 5,280 ft., the average being 1,833 ft. The maximum length of blocks varies from 1,500 to 29,400 ft., the average being 11,243 ft. The average length of all blocks on suburban lines is 5,267 ft. In the United States and Canada, the semaphore signal is used exclusively in the manual block systems. For the automatic block systems, six railroads use the semaphore signal exclusively, one uses the disc signal exclusively, while eight railroads use both the semaphore and disc signals. Upon the three railroads which use both the automatic and manual systems, the form of signal is the semaphore. In Argentina, the semaphore signal is exclusively used, and in Brazil narrow flags are used for block signals.

In the use of signal lights, it is found that for the "clear" indication in the United States and Canada, 19 railroads use white, and six use green. For the "caution" indication, 15 railroads use green, six use yellow, two use a combination of green and red, and two use no "caution" signal. For the "stop" signal all railroads use red. In Argentina, green is used for "clear," and red for "stop"; no "caution" signal being used. In Brazil, white is used for "clear," green for "caution" and red for "stop." All railroads make use of flag and lamp signals displayed by hand as auxiliary to the block signals, and to further insure the stoppage of trains when the block signal indications cannot be clearly seen, four railroads use derails, and four use torpedoes and fusees, in addition to the flag and lamp hand signals.

Upon nearly all railroads, the officials and employees engaged in suburban service also

perform other duties connected with the general passenger traffic, so that it has been found not practicable to determine definitely the total staff employed exclusively in the working of suburban service. This is particularly true as to the station forces, which perform duties for all classes of trains. As to the employees on suburban trains, it is found that for a minimum train service they consist of a crew of two men on the locomotive, the engineman and the fireman; and a crew of two men on the cars, the conductor and the flagman; making a minimum crew of four men to each train. When a train consists of more than four cars, it is customary to add another man to the train crew for each additional two cars, whose duties are chiefly to assist in the collection of tickets, and who is generally designated as a collector. The collectors as a rule occupy positions in the middle of the train, the conductor forward next to the locomotive, and the flagman at the rear to protect the train by hand signals in the event of an unusual stop being made. This disposition of the train crew is subject to variation on different roads, according to the local circumstances and conditions of the service. The work of the crews is regulated by three systems: that of the hours on duty, the number of trips made, or the number of miles run. As the distance traversed in suburban service is generally the lesser factor, the majority of roads regulate the work of the crews upon a time basis, the usual allotment per day being from 10 to 12 hours. When the work is regulated upon a mileage basis, 100 miles is usually assigned as a day's work. Upon a trip basis, the allotment is equivalent to 100 miles, or ten hours of service. The compensation is based upon a rate either per mile, per trip, per hour, per day, or per month, according to circumstances and agreement.

From the information furnished by the different railroads, the following tabulated statement of the seating capacity, length and weight of suburban cars now used, has been prepared:

| Name of railroad. | No. of seats. | Length over end sills of underframe in ft. | No. of wheels. | Weight. Body. | Trucks. | Total. | Total weight—Per lin. ft. | Per seat. |
|---|---|---|---|---|---|---|---|---|
| Atlanta & West Point | 60 | 52.5 | 8 | ..... | ..... | 57,600 | 1,097 | 960 |
| Baltimore & Ohio | 56 | 49 | 8 | 42,920 | 16,080 | 59,000 | 1,204 | 1,054 |
| Baltimore & Ohio Southwestern | 56 | 45 | 8 | 33,050 | 15,000 | 48,050 | 1,068 | 858 |
| Boston & Albany | 82 | 61 | 12 | 35,230 | 28,720 | 63,950 | 1,048 | 780 |
| Boston & Maine | 65 | 50 | 8 | 32,400 | 21,700 | 54,100 | 1,082 | 832 |
| | 70 | 55 | 8 | 36,350 | 21,700 | 58,050 | 1,055 | 829 |
| | 77 | 60 | 8 | 44,100 | 23,300 | 67,400 | 1,123 | 875 |
| Central of Georgia | 56 | 50 | 8 | ..... | ..... | 50,000 | 1,000 | 893 |
| | 58 | 53 | 8 | ..... | ..... | 53,400 | 1,008 | 921 |
| Central of New Jersey | 60 | 51 | 8 | 36,900 | 17,000 | 53,900 | 1,057 | 898 |
| Chicago, Burlington & Quincy | 68 | 51 | 8 | 29,400 | 18,800 | 48,200 | 945 | 709 |
| Chicago & Eastern Illinois | 72 | 56 | 8 | 33,100 | 12,500 | 49,500 | 884 | 688 |
| Chicago & North Western | 60 | 52 | 8 | 41,500 | 17,000 | 58,500 | 1,125 | 975 |
| Cincinnati, Hamilton & Dayton | 64 | 51.5 | 8 | 36,000 | 17,400 | 53,400 | 1,037 | 834 |
| Cincinnati, New Orleans & Texas Pacific | 58 | 48 | 8 | 31,640 | 15,660 | 47,300 | 985 | 815 |
| | 60 | 52.5 | 12 | 33,260 | 27,040 | 60,300 | 1,150 | 1,005 |
| | 64 | 57 | 8 | 46,000 | 22,000 | 68,000 | 1,193 | 1,062 |
| | 68 | 57.5 | 8 | 46,000 | 22,000 | 68,000 | 1,183 | 1,000 |
| | 70 | 57.5 | 8 | 46,300 | 22,000 | 68,300 | 1,188 | 976 |
| | 80 | 67 | 12 | 72,100 | 37,100 | 109,200 | 1,630 | 1,365 |
| Delaware, Lackawanna & Western | 60 | 51 | 8 | ..... | ..... | 60,400 | 1,184 | 1,007 |
| | 66 | 52 | 8 | ..... | ..... | 68,500 | 1,317 | 1,038 |
| | 58 | 52 | 8 | ..... | ..... | 57,150 | 1,099 | 985 |
| | 62 | 51 | 8 | ..... | ..... | 56,950 | 1,117 | 919 |
| Erie | 66 | 52 | 8 | ..... | ..... | 64,200 | 1,235 | 973 |
| | 72 | 61 | 8 | ..... | ..... | 81,650 | 1,339 | 1,134 |
| | 78 | 60 | 8 | ..... | ..... | 69,350 | 1,156 | 889 |
| Grand Trunk, Chicago | 60 | 45 | 8 | ..... | ..... | 47,400 | 1,053 | 790 |
| Grand Trunk, Montreal | 58 | 50 | 8 | ..... | ..... | 46,350 | 927 | 799 |
| Illinois Central, old cars | 56 | 45 | 8 | 25,400 | 16,200 | 41,600 | 925 | 743 |
| Illinois Central, new cars | 100 | 64 | 8 | 61,400 | 23,000 | 84,600 | 1,323 | 846 |
| Minneapolis & St. Louis | 56 | 51 | 8 | 37,150 | 20,350 | 57,500 | 1,127 | 1,027 |
| | 66 | 52 | 8 | 39,150 | 21,350 | 60,500 | 1,163 | 1,008 |
| New York Central & Hudson River | 64 | 54 | 8 | 45,100 | 21,800 | 66,900 | 1,239 | 1,045 |
| | 72 | 60 | 12 | 50,800 | 36,200 | 87,000 | 1,450 | 1,208 |
| | 48 | 40 | 8 | 25,300 | 32,900 | 58,200 | 1,455 | 1,212 |
| New York, New Haven & Hartford | 57 | 45 | 8 | 29,300 | 15,700 | 45,000 | 1,000 | 789 |
| | 66 | 48 | 8 | 30,000 | 17,900 | 47,900 | 998 | 798 |
| | 69 | 60 | 8 | 45,000 | 35,600 | 80,600 | 1,343 | 1,168 |
| Pennsylvania Company | 58 | 46.5 | 8 | 29,150 | 19,000 | 48,150 | 1,035 | 830 |
| | 64 | 54 | 8 | 48,700 | 20,500 | 69,200 | 1,281 | 1,081 |
| Philadelphia & Reading | 66 | 52 | 8 | 41,320 | 11,140 | 63,600 | 1,223 | 964 |
| Average | 64.61 | 52.9 | 8 | 39,467 | 21,555 | 60,925 | 1,144 | 942 |

The average over-all speed of suburban trains between the starting and terminal points of a representative section of line in the United States and Canada, is found to range as follows:

| Speed, per hour. | No. of roads. | Speed, per hour. | No. of roads. |
|---|---|---|---|
| 13 miles | 1 | 25 miles | 4 |
| 17 " | 1 | 26 " | 2 |
| 18 " | 1 | 28 " | 1 |
| 19 " | 1 | 30 " | 3 |
| 20 " | 1 | 35 " | 1 |
| 21 " | 1 | 37 " | 1 |
| 22 " | 5 | 38 " | 1 |
| 23 " | 2 | | |
| 24 " | 2 | | 28 |

The average speed on the 28 railroads was 24.7 miles per hour. In Argentina, the average speed is 31 miles per hour, and in Brazil, 10 miles per hour. The length of the representative section of suburban lines for all the railroads (used in computing average speed) ranged from 5½ to 44 miles, the average being 19.2 miles. The number of stations on the representative sections ranges from 5 to 32; the average being 19 stations. The longest distance between stations ranges from 0.83 of a mile to seven miles; the average being 3.24 miles. The shortest distance between stations ranges from 0.125 of a mile to 1.10 miles; the average being 0.44 of a mile. The average distance between stations ranges from 0.5 of a mile to 2.4 miles; the average being 1.12 miles. The average time trains are at rest at intermediate stations for discharging and receiving passengers is 30 seconds.

The greatest number of trains run in any one hour in one direction ranges from 1 to 50, the average being 9.5 trains. Ten railroads follow the practice of stopping all trains at all stations within the suburban district, while 20 railroads alternate non-stopping trains with stopping trains. Under the practice of stopping all trains at all stations, as many as 30 trains are run in one direction in one hour on a section 26 miles in length with 18 stops; while under the practice of alternating non-stopping trains with stopping trains, the movement of 14 trains in one direction in one hour, is the greatest number reported on a section 12 miles long, in which 14 stops are made by the trains which stop at all stations. There are no cases reported where precisely similar circumstances exist to enable exact comparisons to be made of the capacity for train movement under the two methods of operation, but it is manifest that the method of alternating stopping and non-stopping trains, greatly reduces the capacity of the line for train movement. The greatest number of trains run into the chief terminal station used by suburban trains in any one hour, ranges from 1 to 53; the average being 14 trains. The greatest number of trains run into and out of the chief terminal station used by suburban trains in any one hour, ranges from 1 to 78; the average being 21 trains. The number of trains—total of inwards and outwards—dealt with on an average week-day within the 24 hours, ranges from 4 to 829; the average being 195 trains.

The successful results in respect to punctuality of trains are variously attributed to the following reasons:

1. Suitable train schedules;
2. Efficient locomotives;
3. Good organization;
4. Rigid discipline;
5. Prompt departure of trains from initial station;
6. Short stops and quick work at intermediate stations in discharging and receiving passengers;
7. Distribution of passengers to seats throughout the train after train has resumed motion;
8. Prompt and efficient methods of collecting tickets and fares.

Seventeen railroads have no barriers at stations to prevent access to trains; seven roads have barriers which are closed at the time for departure of trains; two roads have barriers which are closed 30 seconds, and two roads one minute, before the departure of trains.

The cost of operation per suburban train mile is not readily ascertainable for the reason that few railroads keep separate account of the expense of suburban service; this expense ordinarily being included in the general expense account of passenger service. Some 13 railroads of the United States and Canada, however, have submitted estimates of the expense of suburban operation, which ranges from 30 cents per train mile upon lines of light traffic and simple methods of operation, to $1.00 per train mile upon the heavy lines; the average cost for all of the roads giving this information being 61 cents per train mile. On the question as to what is a remunerative earning per train mile in a suburban district, the opinion prevails that inasmuch as the service offered by the suburban trains of a railroad is to be considered more from the point of view of public necessity and convenience, than from considerations of net revenue, that any rate of earnings which exceeds the cost of operation, is to be considered remunerative.

## Notes on the Early History of the Hudson River Tunnel.*

BY S. D. V. BURR.

As planned originally the grade of the tunnel for the first 1,600 ft. from the western shore was 2 per cent., which then continued as 1 per cent. to 1,300 ft. from the eastern or New York shore. From this point the grades were 4 per cent. and 3 per cent. to the terminus. The contour of the bed of the river governed this grade and as the channel was only about 60 ft. deep and about 1,000 ft. from the New York bulkhead, the steepest grade was at the eastern section. This, of course, also permitted the easy grade for four-fifths of the distance from the Jersey side.

But those who now enter the tunnel at the western end will look in vain for this

*Previous articles on this subject by the same author were printed in the *Railroad Gazette*, June 3 and October 14 of this year.

easy grade for the first three or four hundred feet from the shaft. That portion of the tunnel takes a wonderfully erratic course and dips, rises and level stretches follow each other indiscriminately. The crown appears to have assumed its own grade—which it undoubtedly did—irrespective of the plans of the engineers, as will be explained later. At one short section the grade is over 10

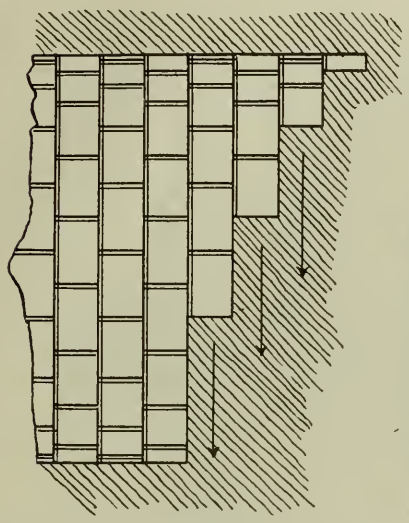


Fig. 1—Section Through Heading Showing Terraces.

not protected in any way and was cut into steps or terraces upon which the men stood while shoveling out the silt. As fast as the silt was dug out to the circumference of the tunnel a plate was inserted and bolted to the ring already in place. As soon as three or four rings had been completed the brick work—at first 24 in. thick and afterward 30 in. thick—was started at the invert, carried up the sides and over the arch. A finished portion of the tunnel, four rings of plates and the advance plates are shown in both Figs. 2 and 3. The plates were of boiler iron ¼ in. thick, 2½ ft. wide and 3 ft. and 6 ft. long. The flanges were 3 in. wide and the bolt holes 6 in. apart.

or expectation that it would settle to the proper position. This proceeding was of no avail, mainly for the reason that the exact nature of the material in advance of the heading was not known. If it turned out to be stiff and tenacious the settlement would be slight, possibly not enough to bring the crown to grade, and if a little sand were encountered the crown might come down so rapidly as to carry it below grade. It will thus be understood why that portion of the tunnel first built is noted principally for the eccentricity of its course.

The engineers were in a quandary, and fully appreciated the fact that their methods must be changed, and changed radically, if

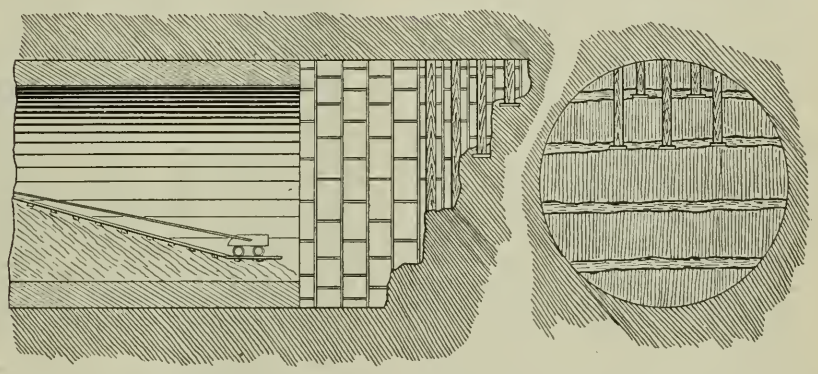


Fig. 2—Sections Through Unprotected Heading Showing Crown Sheet Supports Stepped on the Terraces.

per cent. The changes are abrupt and the tunnel is so irregular as to convey the idea that it was built of odd pieces, put together at odd times by builders who worked, each according to his own ideas of what was proper, irrespective of the conditions upon either side of them. The old engineers knew this grade would be excessive for steam traffic and therefore had in mind the rebuilding of this section, or, as a substitute, the filling in of the hollows, which the size of the tunnel would have allowed.

With the methods then followed it was

Necessarily the crown was pushed ahead of the finished ring and the shell had, therefore, the appearance, in longitudinal section, of a buggy top or inverted sugar scoop. This overhang of the crown was responsible for all the trouble. As soon as a crown plate had been inserted it was propped as firmly as possible, but as the foundation upon which the strut rested was nothing but silt which had been more or less disturbed by the men in digging, the support was inadequate. The weight or pressure of the silt upon the crown was constant and was continually increas-

they were to finish the udertaking. Since the difficulty seemed to increase as the depth below the river surface became greater, it was necessary to alter the plans as soon as possible.

At this stage of the work the superintendent, John F. Anderson, came forward with his scheme of tunneling through soft material with a "pilot." His plan provided a rigid center from which the plates could be braced as soon as they were put in position and which had ample strength to resist the movement of the silt. The plan was exceed-

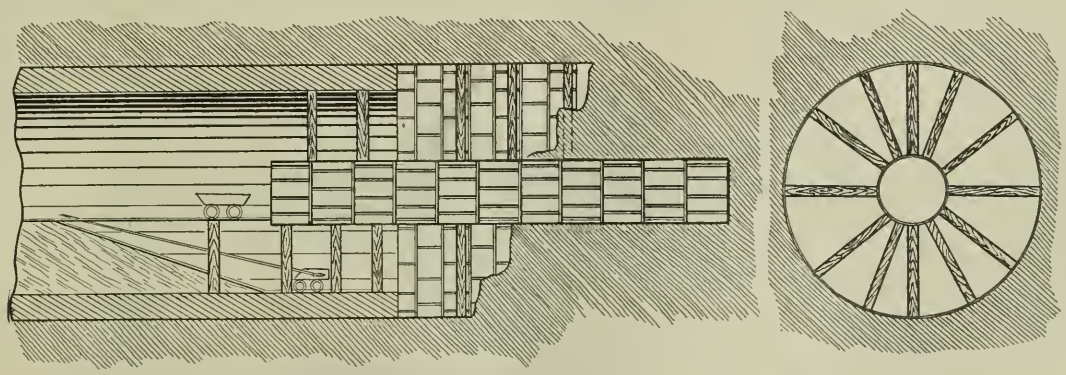


Fig. 3—Unprotected Heading, with Pilot Tube to Support Braces.

absolutely impossible to keep the tunnel anywhere near a uniform grade. The tunnel determined its own lines as it was pushed along and it was not within the power of the engineers to even influence this to any appreciable degree. The explanation was simple, but for a long time the remedy was not forthcoming, although it was known that unless the evil could be overcome the work would have to be abandoned, especially as the trouble became greater as the heading was advanced.

An examination of Figs. 1 and 2 will show the cause of the difficulty. The heading was

ing in amount. Of course this upper layer of silt had not been disturbed, but it is one of the properties of silt that, given the opportunity, it will move. When the bore of the tunnel had been removed, the overlying mass of silt settled. This settlement was slow, steady and sure and with no sufficient appliances at hand for resisting it, was irresistible. The work was performed as rapidly as possible in the endeavor to complete the rings and build the masonry before the depression occurred. Also, the attempt was made to obviate the difficulty by making the crown higher than it should be in the hope

ingly simple and comparatively inexpensive. It contemplated the employment of a strong axis, or beam, which should extend into the silt in advance of the face of the heading and be long enough to enter the completed masonry a short distance. Its front and rear ends being thus firmly held, the central portion would serve as a solid base from which the plates could be supported as long as need be.

As actually constructed this beam was an iron tube 6 ft. in diameter made up of plates 4 ft. deep, 22 in. wide and ¼ in. thick. Each edge of the plate was reinforced with angle

iron, and between the longitudinal and transverse joints were placed thick iron strengthening plates which projected beyond the outer surface of the tube. These plates were interchangeable and those at the rear were removed and carried forward as the work advanced. The tube was some 50 or 60 ft. long, about 25 or 30 ft. of which was in the solid silt in advance of the heading, hence the name "pilot."

By referring to Fig. 3 it will be seen that both ends of the pilot were held against any possible movement, the middle portion being free to receive the plate braces. The pilot was carried forward in precisely the same way as the main heading. Unusual settling of the plates of the pilot (as they were inserted) made no difference with its work, since its advance end was bound to be held firmly as soon as the silt had come to rest around it, and the particular grade it assumed was of no importance since it had no bearing upon the principal undertaking.

No rule was followed in locating the braces; they were merely inserted where needed and where most convenient. A track extended along the top of the pilot for the removal of material from the heading and the bringing forward of new plates. Another track was placed inside the pilot and served the same purpose.

After the introduction of the pilot there was no difficulty in keeping to grade; in fact, the direction of the tunnel, vertically or horizontally, could be changed at will. Over 3,000 ft. of tunnel were built with it and it was not discarded until the English engineers assumed control and introduced the shield.

## Tie Timber and Spikes in Argentine Republic.

In a recent communication to the Department of Agriculture, Bureau of Forestry, Mr. Guillermo Dominico, Inspector General of the Ferro-carriles y Transportes, Argentine Republic, gives some interesting facts about tie timber in that country and also about screw spikes and dowels. The only wood used for ties is the "Quebracho Colorado," or iron wood, which is of the Anacardiacæ family. It is much heavier than water, having a specific gravity of 1.350 to 1.400, and is as hard as its name would indicate. This timber has 30 per cent. more elasticity than oak or pine, three times as much resistance to compression, 20 per cent. more strength in tension, and twice as much resistance to flexure as oak. It will apparently last forever since not a single case has been ever observed where sound quebracho, without sap, has rotted, but on the contrary it seems to get harder with time and exposure. One of the exhibits of the Argentine Republic at the World's Fair, St. Louis, consists of a railroad tie cut in two pieces and other cross-sections of ties which have been in track under constant use for 25 years. They would have been perfectly good for another 25 years or even longer if they had not been removed for exhibition. The original spikes driven 25 years ago have been left in the wood. Pieces of this and other native hard woods which have been removed from piers and docks after immersion in salt water for 50 years show no rotting in the portions exposed to the alternate wetting and drying caused by the tides.

Three sizes of ties are used, one 9 ft. x 5 in. x 9¾ in. for broad gage (5 ft. 6 in.) track, one 8 ft. 4 in x 5 in. x 9¾ in. for middle gage (4 ft. 8 in.) track, and one 6 ft. x 5 in. x 9¾ in. for narrow gage (3 ft. 6 in.) track. These weigh 220, 198 and 165 lbs. respectively, and when spaced 12 to 15 ties under each rail length of 33 ft. 4 in., give a very solid track. In case of derailment these ties are seldom damaged by cutting of the wheel flanges even on bridges. Ties are cut from small trees 10 in. to 12 in. in diameter, or sawed from large trees 2 ft. to 3 ft. in diameter and 50 ft. high. Those most preferred are cut from logs which will give two ties for each length of log. These logs are hewn or sawed to about a 10-in. square section and split down the center, and ties cut in this manner are usually the soundest and best timber procurable. The large quebracho trees and those having curved or bent trunks are cut up into sections weighing from two to three tons, and are shipped to Europe for tanning purposes, this wood being very rich in tannin.

In the timber regions, the price of ties delivered alongside the track is from $1.10 to $1.20, American gold, for the broad gage ties, 88 cents for middle gage ties, and from 50 cents to 60 cents for narrow gage ties. The cost aboard ship in the upper Parana river ports is about $1.50, $1.20 and 80 cents respectively, and delivered in Europe the estimated cost is $2, $1.70 and $1.20 each, American gold. These ties form an ideal cargo because of the regularity of dimensions and the relatively small proportion of weight to volume. The most important advantage of quebracho timber, however, is the fact that after having been in track for 30 to 40 years they are still worth 50 per cent. of their original value because of the tannin contained in them.

The quebracho colorado grows in vast and almost virgin forests covering the plains reaching from Santa Fe and Santiago del Estero to the north frontiers of Bolivia and Paraguay. The climate on these plains is temperate, from 40 deg. to 105 deg. Fahr. Within the last few years a number of railroads have been built into this territory for the purpose of hauling out the timber. The native Indians who are dexterous with an axe do most of the cutting and are paid from 25 cents to 40 cents per tie for hewn ties. The squared logs are usually brought to saw mills and cut in two with circular saws. Forest lands on these plains can be bought from the Government for about $325, American gold, per square mile.

No tie plates are used under rails laid on these ties in the Argentine Republic since they are entirely unnecessary owing to the hardness of the wood. After 25 years service these ties show a perfect rail seat. Spikes cannot be driven into the wood without first boring a hole slightly smaller than the spike, but having once been driven they are practically immovable and cannot be pulled out without strong pressure. Screw spikes have, however, almost entirely replaced smooth spikes, but not because the latter will not hold down the rail. In case of derailment and consequent damage to track, the smooth spikes are bent and the heads are sometimes broken off, requiring new holes to be bored in the tie. In course of time the tie becomes full of holes near the rail seat and must be taken out long before its natural life is destroyed. With screw spikes this is avoided since the spike can be screwed out of the tie and a new one put in the same hole provided moisture has not entered and rusted the spike fast. The screw spikes used have shallow threads of small pitch, closely resembling metal screw threads. Dowels are not used because there has as yet been no scarcity of timber and therefore no necessity for employing expensive means for prolonging the life of ties.

## Railroad Shop Tools.

(*Continued.*)

### SPECIAL DRILLING MACHINES.

Fig. 1 shows a four-spindle brake lever drill, made by the Newton Machine Tool Company, Philadelphia, Pa. This machine is used for drilling at one operation the four holes in the brake levers of freight cars. The distance between the uprights is 4 ft. 6 in. The minimum distance between the centers of the two heads on the left-hand side of the rail is 4½ in., the minimum distance between the centers of the two center heads is 6½ in., and the minimum distance between the two heads on the right-hand side of the rail is 10¼ in. All the heads are adjustable along the rail and the distance between the spindles can be adjusted so as to be used for all sizes or designs of brake levers within the capacity of the machine. The spindles are driven through gearing by a two-step cone and have no vertical adjustment. The

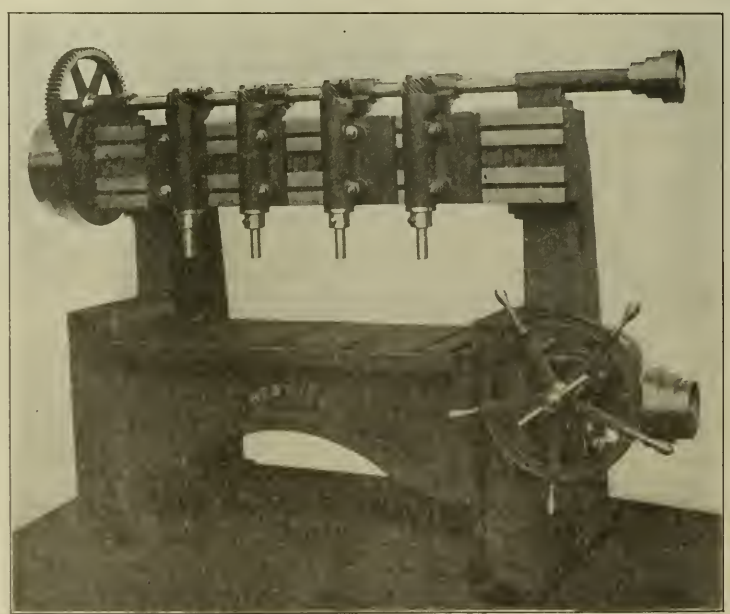


Fig. 1—The Newton Four-Spindle Brake Lever Drill.

feed is obtained by moving the work table, which has a vertical adjustment of 9 in. with three changes of automatic feed and quick hand movement. The maximum distance from the end of the spindles to the work table is 20 in. Each spindle is fitted with a sliding socket so that the different lengths of drills can be adjusted to the proper height from the table.

The drill shown in Fig. 2 is made by Foote, Burt & Company, Cleveland, Ohio. It is known as the No. 1 mud ring and flue sheet drill. It was especially designed for the above purpose, but it is also adapted for a wide range of general work, such as steam chest covers, I-beams for trucks, brake levers, dome caps, and, in fact, any work which can be done on a multiple spindle machine. This tool can drill four holes 1⅜ in. in diameter in steel, and will take work up to 10 in. thick. The maximum distance between the nose of the spindle and the top of the table is 16 in. and each spindle has 12 in. of vertical power feed. The distance between the housings is 6 ft. 1 in. and the minimum distance between spindle centers is 6 in. The distance between the outside spindle centers is 72 in. The machine has three spindle speeds and three power feeds. An automatic "knock-off" is supplied to the feed and the heads are adjustable along the rail while the machine is in motion. The table has an in-and-out adjustment of 18 in. This adjustment is operated by a crank wrench from either end of the machine. The spindles are of forged open-hearth steel and the spindle sleeves are of cast-steel bushed in the spindle fit with phosphor bronze. All of the miter gears are cut from drop forgings. The machine weighs about 11,000 lbs.

The independent feed drill shown in Fig. 3 has a capacity for drilling holes up to and including 2 in. diameter in steel. The spindles are adjustable along the rail and the minimum distance between centers of the spindles is 8 in. The maximum distance between the faces of the uprights and the center spindles is 12⅛ in. and the distance in the clear between the uprights is 49½ in.

The spindles have a power feed of 12 in. and an automatic knock off. The table has a vertical adjustment on uprights of 14 in. and is 24 in. wide by 121 in. long. The maximum distance from the nose of the spindle to the top of the table is 26 in. Arch bar fixtures are supplied with the drill and are used as shown in the illustration. It is claimed that this drill, equipped as shown, can give an output of drilled arch bars nearly equal to any standard arch bar drill on the market, and at the same time the user has a tool that is suitable for almost any other class of drilling. The machine is geared 10 to 1 and has three changes of power feed. The spindles are forged open-hearth steel castings bushed with phosphor bronze. The spindle driving gears are 10 in. in diameter by 2½ in. face. This machine is known as the No. 5 independent feed drill and is made by Foote, Burt & Company, Cleveland, Ohio. The weight of the machine is about 12,000 lbs.

*(To be continued.)*

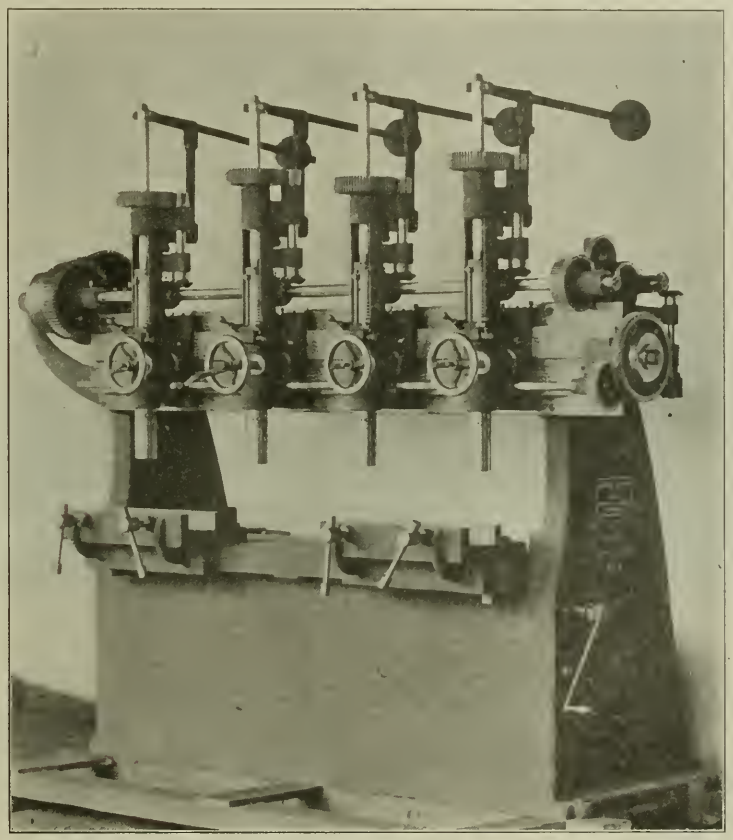


Fig. 2—Foote, Burt & Company's Mud-Ring and Flue-Sheet Drill.

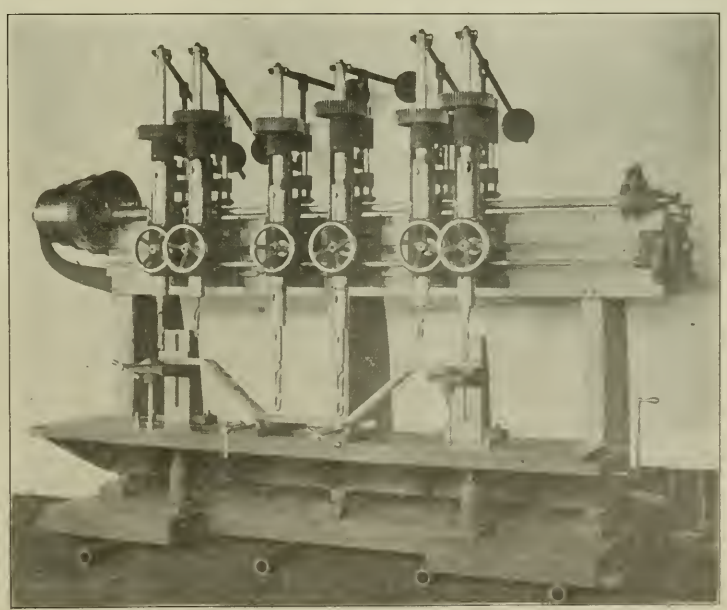


Fig. 3—The Foote, Burt & Company's No. 5 Independent Feed Drill.

## European Regulations Governing Railroad Employees' Hours.*

Legal or at least official regulations control the conditions of work of certain classes of railroad employees in Germany, Austria, France, Italy, Holland and Russia. The same applies to India and Australia, whereas in England the law, without specifying anything definite as to the duration of work and of rest of railroad employees, is limited to giving the authorities the right to control the conditions of work of the men whose work affects the safety and gives the Board of Trade the power to reduce the hours if it considers them excessive.

In Hungary, Belgium, Denmark, Spain, Luxemburg, Roumania and Servia, there are no law bearing on the duration of work and of rest of railroad employees. Nevertheless the regulations applied by the chief railroads of these countries themselves and by the English companies, do not differ very appreciably from those laid down in countries where the State is the chief owner of railroads, i.e., in Germany, Russia and Austria. The regula-

*Abstract of a report prepared for the next session of the International Railway Congress by Mr. Philippe, General Inspector of the North Belgium Railroads, Liege. The report deals with all countries except America and Switzerland. It is published in the I. R. C. Bulletin for September.

tions all show the very marked desire to proportion the work to the resulting fatigue, so as to avoid any possibility of men becoming overworked. As a general rule, the legal enactments as well as the private regulations only deal with the conditions of work and of rest of the employees whose work affects the safety of the traffic.

Most of the regulations examined divide employees into two classes: (1), station and roadway employees; (2), locomotive and train staff. For the first class the requirements are, of course, simple. In the second class the work from day to day varies in amount, so that in the regulations the unit is usually a longer period. In Germany and in Austria work days and rest days are calculated on a basis of 30-day terms; in France on 10 days; in England on seven; in Holland on 14, and in Russia on six. Requiring shorter periods of work from enginemen and firemen than from other trainmen is very general. In Germany employees have two off days per month, except those on secondary lines or posts, who have only one day off. The same is the case in Austria. In France, drivers and firemen have one off day out of ten, the train staff one day out of 15, and station employees one day per month. In Italy, the drivers and firemen have one off day per month, and the train staff three days per two months. In Holland, all the men have one off day out of 15. A similar practice is adopted on the Belgian and Danish railroads. The practice as to annual leave varies too much in the different countries to enable us to make a summary of it.

Mr. Philippe has found it impossible to make useful comparisons, between different countries, of the hours per day alloted for work and for rest, the customs of the inhabitants, conditions of climate, and other factors making it impossible to draw conclusions of value. In Germany employees whose work requires unbroken and sustained effort, must average not more than eight hours a day, with a maximum of 10 hours. Employees at large stations where the work is hard must be favored, while at small stations, with long periods of rest, 14 hours a day, and even 16 hours, may be allowed.

Referring to England, where there is no legal restriction except the power of the Board of Trade to interfere where work is found excessive, Mr. Philippe concludes that the regulations made voluntarily by the railroad companies are reasonable. In this connection he says that "the fable of overworked railroad servants is too readily believed in by the public of certain countries, where it is revived after every railroad accident, no matter of what nature and what may be its cause. Some governments have been affected by this fable and have desired to reassure public opinion; hence the more or less strict laws and regulations which we have considered."

## Canadian Pacific Superheated Steam Locomotive.

The Canadian Locomotive Company, Lim., Kingston, Ont., has just completed an order for 10 simple consolidation (2-8-0) locomotives for the Canadian Pacific. These engines were designed by Mr. H. H. Vaughn, Superintendent of Motive Power, and are chiefly interesting because they are fitted with Schmidt superheaters. The Canadian Pacific was the first in this country to experiment with superheaters and last year ordered them applied to a number of ten-wheel passenger locomotives built in Germany. Their application to this last order would seem to indicate that the results from those now in use have been satisfactory. The following table gives the principal dimensions of the engines.

Consolidation (2-8-0) Locomotive with Schmidt Superheater, Canadian Pacific.

| | |
|---|---|
| Type | Consolidation, 2-8-0 |
| Fuel | Bituminous coal |
| Weight, in working order, total, lbs. | 186,200 |
| Weight in working order, on drivers, lbs. | 163,675 |
| Total wheel base, ft. and in. | 24—4½ |
| Rigid wheel base, ft. and in. | 15—10 |
| Length of fire-box, in. | 96 |
| Width of fire-box, in. | 65¼ |
| Diameter of drivers, in. | 57 |
| Type of valves | Piston |
| Cylinders, stroke, in. | 28 |
| Cylinders, diameter, in. | 21 |
| Type of boiler | Wide fire-box, radial stays |
| Working steam pressure, lbs. | 200 |
| Tubes | 22—5-in., 244—2-in. |
| Length of tubes, ft. and in. | 14—2½ |
| Weight of tender, loaded, lbs. | 130,000 |
| Capacity of tank, Imp. gal. | 5,000 |
| Coal capacity | 12 tons |

## Office Organization.

At the meeting of the Central Railway Club in Buffalo, November 11, there was a paper on office organization by Mr. W. R. Heath. Following are extracts:

*Discipline.*—There will come a time when some positive shock will be suffered in the organization—something which for the time almost paralyzes the institution. This should be dealt with strenuously. If the organization has been shocked out of adjustment perhaps a similar shock will place it in adjustment. Discipline should be so administered that it will not often be necessary. There should not be a continual bickering. All small difficulties should be passed without notice—large difficulties should be noticed vigorously, promptly and fearlessly. Never make rules. There are certain general rules which are always accepted and understood—such as the hours of employment, the time of beginning the sessions, the closing of the day, and the like, but rules often bind the haud of the management much more tightly than they hold the machine together. Specific punishment should never be prescribed for certain offenses. What can or cannot be done consistently with conditions is quite as well known by the organization as the management and does not need to be discussed. Circumstances alter cases and in some situations privileges might be granted that in other situations would be impossible. At all times, all the liberty consistent with the best results should be permitted. There should be no persistent rules, no strait-jackets. Everyone should feel the least restraint possible and with the liberty and freedom should be maintained a wholesome regard for the law and order essential for the best progress. Do right. Do nothing that will encroach upon the rights of another. Do as you know you ought to do. These are quite enough rules of conduct.

*Thought.*—The office thought must be one thought and yet all must think. Thought is power and there must be the maximum of power and the minimum of machinery. I care not how great a thinker the manager may be he will fail if he does not inspire thought in every one. A man may have ten times the power of thought that his clerk has and yet he then has thought force equivalent only to ten clerks, and if he has one hundred clerks under his control he is then capable of but one-tenth of the thought which the office possesses, and if the office thought is retarded the power back of the machine is retarded. Encourage every man to think.

*Moral Element.*—President Roosevelt's statesmanship is of the moral type. Your worth and mine in the last analysis is a moral worth. Every man and every thing has an essential integrity. We hate a counterfeit, a hypocrite, a cheat and an impostor. We are all looking for the good, the true and the honest in all we do and touch. You put a ring on your finger because of its precious metal or its precious memory. I care not how depraved a man may be himself, he speaks with pride of the man who is square. A straight line, a square, the lever and the plumb-line differ in their nature, yet one cannot imagine a disagreement between them—like true friends they each guarantee the other. When the whole world is wrong these are right. They are never sworn to tell the truth, their integrity and morality are known to every man and feared by every liar. Nothing can be more important in the office organization than this moral element. It is not so much smart men that we need as true men. The heart feeds and fires the brain.

RAILROAD GAZETTE

## RAILROAD MOTOR CAR SERVICES.

An extract is printed this week, in the General News Section, from a paper which gives a comprehensive review of the progress which has been made in Great Britain in the use of rail motor cars (*Transport and Railroad Gazette*, Nov. 11, 1904). The subject is receiving the greatest attention throughout England at the present time. For example, the Great Western is now building steam motor cars as fast as its Swindon works can turn them out, and proposes to very greatly extend its motor car services, of which there are already some 16 in operation, involving at present the use of approximately 25 cars. These Great Western cars are 59 ft. 6¾ in. long over headstocks, 8 ft. 6¾ in. wide and 8 ft. 2 in. high inside, with steel underframes and a wheel base of 48 ft. 9 in. The passenger compartment is 39 ft. 6 in. long, the motor 14 ft. long, and the vestibule 4 ft. 9 in. long. The passenger compartment holds 52 passengers, 16 in cross seats and 36 in the longitudinal seats; the arrangement being substantially the same as that of the cars in use on the lines of the Interborough Company in New York. The engine has a vertical boiler with a cone top, 4 ft. 6 in. in diameter, and with 477 tubes 1¼ in. in diameter. The height of the boiler is 9 ft. 6 in.; working pressure 160 lbs., and a total of 672.33 sq. ft. of heating surface, to which the tubes contribute 625.58 sq. ft. and the fire-box 46.75. The grate area is 11.54 sq. ft. and a 450-gallon water tank is carried under each coach. The cylinders are 12 in. x 16 in., fixed horizontally and driving the trailing pair of wheels, which are coupled to the leading wheels. This description applies to the cars used in the suburban services. The cars used on branch lines have the same outside dimensions and characteristics and the same engine, but the passenger compartment is made somewhat shorter to allow for a baggage compartment 6 ft. 3½ in. long. These cars seat 46.

The Great Western cars afford a characteristic example of most of the steam motor cars with which experiments are now being made in England, subject, of course, to certain modifications. A couple of petrol-electric cars are in use on the North Eastern, and much interest is being shown in this type of motor car for the reason that it reduces the crew of the car to two men instead of three. The light train in England carries a normal crew of three men; engineer, fireman, and a guard who also performs the duties of a flagman, but who only has a part of the work of the conductor on an American train, for the reason that tickets are usually collected at the station platforms. Therefore, a steam motor car does not effect any saving in train crews, in English practice. This statement applies only to the steam cars which are now in use on English roads. Other types of steam cars have been designed which do not require the services of a fireman. With the certain development of the flash boiler, the arguments in favor of the petrol car will have less force. Theoretically the thermal efficiency of a petrol motor is greater than that of a steam boiler and engine, but saving of fuel is not the only consideration. The steam car has the advantage of great flexibility and certainty of action, and even if the petrol car shows a slight saving in the fuel cost, it does not follow that it is necessarily the most economical type of car. The chief economies of motor car service, as outlined in further detail in the reprint from the English paper, lie in wage saving, small service unit, station force, and in the avoidance of a considerable part of the switching necessary for a train.

The engines of the best railroad motor cars of the present day leave much to be desired in simplicity, space required and reliability, but builders of these cars owe an important debt to the automobile manufacturers who have for many years been trying to meet a similar problem, but one which is in many respects harder to solve. It seems evident, regardless of the attitude of railroad men to motor cars, that the automobile makers will keep on with their experiments, and that the time will surely come when a satisfactory and economical engine can be found to drive rail motor cars. There are countless localities in this country where there is needed a frequent service, conducted in small units, at a low cost—the kind of service for which a rail motor car is especially well adapted; yet, so far as we know, there is not a single rail motor car service at present in regular operation in the United States. The Burlington is understood to have a petrol-electric car about ready for use at the present time, but no reports are available from it as yet. It is well known that a steam motor car, equipped with a small locomotive engine of the ordinary type, was tried several years ago on the New York Central and the Boston & Albany, but failed to show sufficient economies to create a demand for other cars of the same type. It is hard to say at the present time, as the result of actual tests, whether petrol-electric cars can show a permanent saving in fuel and up-keep as compared with steam motor cars, but the engine requires so little attention while in service that even in the present state of the art the petrol cars can be counted on to operate with a crew of two men.

British railroad managers have found that rail motor cars are very effective in meeting certain forms of trolley competition. Assuming that the advantage possessed by trolley lines in handling short-haul passenger traffic is derived mainly from two sources—the possibility of running a frequent service in small units and the benefit derived from the use of city streets as a terminal—it is evident that motor cars can compete actively with one of these functions; that of the frequent service; and their advantage in having a private right of way between stops may compensate, at least in part, for their disadvantage in not being able to collect and set down passengers in the streets of the cities through which they pass. It is probable that there are a good many places in the country to-day where trolley roads are making havoc with short-haul profits, where a rail motor car service would redeem much of the lost business and share in the new business created by the trolley lines. Besides this competitive use of the cars, which is comparable with that of the suburban cars on the Great Western, there remains in this country, as in England, the advantage of being able to conduct light branch line business at smaller cost than can be done with steam trains. A road like the Great Northern should be able to maintain a large number of motor car services at considerably less cost than that of the present passenger train service on some of its northern branches, if the construction details can be worked out so as to avoid breakdowns and an undue repair account. Or, again, a road like the Florida East Coast, which has a heavy passenger traffic for an extremely short season, might well find economy in the use of these cars to handle extra business which is merely temporary. It would seem that these three fields alone—services which compete with trolley lines, under certain conditions; branch line services, and services in which the traffic is subject to considerable fluctuations—would offer an attractive field for experiment with rail motor cars, without consideration, for the moment, of some of the other uses to which the cars are now being put in England. Moreover, it well may be that the rail motor car can serve a useful purpose as a forerunner of electrification. Wherever its use results in developing a large short haul business, it may be concluded that electrification is worth considering, and the motor car can be moved on to exploit new fields.

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The most-talked-of fact in connection with the railroad accident records of the last few years is that the railroads of Great Britain and Ireland were worked for 15 months (ending with March, 1902) without causing the death of a passenger in a collision or derailment. This is a remarkable record, indicating sound structures, correct methods, efficient men and good discipline. Comparing it with the record in America, we cannot avoid self-reproach. But it must be borne in mind that this one item is not the "whole thing." The Vandalia Line (Indianapolis to St. Louis, 242 miles) has killed only one passenger in a train accident in 50 years; and that accident did not belong to the class that causes our present reproach—collisions; it was a derailment, due to a broken rail. This fact was stated recently by an officer of the Vandalia before the St. Louis Railway Club, as reported in another column of this paper. At the same time the Vandalia has had collisions, like other single-track roads. The English lines had some train accidents in their 15-months' record referred to, and have killed passengers since then. We shall not in this place take the reader's time to elaborate the reasoning from these facts; many of the conclusions are obvious. The question of safety in railroad travel is not to be settled by a newspaper article or two. This Vandalia record, and that of the Albany & Susquehanna, referred to last week, bring out another phase of the subject; the difference in the danger on single-track roads with light or moderate traffic as compared with double-track lines with heavy or crowded traffic. In the statement concerning the Albany & Susquehanna attention was called to the fact that a comparison of passengers killed in proportion to the number carried would show that road's record to be much better than the English

record. By taking a sufficiently long term of years a short road in the thinly settled parts of New York State can be compared with a single year on the thousands of miles of roads in the densest parts of England. A statement of similar import has been published in Chicago concerning the accident record on the Southern Pacific for a recent period. Finding that the average deaths and injuries per train mile equal only one-half the average per train mile in the whole United States, and assuming that this difference is due to the good discipline of the Southern Pacific, the conclusion is offered that if the rest of the roads of the country would adopt S. P. discipline the casualties everywhere would be reduced one-half! Here, again, we leave the reader to draw his own conclusions. Just how much a passenger gains in safety on a line where there is only one train a day, as compared with a four-track line that is constantly crowded, no one can calculate; but that the difference is enough to completely vitiate such comparisons as this which comes from Chicago is too patent to need stating. It is not to be supposed that the management of the Southern Pacific fathers these comparisons; but some railroad men do seem to imagine that comfort can be got out of that kind of arithmetic, hence this notice of the matter. All these various sophistries make no difference with the central facts: That large numbers of deaths are caused on American railroads by collisions, and that the collisions, occurring by the hundreds every year, are due to causes which in very large measure can be quickly done away with, and at moderate cost.

The recent large orders for cars and locomotives from all parts of the country cause the natural query whether this increase in equipment contracts is for the purpose of relieving temporary congestion, or in anticipation of a larger movement of traffic. The increased activity along these lines, which started in the latter part of September, does not seem to be due to a universal state of congestion, as was the case in 1902. Serious car shortage is reported only in the northwest, while in the middle west and east the congestion does not appear to be abnormal except in certain parts of New England. It seems rather to be due to the feeling which prevails that conditions are favorable for a good year in 1905 in all branches of business throughout the country. The increase in orders is in part the indirect result of a rather poor year in 1903, and some of the contracts recently placed were undoubtedly held over from last year because many of the railroads found it so hard to secure the necessary money that they preferred to get along with what equipment they had, at a time when gross earnings were slackening. The situation this year is the reverse, and it is now possible to obtain sufficient money for equipment at reasonable rates. The tremendous recovery in the market value of the more important equipment companies from the low prices of 1903, shows the disparity between the orders on hand last fall, and the orders now on hand. In December, 1903, many of the equipment companies were running their shops with half their forces, and with only a meagre amount of orders on their books. In direct contrast to this, many of the works are now running full force with orders booked ahead. Carefully compiled figures show that during the past two months orders have been placed for 60,000 cars and about 800 locomotives. The greater part of these orders will not show in the year's output, as they will not be finished until the first part of 1905. In fact the estimate for the car and locomotive output for 1904 will probably fall far short of the figures for 1903. Present indications point to a general revival in business and heavier traffic in 1905, and orders for new equipment and rolling stock should show a steady increase from now on, to meet the prevailing larger traffic movement.

In the message sent by President Roosevelt to Congress this week, industrial and commercial matters are made more prominent than anything else, the relations between capital and labor forming the subject of the opening chapter. No important new proposals are offered, however, and the message is significant of general purposes rather than of intention to do any specific thing. The same may be said of the chapter on industrial corporations; it is a general plea, based on the theory that the powers of the Federal government should be used to the fullest extent to right all wrongs. The President endorses the Interstate Commerce Commission's proposal for compulsory block signaling, and asks for a law limiting trainmen's working hours and establishing tests of their qualifications. The Commission, he says, should not only receive monthly reports of accidents, but should investigate accidents in cases where it is deemed desirable to do so. The most radical passage affecting railroads is that endorsing the proposition to empower the Interstate Commerce Commission to correct unjust freight rates. The President accepts the fallacious notion that correcting rates which have been complained of is not so great a power as that to make rates *de novo*, and he goes the whole figure with the Western Governors and the other promoters of the bill presented in Congress last session by Senator Quarles. Whether the President's action will add force to this movement it is impossible to predict; but, whatever the outcome, it is unfortunate that, while so warmly espousing the cause of the radicals he did not listen for a moment to the conservative radicals—those who wish to give the Commission more power, but who look a little into the future. Even so wild a Populist as Senator Tillman recognized the need of making the Commission a thoroughly judicial body, and of having such partisan work as Commissioner Prouty sometimes indulges in relegated to a non-judicial body. The Commission can never serve the public acceptably as a judicial body until it is clothed with all of the attributes of our high courts. Even then the vast extent of our territory might necessitate local subsidiary interstate commerce courts.

The earnings and expenses of the Pennsylvania system are always of especial interest as an index of the general traffic condition of the country, because the lines involved cover a territory so large and so complex that temporary local disturbances do not magnify the general result disproportionately. It is of especial interest to see, therefore, that the statement of earnings and expenses for the month of October, 1904, shows the first increase in gross for some months. In August gross earnings of the lines directly operated decrease $741,400 as compared with August, 1903. In September this decrease was cut down to $292,100 as compared with the year previous, but in October there was an actual gain of $3,100, a figure small in itself but significant as indicating what appears to be the turning point. A year ago at this time the monthly statements all showed the somewhat disheartening increase of expenses at a more rapid rate than the increase of earnings, but by a rather radical curtailment of extraordinary expenditures and by good management and careful operation this was at last remedied, so that in all three of the months now under review, even while gross earnings were showing a decrease, operating expenses were showing a larger decrease, and net earnings gained steadily from an increase of $152,000 over 1903 last August to $257,900 in September and $358,800 in October. This is on the lines directly operated. On the Philadelphia, Baltimore & Washington, with much smaller totals, the results have not been so good. On that line gross earnings increased in August but decreased in September and October. Net earnings increased in August but decreased in September and October. On the Northern Central gross earnings increased in all three of these months, with a particularly large increase in October, and net earnings also increased right along. On the West Jersey & Seashore both gross and net earnings showed a decrease in August and both gross and net have showed increases in both September and October. On the Lines West of Pittsburg and Erie, directly operated, the results are similar to those of the lines east. Gross earnings decreased considerably in August, somewhat less in September, and showed a small increase in October, while expenses were kept down so well that net earnings showed a good increase in all three of the months.

For the first time in the annals of transportation we are able to set forth in stately figures the magnitude of an up-to-date football match in its relations to railroad traffic. On Saturday, Nov. 19, there was played at New Haven the climacteric Yale-Harvard game cheered by 32,000 spectators not counting unreserved seats in the treetops. On that red lettered day of blended glory and gore the New York, New Haven & Hartford Railroad Company sold at the three stations, New York, Boston and Providence, a total of 8,471 round trip tickets connoting, by the usual formula of computation, 16,942 passengers, and actually bringing in $35,632. Tickets sold at other stations carried the impressive total up to about 32,000 passengers, with receipts of some $53,000; and the latter figures presumptively do not include football passengers before and after the day of the game who would probably add some thousands to the returns. Last year, subtracting from its passenger department earnings the receipts from express, mails and extra baggage, the New Haven Company earned $21,210,259, or, approximately, $57,594 per average day. Thus a single big football game brought in receipts about equal to a single day's gross passenger earnings on a system with a total track mileage of 4,154 miles, whose passenger earnings about equal those from freight and whose high passenger earnings per mile are unique in the railroad traffic returns of the country. But this is not all: It appears by comparison of the receipts with those of the Yale-Harvard game

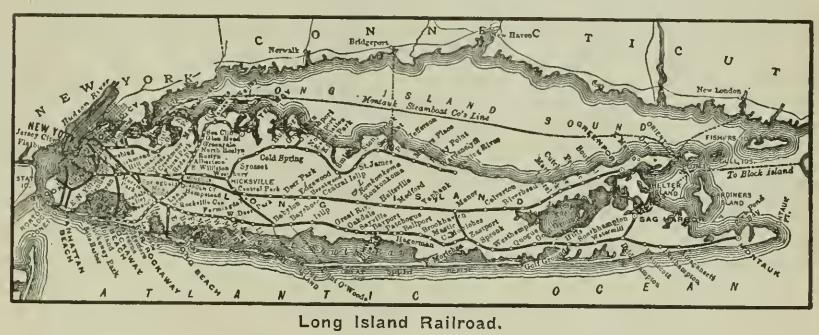
at New Haven in 1902, two years ago, that the conviction of football devotees that last month Yale had a so-called "cinch" on the great match cost the railroad company probably about 2,000 passengers and $6,000 receipts. Under such lucrative conditions railroads may well view with alarm the efforts of humanitarians to abolish the gridiron on which so many academic youths are basted and scored.

The annual report of the Board of Rapid Transit Commissioners of the city of New York, which is now at hand, loses much of its current interest from the fact that it covers the year ending Dec. 31, 1903, and deals, in great part, with a discussion of engineering and construction problems which were uncompleted during the time under review but which have since passed into history. In view of the papers printed in the *Railroad Gazette* at the time the subway was opened, taking up a number of features of the work in considerable detail, it seems unnecessary to make further reference to the engineering matter contained in the present report. The most interesting work which now lies before the Board of Rapid Transit Commissioners, following after the extremely successful completion of their original work in building the subway, is the planning and carrying out of further underground rapid transit routes. It will be recollected that in February, 1903, Mr. Parsons presented a report on a comprehensive plan for rapid transit in the boroughs of Manhattan and the Bronx, and that in the month following this report was perfected by the addition of corresponding plans for the boroughs of Brooklyn and Queens. It does not appear that the present report can add very much to the situation as then presented, except with regard to the opinion of counsel that no new rapid transit construction of any large importance can be undertaken until legislation is secured covering two points: the enlargement of the power of the city to borrow money for rapid transit construction, and the removal of the existing doubt as to the power of the Rapid Transit Board to lay out routes which should embrace the bridges belonging to the city. Both of these objects can be secured by very slight amendments to the existing rapid transit legislation.

## Long Island Railroad.

With exceedingly great potential strength, owing to a practical monopoly of a suburban field which is bound to have a tremendous development in the next few years, the Long Island is at present laboring under serious difficulties in the cost of its service. From the nature of its geographical position the road is primarily a passenger carrier, although an excellent short-haul freight business has been built up and is steadily increasing; but passenger, express and mail traffic constitute 70 per cent. of the gross earnings. This traffic has been showing good increases steadily, year after year, but the necessity for development, together with certain abnormal conditions which have arisen within the last few years, have increased fixed charges and the cost of transportation at a rate so much faster that while gross earnings have increased almost a million dollars in the last three years, to a total of $6,835,848 this year, net earnings from operation have decreased steadily during the same period; while the charges against gross income have brought net income down from a profit of $544,255 in 1902 to a deficit of $275,205 in 1904.

Besides the universal increase in wages, two or three items stand out significantly in the reports of the last few years as indicating the reason for the great increase in expenses. For example, in 1901, with a total revenue train mileage of 3,456,305, fuel cost $403,173. In 1904, while revenue mileage had increased to 4,387,430, 27 per cent., the cost of fuel had increased to $838,422, 108 per cent. The reason for this disproportion between fuel cost and traffic moved is due primarily to the fact that because of the termini and terminal mileage within the limits of Greater New York, the road has been compelled to use anthracite coal instead of bituminous on most of its engines. It is rather curious that this is not explained in any of the company's reports, as the *prima facie* showing of coal cost is very bad, although due to causes beyond the control of the railroad. Another interesting item in the report is the charge for balance of car service under the per diem rule. In 1902 the car mileage balance against the road was $17,951. This current year it was $199,711. It is easy to understand that the Long Island, reached only by car floats at one terminus and not reached at all at the other, is singularly badly placed geographically for the prompt handling of foreign cars; that its business is really a switching business, although it participates in through rates. Owing to the efforts of the General Manager, Mr. Potter, the car service charge will in future be on the basis of a switching company, so that there will




Long Island Railroad.

be a large reduction in the per diem balance next year.

To these heavy charges for coal, wages and car service, exclusive of the maintenance charges, both for way and structures and for equipment, which have been increased largely, must be added the interest on the new securities authorized to provide absolutely necessary funds for the proper handling of local traffic, the elimination of grade crossings and the electrification of a portion of the system, besides the outlay for double tracking, yards and other terminal facilities, required for the through traffic to be exchanged between the Pennsylvania, the New Haven road and the Long Island. A 4 per cent. refunding mortgage was authorized, to aggregate $45,000,000, of which $26,605,000 has been reserved for all underlying liens, and $10,000,000 of the balance sold to meet part of the expenditures mentioned above. The mortgage is dated September 1, 1903, and runs for 45½ years, and the Pennsylvania Railroad guarantees principal and interest of the ten millions of bonds referred to as having been issued. This mortgage is of the same authorized amount as, and practically takes the place of, the unified mortgage, under which $9,673,000 bonds had been issued. The unified mortgage was for the same authorized amount, but was too restricted in its scope to meet the changed conditions of the property, and no further issues of bonds will be made under it.

By means of a rather elaborate classification, the Long Island has for some years apportioned earnings and expenses between freight and passenger traffic. Where the charge cannot be divided specifically, the pro rating is on a train mileage basis. According to this somewhat unsatisfactory division, it is interesting to see that while the average passenger mile earnings this year were 1.44 cents, the average passenger mile cost was 1.548 cents, showing that the traffic was handled at a considerable loss. It is worthy of mention that any train mileage apportionment of general expenses between passenger and freight puts passenger traffic at some disadvantage, owing to the smaller trains. The total passenger earnings per train mile are given as 97.5 cents, and the general passenger expenses per train mile as 104.8 cents. The freight showing is better, although the aggregate amount involved is smaller. Freight earnings per revenue freight train mile are given as 401.2 cents, and freight expenses as 206.1 cents.

Unsatisfactory as the general results of the year's working are, they can be in no way attributed to any defect in the excellent work done by Mr. Baldwin and Mr. Potter. The road is simply placed in such a position that it will have to wait for the completion of the East River tunnels and the general perfection and linking up of that part of the New York transportation system. Its prosperity, in a word, must come from increased earnings, and not diminished expenses, except in so far as the proposed electrification can reduce the operating costs of passenger trains. There is every indication that the time is coming when the Long Island road may look for passanger traffic all out of proportion to that which it now carries, for it holds the key to a very large suburban territory, which will at once become readily accessible to the heart of New York on the completion of the East River tunnels, and the connecting tunnel across New York to the new Pennsylvania terminal. During the present period of incomplete development the property must meet heavy expenses without much chance either of materially reducing them or of making large gains in earnings. The best assets of the road now are its geographical position and its management.

The following statistics show some of the principal results of the year's operations:

| | 1904. | 1903. |
|---|---|---|
| Mileage worked | 392 | 392 |
| Freight earnings | $1,923,498 | $1,784,056 |
| Passenger earnings | 3,842,310 | 3,592,614 |
| Express traffic | 907,910 | 826,195 |
| Gross earnings | 6,835,848 | 6,440,992 |
| Conducting transportation | 3,767,910 | 3,291,162 |
| Main. of way and struc. | 913,665 | 735,879 |
| Operating expenses | 5,591,971 | 4,787,968 |
| Net earnings | 1,243,877 | 1,653,024 |
| Gross income | 1,394,402 | 1,827,018 |
| Net income | 275,205* | 305,588 |

*Deficit.

## NEW PUBLICATIONS.

*Builders' Hardware.* By Henry R. Towne. New York: John Wiley & Sons. Price $3. Leather, 1,117 pages.

The author in his preface to this new handbook says very frankly that inasmuch as it

was absolutely necessary to refer many times to specific articles of builders' hardware, he availed himself of his intimate knowledge of the product of the company of which he has long been president, and while this has involved frequent reference to the Yale & Towne Manufacturing Co. the book is in no sense an advertisement or trade catalogue but a technical treatise on the subject. It is profusely illustrated with many thousand examples of hardware designs and includes an historical review of the evolution of artistic design during different periods, technical descriptions of locks and lock making, detailed lists with approximate prices of standard forms of the many articles included under the title, and a discussion of architects' specifications for hardware and finishings. One feature of special interest and value is a series of articles by W. W. Kent on the "Schools of Ornament," fully illustrated, in which the origin and characteristics of nearly all the recognized schools of architectural design are briefly discussed.

*Elements of Mechanism.* By Peter Scwamb, Professor of Machine Design, M. I. T., and Allyne L. Merrill, Assoc. Professor of Mechanism, M. I. T. New York: 1904. John Wiley & Sons. Cloth, 264 pages. Price $3.

The elementary principles of mechanism have been the subject of treatises and books since long before the time of Archimedes and no new book on the subject can lay claim to much originality. There are, however, different ways of presenting the subject to the student and the chief claim for consideration of this book lies in the systematic, clear and practical development of the principles and their application to mechanical movements and machines in common use. The authors' long experience as instructors has been of value in the selection and analysis of problems best suited to a short but comprehensive course. Much of the subject matter has been re-cast from notes written in 1885 and used since that time as a basis of instruction in mechanism at the Massachusetts Institute of Technology. The treatment of linkages and gear trains is especially good. As a whole, the demonstrations are simple and direct and but little knowledge of higher mathematics is required for their understanding.

*Pipe, Fittings and Valves.* Compiled by W. D. Browning. 79 pages, 6 in. x 9 in. Published by The Draftsman, Cleveland, Ohio. Price, bound in flexible cloth, 50 cents, and in flexible leatherette, 75 cents.

This book is liberally illustrated throughout and contains over 50 tables of dimensions pertaining to all kinds of pipe, valves and pipe fittings such as elbows, unions, flanges, railing fittings, etc. Some useful data in regards to steam coils and radiators is also given, as well as a table showing the properties of saturated steam. This book will be of interest to all who have to do with pipe work and will be of special aid to draftsmen.

## TRADE CATALOGUES.

*Pumps, Condensers and Water Meters.*—Henry R. Worthington, New York, has just issued a 132-page catalogue bearing the title "Pumping Machinery." It is illustrated throughout with finely executed half-tones, and the apparatus described comprises all of the many types of pumping, condensing and measuring devices developed by this company in the 64 years of its existence, the most prominent being the duplex steam pump, of which Henry R. Worthington was the inventor. Special designs of this type of pump are adapted to boiler-feeding, mine-pumping, removing air and circulating water for condensers, water-works service, fire service, etc. A water-works engine of this type, without fly wheels, gave a duty of 174,000,000 foot pounds per thousand pounds of steam in a test made at the Central Park avenue pumping station at Chicago.

*Air Compressors.*—The Clayton Air Compressor Works, New York, is distributing a 48-page pamphlet, 6 in. x 9 in. More than 21 types of air compressors are illustrated, including single and duplex machines, steam-driven, power-driven and electrically-driven by gear, chain and belt. The last page shows two air compressors driven by direct-connected oil engines, forming small convenient units which may be installed almost anywhere and which are said to be used extensively in quarries, stone shops, small machine shops and all small plants where air is used for general purposes, such as cleaning, etc. Other pages describe the air lift, the uses of compressed air in car barns, vacuum machines for experimental work, etc. The range of sizes includes machines displacing from 2 cu. ft. of free air per minute to those having a capacity of 1,400 cu. ft.

*Water Turbines and Pumps.*—The I. P. Morris Company, Philadelphia, Pa., is distributing its bulletin No. 1, which describes water turbines and centrifugal pumps. It is illustrated throughout with both half-tone and line engravings of some of the largest turbine installations made by the company. Notable among these is the plant of the Niagara Falls Power Company, which is equipped with turbines aggregating 110,000 h.p. Illustrations and a detailed description of the Metairie pumping station of the New Orleans Drainage Commission are also shown. The centrifugal pump used in this station was designed and built by I. P. Morris & Co. and is claimed to be the largest centrifugal pump ever built. The diameter of the discharge is 6 ft., and the diameter of impeller 9 ft. 4 in. It has a capacity of 320 cu. ft. per sec. at a lift of 10 ft.

*Cement Buildings.*—The American Hydraulic Stone Company, Denver, Colo., is distributing a 48-page pamphlet. The process of manufacture of cement building blocks is described, half-tone engravings being used to illustrate the text. A view of the first building constructed under this system is shown, the Angelus Hotel of El Paso, Tex., built in 1902. Views of a large number of other buildings are also shown, including public buildings, business blocks, residences, etc., with accompanying testimonial letters and extracts from various publications in regard thereto. Retaining walls, bridge abutments and piers, dams, wide foundations and walls and other heavy construction are possible with this system, and illustrations showing methods of construction are included and described.

*Wire Rope Tramways.*—The Otto Wire Rope Tramway Company, Chicago, issues a catalogue which describes and illustrates the Otto system of ærial wire rope tramways. The mechanism is described in detail, with illustrations to correspond, in addition to which there are a large number of half-tone engravings from photographs of installations of the system all over the world. In the back is a folded sheet showing the profile of a ropeway built at Mazatlan, Mexico. The installation was a difficult one through rough country and involved spans up to 3,657 ft.

*Industrial Bulletins.*—The passenger department of the Union Pacific issues bulletins relative to the agricultural and live stock industries of the States the line traverses. Bulletins 31 to 36 (excepting 33) deal respectively with the Irish potato crop of Kansas for 1904; the Irish potato crop for Nebraska for 1904; live-stock in Nebraska for 1904; the alfalfa crop of Kansas for 1904, and Kansas livestock. The figures are tabulated by counties and are complete.

*Rolling Mill Machinery.*—The United Engineering & Foundry Company, Pittsburg, Pa., sends a handsome catalogue containing upwards of 200 pages, 8 in. x 10 in. Illustrations of the company's works and offices are shown on the first five pages. These are followed by illustrations of rolling mill machinery such as lever shears, punches, rail straighteners, hot and cold metal saws, roll turning lathes, hydraulic accumulators, cranes, etc.

*Boring Mills.*—The Gisholt Machine Company, Madison, Wis., sends its catalogue of boring mills. It is handsomely illustrated throughout and shows different sizes of vertical and horizontal boring mills made by this company. General descriptions of the above machines are given, as well as descriptions and illustrations of the Gisholt turret lathe and tool grinder.

*Graphite.*—The Joseph Dixon Crucible Co., Jersey City, N. J., sends its December issue of *Graphite.* As usual it is full of interesting reading pertaining to this company's product. It also contains an illustrated article by W. H. Wakeman on "Underloaded Engines." Light reading in both verse and prose is also scattered throughout its pages.

*Pumps.*—The Prindle Pump & Engineering Company, New York, sends its catalogue A, which describes and illustrates the Prindle standard house tank pump. This pump is driven by a direct connected motor and the tank supply is controlled by a quick-acting automatic electric switch which is actuated by a ball float and weight arm.

*Rail Loader.*—The United Supply & Manufacturing Co., Chicago, issues a 9 in. x 12 in. 8-page pamphlet relative to the American rail loader. The construction and operation of the device are described and three full-page half-tone views are included, two of which show the loader in operation.

*Steel Furniture.*—The Art Metal Construction Company, Jamestown, N. Y., sends an illustrated folder descriptive of its fireproof metallic office fixtures and furniture, including filing cabinets, tables, roll top desks, book cases, letter files, lockers, etc.

*Machine Tools.*—The November issue of the *Progress Reporter* published by Niles-Bement-Pond Company, New York, is being distributed. It contains a number of interesting descriptions and illustrations of tools especially adapted to railroad shop use.

*Cranes.*—The Northern Engineering Works, Detroit, Mich., sends its booklet No. 19. It consists of 28 pages 3½ in. x 5½ in., and contains about 26 cuts, illustrating different types of "Northern cranes."

## The Passenger Agent in the Orient.

BY JOHN S. TANNER.

A short account of five years' experience in the Orient as passenger agent for one of the large transpacific steamship lines, may perhaps not be without interest to the railroad man on this side.

It may be laid down as a broad principle

that so far as his time and duties allow, the passenger agent should be in a position to give the traveling public all possible information regarding the countries, districts and towns through which their travels may take them. Owing to the great distance and also to the lack of literature on the subject, and doubtless to the fact that his time is fully occupied with his railroad duties, the passenger agent on this side has little opportunity to post himself about the Far East; passengers therefore arrive in the Orient with only a vague idea as to their future plans and with very little information as to what is to be seen and the necessary time required in the different countries to be visited.

On the other side of the Pacific, however, the passenger agent must consider it well within the scope of his duties to not only post himself on his immediate territory, but also on the many eastern countries visited by the traveler in order that he may be in a position to give accurate and detailed information to the patrons of his line. Travelers from America, landing in Japan for the first time, find themselves among a people with only a very limited knowledge of the English language. The hotel porter, a most useful man in the Far East, will assist the traveler in passing the customs and will deposit them in the "rikishas" to take them to the hotel. This first ride in one of the "human powered" automobiles is a unique experience, the feelings produced having been often described by various authors. As soon as the travelers are settled in the hotel they set forth to the office of the steamship company, by whose boat they have crossed on, the familiar sign over the door looming up like home to them.

Innumerable questions as to the curio shops, festivals, sights to be seen, hotels and sailing dates are among the many that the genial "man behind the desk" must be prepared to cheerfully answer. "Around the world" passengers want information as to connections at way ports, points of interest to be visited in China, Siam, Ceylon, India, etc.; whether the scheduled length of stay in the different ports is sufficient to enable them to visit the many famous inland towns; regarding the different climates to be met with in their travels, and probably the connecting steamer that is to take them from England back home again; cost of hotel and traveling expenses must be carefully figured out, in order that the bank account may not be unduly strained in the purchasing of curios in Japan. Perhaps the traveler is returning via Australia and New Zealand, calling, of course, at Manila, which no self-respecting American citizen will pass by without a visit; information must be at hand to satisfy these passengers.

The successful passenger agent therefore must be posted on conditions of travel in the following countries: Japan, China, Philippine Islands, Straits Settlements, Siam, Australia, New Zealand, Ceylon, Burmah; the interesting sights to be seen, and the dates of the countless festivals with ways and means of seeing them, the latter being one of the most interesting features of the Orient. The Overland route across India, with all the noted places of historical interest as the scenes of the great Indian mutiny must not be forgotten, and Egypt even may come in for some attention. As the majority of passengers leave the steamer at one of the Mediterranean ports, Brindisi, Genoa or Marseilles, particulars of these overland routes across Europe must figure as part of his knowledge. It is true, of course, that this information can be gathered en route, but the majority of passengers prefer to settle their plans as definitely as possible on their first arrival in the Orient, in order that they may advise their friends at home of their movements at the earliest opportunity, and as they feel more at ease in the office of their home steamship company, it is there that they resort for assistance and information.

With the advent of the Trans-Siberian Railway a new route was opened up for tourist travel, and while for the moment it is closed, owing to the war, when once more enabled to handle public business, it is likely to prove a keen competitor with the Suez Canal route. It is true that for scenic beauty it cannot compare with the American overland routes, at the same time it passes through an enormous, fertile territory, full of interest and novelty and with immense possibilities if properly developed. Not the least advantage this route possesses for tourists is that of a temperate climate during the summer months, thus enabling passengers to arrive in Japan during the months of April, May and June; the best time of year for a visit; proceeding on to Europe during the summer, avoiding consequently the extreme heat of the Suez Canal route.

So far reference has only been made to westbound travel from America. Eastbound we find the heaviest tourist traffic during the months of April, May, June and part of July. This consists very largely of English tourists who, leaving home in midwinter, travel through India and the tropics during the cool months, crossing the American continent during the summer. To many of these the United States is almost as strange a land as the Orient is to the American traveler, and it is to the passenger agents of the transpacific lines that they refer for detailed information of this country, in order to settle their route home and to arrange at the earliest opportunity for their accommodation on the Atlantic lines during the period of heaviest traffic on that ocean.

The passenger agent taking an interest in his work and who himself enjoys the pleasures of traveling, will find his duties in the Far East full of interest and free from that monotony so often a part of his work on this side. He comes into closer and more intimate touch with the very best class of traveling public, the majority of whom fully appreciate the interest taken in them. He must remember, however, that he is in a conservative country with the most conservative English customs, and that the traditional "rustler" necessary on this side, perhaps, is neither appreciated nor desired over there, and whilst leaving no stone unturned in striving to secure business for his line, must tune himself to the tone of the country and proceed in a quiet and gentlemanly manner in keeping with the dignity of his position, which amongst the class of people he will be brought in contact with will be far more effective. His territory is the wide, wide world; and he needs to be diligent to cover it successfully. The very great amount of attention that is now being drawn to Japan and the Far East, will without doubt at the close of the war result in a very large increase of travel across the Pacific; and it is well within reason to expect that the present tonnage—about 225,000—will be more than doubled within the next four to five years.

At the present time there are no permanently stationed passenger agents for the transpacific lines west of Hong Kong. The companies are represented by local firms in certain of the large cities, but they are not in a position as a rule to furnish very detailed information regarding this country. It seems to the writer that it might be a paying advertisement for one of the large transcontinental lines to open an information bureau in some central point like Colombo, where passengers could obtain authentic information as regards this country while at the same time it could be of assistance to them in seeing the Orient.

## Problems of Heavy Electric Traction.*

BY O. S. LYFORD, JR., AND W. N. SMITH.

The Long Island Railroad has at present two passenger terminals, one at Atlantic avenue and Flatbush avenue in Brooklyn, and one at the Thirty-fourth street ferry in Long Island City, Borough of Queens. When the great tunnels of the Pennsylvania, New York & Long Island Railroad are completed there will be a third terminal for the Long Island Railroad passenger traffic in the Borough of Manhattan. From the present terminals there branches out an extensive system of through and suburban lines, over which is maintained a train service, both express and local, reaching all parts of Long Island. In addition to the suburban service at these terminals there is an interchange of traffic with the Broklyn Rapid Transit Company at two points, and a connection is to be established between the subway system of the Long Island Railroad and the extension of the Rapid Transit Subway now being built between Brooklyn and the south end of Manhattan. The accompanying map shows the location of the western lines of the Long Island Railroad and the new connections which are to be made.

Extensive plans for the electrification of the suburban service of this road have been under consideration for some years. These plans provide for the immediate adoption of electric traction on the lines running from Flatbush avenue and for a progressive extension of electric traction over all of the strictly suburban routes, as rapidly as the conditions shall justify. On some of these routes the traffic is of a purely suburban nature, providing facilities for out-of-town residents to reach Manhattan and Brooklyn. On other sections the important traffic is an excursion movement to and from New York's great playgrounds at the beaches. For the convenience of the suburban residents, a frequent service of comparatively short trains is to be provided, but for the excursion service comparatively long trains are necessary. As a result, the number of cars per train in this system will vary from one to eight or possibly ten. The initial service, limited to a maximum of six cars per train, results in 52 types of runs varying in number of cars per train and distance between stops. On some sections the lines are fairly free from grades and curves, but on others the grades and curves are heavier than would be supposed from a general knowledge of the contour of Long Island. These few statements indicate in a general way the complex nature of the problem involved in the selection of a suitable electrical system for such a service and in the determination of types and sizes of apparatus to be used. Even in a complex problem like the one under consideration, some main points may be decided by similar methods of analysis.

(a) The number of cars per train varies from one to six, as stated. Eight or ten-car trains may be desirable at times. Such variations in train length cannot be provided for economically with electrical locomotives. Motor-cars must, therefore, be used, and for all except trains of one or two cars, more than one motor car per train is necessary. The multiple-unit system of motor-car opera-

*Extracts from a paper presented to the American Institute of Electrical Engineers, Nov. 25, 1904.

tion is, therefore, best suited to this service.

(b) The greatest flexibility for make-up of trains is obtained by making all cars motor-cars.

(c) On the other hand the first cost of equipment and the cost of maintenance and inspection is least if the motor selected is of the largest size practicable, and the number of equipments required is thus made a minimum.

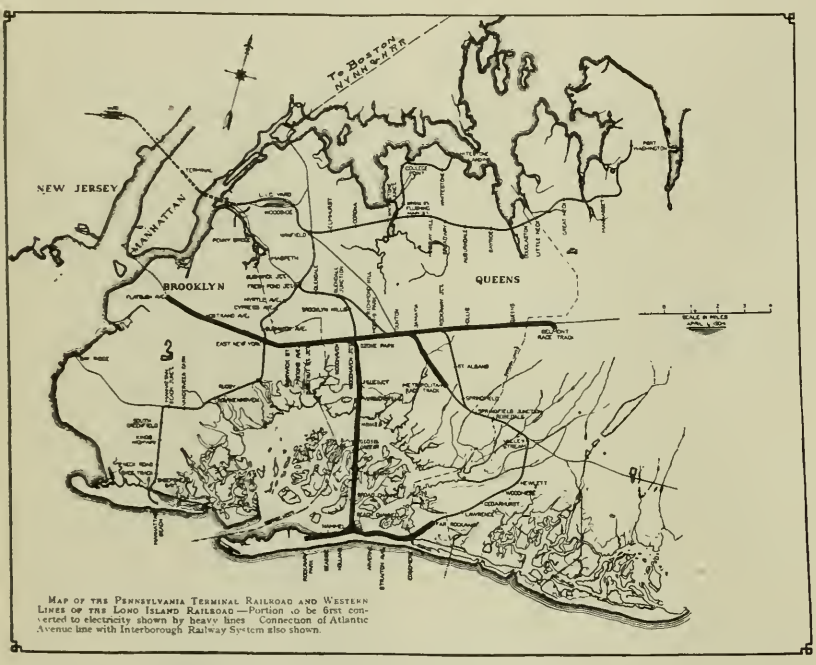
(d) For a miscellaneous service of the character contemplated, all trains, both local and express, should preferably be provided with equipment having the same speed characteristics, so that all motor cars are available for all classes of service. (Trains may operate as express in one direction and as local in the other.)

(e) For express runs of this suburban service, averaging not over five miles between stops, a moderately high speed, say 50 to 55 miles an hour, is found by experience in steam practice to be most suitable. For these runs, therefore, it is essential that the electric trains shall be able to approximate these speeds.

(f) Future development of the service, such as increase in number of stops and decrease in running time, will mean heavier work for the motors. Therefore, reasonable reserve must be provided in the equipment, and consideration must be given to equipment which will make possible a convenient increase in number of motors per train.

*Size of Motors.*—The largest motor in general use for motor-car trains is of 200 h.p. nominal rating, two of these being about the limit of motor capacity that can be placed on a truck with 33 or 36-in. wheels and a reasonably short wheel-base. On the basis of condition (c), this should be the motor adopted, provided the train combinations can be effected satisfactorily with motors of this size. Condition (f) is also complied with by selecting the largest motor practicable, as the number of motors per train in the initial service will then be a minimum.

*Gear Ratio.*—To meet condition (e), a gear ratio must be selected which permits the operation of trains at high speeds without damage to the equipment. On the other hand, the best starting conditions and least heating effect are obtained with a high gear ratio. The gear ratio should, therefore, be as high as practicable and still permit of the maximum train speeds necessary for the express schedules. Provision must also be made for extra speeds which may occur on down grades. From observation of the existing service it was concluded that it is safe to assume 60 miles an hour as a maximum.


To Boston
NEW JERSEY
MANHATTAN
BROOKLYN
QUEENS
Map of the Pennsylvania Terminal Railroad and Western Lines of the Long Island Railroad.—Portion to be first converted to electricity shown by heavy lines. Connection of Atlantic Avenue line with Interborough Railway System also shown.

Map of Long Island Railroad Suburban District.

*Train Weights.*—The motor cars of the service are to be steel cars similar to those adopted for the Rapid Transit Subway. For the determination of motor characteristics, trailer cars were assumed to have the same size and weight of bodies. The weights assumed were as follows:

| | Motor car. | Trailer. |
|---|---|---|
| Seated load | 81,000 lb. | 60,400 lb. |
| Standing load | 88,000 lb. | 66,000 lb. |

These assumed weights are close to the actual weights of the subway equipment.

The 200-h.p. motor was found to be the proper size for the service of the subway; but the schedule conditions are so different that this in itself does not signify that the same motors are suitable for the Long Island Railroad conditions where the distance between stops for most of the local runs is greater than that of the express runs of the subway, and the express runs are longer in proportion. More or less of the usual calculating must, therefore, be done to reach a decision as to whether the characteristics of the standard motor of this size are suitable for this service or whether a smaller size could be used to advantage.

*Plotted and Test Runs Compared.*—The power required to overcome inertia and gravity may be calculated with exactness. Train resistance, however, made up of head resistance, mechanical friction, and skin friction, may be estimated only by empirical formulas, based on practical tests. Such formulas have been derived and published by various engineers. Owing to differences in character of equipment and road-bed, nature of the train service, design of car bodies and trucks, methods of test, etc., there are material differences in the conclusions reached. For ordinary electric car service on urban and suburban lines, where the number of stops is frequent and the maximum speed is low, the train resistance is relatively unimportant as compared with the effect of inertia and grades, but as the speed increases the train resistance becomes a more important matter. The lack of agreement of these formulas when applied to the conditions of the L. I. R. R. are illustrated in curve sheet 1. The Davis and the Baldwin Locomotive Works' formulas are extremes; they therefore afford a sufficient illustration of the divergence of authorities on this subject. These formulas are expressed as follows:

Baldwin Locomotive Works, $R = 3 + \frac{V}{6.}$

W. J. Davis, $R = 4 + 0.13\ V + \frac{.004\ A}{T} V^2 \times [+ 0.1\ (n - 1)]$

$R$ = Train resistance in lbs. per ton of 2,000 lbs.

$V$ = Velocity in miles per hour.

$A$ = Cross sectional area of car in sq. ft.

$T$ = Weight of train in tons of 2,000 lbs.

$n$ = Number of cars per train.

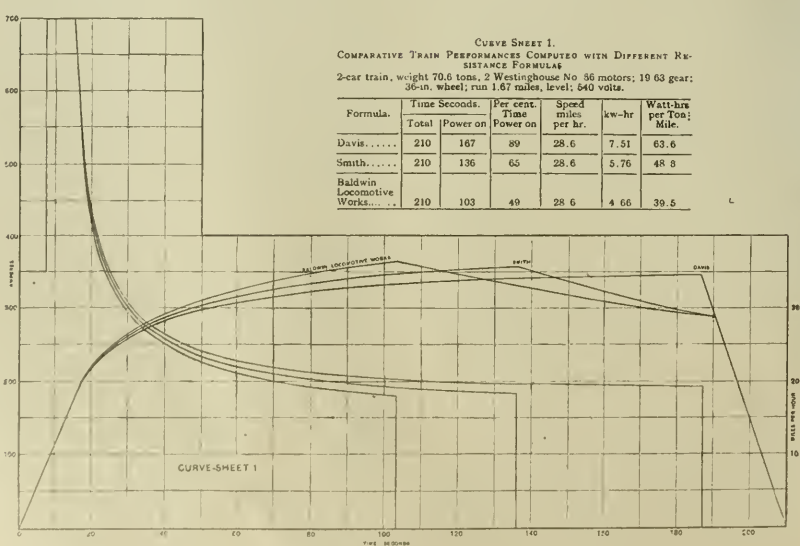
The formula marked "Smith" is one suggested by one of the authors and has been found to give results close to actual practice as will be explained in the following

Curve Sheet 1.

Comparative Train Performances Computed with Different Resistance Formulas

2-car train, weight 70.6 tons, 2 Westinghouse No. 56 motors; 19.63 gear; 36-in. wheel; run 1.67 miles, level; 540 volts.

| Formula. | Time Seconds. Total | Time Seconds. Power on | Per cent. Time Power on | Speed miles per hr. | kw-hr | Watt-hrs per Ton Mile. |
|---|---|---|---|---|---|---|
| Davis | 210 | 167 | 89 | 28.6 | 7.51 | 63.6 |
| Smith | 210 | 136 | 65 | 28.6 | 5.76 | 48.8 |
| Baldwin Locomotive Works | 210 | 103 | 49 | 28.6 | 4.66 | 39.5 |



paragraphs. This formula has the following expression:

$$R = 3 + 1.67\ V + 0.0025\ \frac{A}{T}\ V^2.$$

The speed-time curves on this sheet are derived for a two-car train with cars of weight and dimensions similar to those of the New York Subway. The length of run is an average for the total Long Island suburban service. It will be noted that the power consumption (watt-hours per ton mile) varies from 39.5 to 63.6, the figure according to Davis's formula being 61 per cent. greater than the Baldwin figure. Moreover if the conditions were such that the average speed of 28.6 miles an hour between stations had to be maintained, the speed-time curve of Davis would be impracticable because of no allowance in coasting to provide for possible delays, etc. Therefore, whereas the Baldwin formula indicates a satisfactory equipment working with very low power consumption, the Davis formula for the same equipment shows, relatively, a very high power consumption and an impracticable equipment. The necessity of careful investigation of this matter in connection with the problem is apparent.

TABLE 1.—AVERAGE SPEED AND WATT-HOURS PER TON-MILE.

(Comparison of Theoretical Results with Actual Tests.)

| | G. R. G. H. & M. Ry. (Schedule speed the same.) | | | | D. Y. A. A. & J. Ry. (Schedule speed the same) | | | Arnold & Potter Tests. (Power cut off same distance from start. Schedule speed not the same.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Test number | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
| Weight of train, tons | 29.5 | 29.5 | 29.5 | 29.5 | 32 | 32 | 32 | 228.5 | 201.5 | 175.5 | 148.5 |
| Davis, miles per hour | 27.9 | 32.7 | 30.4 | 30.4 | 28.3 | 31.5 | 33.4 | 26.6 | 27.7 | 29.2 | 29.6 |
| " watt-hrs. per ton-mile. | 98.0 | 99.2 | 85.7 | 115.1 | 99.0 | 102.0 | 95.0 | 87.0 | 98.5 | 102.0 | 111.0 |
| Smith, miles per hour | 27.9 | 32.7 | 30.4 | 30.6 | 28.3 | 31.5 | 33.4 | 27.6 | 28.4 | 30.9 | 30.6 |
| " watt-hrs. per ton-mile. | 79.2 | 81.6 | 75.0 | 111.5 | 94.0 | 96.0 | 89.0 | 72.0 | 84.5 | 84.0 | 89.5 |
| Test, miles per hour | 27.9 | 32.7 | 30.4 | 30.6 | 28.3 | 31.5 | 33.4 | 27.1 | 28.4 | 29.9 | 30.6 |
| " watt-hours per ton-mile. | 88.2 | 81.0 | 86.2 | 110.0 | 99.0 | 105.0 | 97.0 | 79.4 | 82.0 | 86.9 | 93.4 |
| Motors | Two No. 50-C. | | | | Four No. 76. | | | Eight Gen. Elec. No. 55. | | | |

*Application of Formulas.*—The essential points to be determined are the schedule speeds which can be obtained with given equipments, the power that will be required to obtain these speeds, and the heating effect on the motors. The value of train resistance is best determined at full speed, or while coasting; but except in the case of long runs most of the power is consumed in accelerating. By comparing actual test runs with plotted runs from start to stop, we get some check on the train resistance formulas, but, what is of more immediate importance, we get a verification of the accuracy of all the elements entering into our calculations.

To effect a comparison of theoretical results with actual tests, some special tests were made on the Grand Rapids, Grand Haven & Muskegon Railway, and on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway in Michigan. These tests were necessarily confined to trains of one car each. The tests reported by Messrs. Arnold and Potter, made at Schenectady, were on trains of greater lengths. To supplement the single-car data of trains of identical composition and equipment, theoretical runs were plotted for comparison with some of these Schenectady tests. The various comparisons made are summarized in Table 1, which, therefore, shows the comparison of theoretical and actual results for trains of from one to eight cars.

On the G. R., G. H. & M. the equipment consists of two 150-h.p. motors mounted on a heavy Baldwin truck with Gibbs suspension. The non-motor truck is also of the Baldwin make and the entire equipment is of the highest standard. On the D., Y., A. A. & J. the equipment consists of four 75-h.p. motors mounted on rather light trucks.

For comparison with these actual results, theoretical runs were plotted in which the length of run was made the same, the average speed was made the same where possible, and the average rate of braking was assumed to be the same as in the actual experiments. The curves were corrected for pressure and grade so as to conform as closely as possible to the conditions prevailing during the test.

The acceleration curve from the Davis formula conforms more closely to the tests for the D., Y., A. A. & J. car, but for the G. R., G. H. & M. car and for the Arnold and Potter trains it falls below the actual curve, in some cases to such an extent that the theoretical schedule speed is below the actual, even with coasting eliminated. The Smith formula gives accelerations practically coincident with the G. R., G. H. & M. tests and somewhat higher than the actual for the other tests, the difference in any case not being sufficient to be misleading in the results as to schedule speed. This difference may easily be accounted for by difference in pressure or inaccuracies in observation of instruments. In the case of the D., Y., A. A. & J. car the type of trucks and the drops in pressure may have caused the reduced acceleration. In the case of the Arnold and Potter tests the most decisive point in the comparison is the fact that, under the prescribed condition of cutting off power at the same distance from the start and making the same length of runs in the same time, to follow the Davis formula would not only necessitate the elimination of coasting but would require braking at a practically impossible rate. In other words, if the Davis formula be correct the trains could not have made the runs in the time that they actually did make. The conclusion, therefore, is that the Smith formula most nearly represents the actual train resistance for all of these tests.

With reference to power required, the actual results appear to fall between the results obtained with either of the two formulas. The calculations based on the Smith formula are closer to the actual results in most cases. For the G. R., G. H. & M. car, where the acceleration curves agree, the watt-hours per ton mile are also very close, and in the Arnold and Potter tests even with a reduced schedule speed the watt-hours per ton-mile are considerably greater for the Davis formula than for the observed tests. The conclusion reached is that the Smith formula affords a better basis for calculating the average speeds, and is sufficiently close for the determination of power required.

### *Test of Equipment Similar to that Proposed for the Long Island Railroad.*

Through the courtesy of the Interborough Rapid Transit Company and Westinghouse Electric & Manufacturing Company it is possible to present the record of a special test which has a direct bearing on this subject, because the type of motor equipment used in the test is the same electrically as that recommended for the L. I. R. R. project. On Jan. 30, 1903, a test was made on the Ninth avenue line of the Manhattan Elevated, of the sample motors submitted by the Westinghouse Electric & Manufacturing Company as representing the motors which that company was to furnish to the Interborough Rapid Transit Company. In these tests the train weight corresponded closely with the weight per motor of the equipment proposed for the L. I. R. R. and the motors were of the same size and general characteristics. The length of the test run was too short to permit the cars to reach maximum speed; as the value of train resistance is best determined at maximum speed, this test cannot by itself be considered an absolute check on calculated curves. The conclusions derived from this tests, however are as follows:

(a) The motor control did not permit of the rapid application of power assumed in the calculations, time being lost in going from series to parallel. This, however, did not affect the results adversely.

(b) At the maximum speed when current was on, namely, 26 to 28 miles per hour, the theoretical curve shows practically the same energy consumption as the test. This indicates that the train resistance was practically as calculated. For corresponding speed on the motor curve, the power required according to theory is in both cases slightly higher than the power required according to test; this indicates that the Smith formula gives a train resistance which is slightly higher than the actual resistance for this equipment. The Davis formula, giving higher values than Smith would give results still farther from the actual conditions.

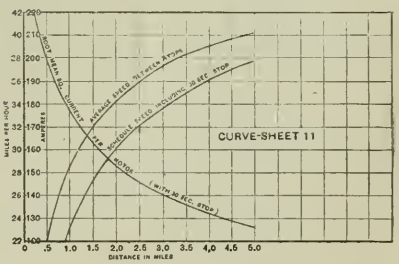
(c) The calculations for energy consumption and square root of mean square current give results slightly higher than the test.

(d) The theoretical methods, therefore, give values which are slightly on the safe side for short runs.

(e) The tests do not afford direct evidence of the accuracy of the theoretical methods when applied to longer runs with higher speeds, but the indications are that for such runs the theoretical values will also be on the safe side and close enough for all practical purposes.

*Use of Typical Run Curves.*—As previously stated, the proposed electrical schedule for the Long Island Railroad provides for a large number of combinations of weights of trains and lengths of run. It is obvious that a tremendous amount of time would be consumed if an attempt were made to plot each of these runs and to make the determinations of schedule speed, power consumption, and heating effect for the various types and sizes of motors which might be used. To avoid this expenditure of time it was necessary to adopt certain approximate methods, and one method which was used after verification by a practical comparison is what may be called the "Typical Run Curve."

Disregarding grades and curves, a single run for a distance equal to the average length between stops will represent the conditions pertaining to a through run; by plotting results for such average runs of differ-




CURVE SHEET 11.
GENERAL PERFORMANCE CURVE.

3-car train for L. I. R R.; two 44-ton motor cars; one 33-ton trailer car; total weight 121 tons; four No. 86 Westinghouse motors; 23-59 gear ratio; 36-in. wheel; 540 volts; 1.5 miles per hr. per sec. braking; no coasting.

ent lengths, curves are obtained which will give exact results for the actual conditions assumed and approximate results for the varying distances between stops and on a succession of light grades and curves. Curve sheet 11 illustrates the character of the curves obtained in this way.

The principal question involved as to the propriety of such a typical run curve is whether the result so obtained (by considering the track straight and level and the distance between all stops the same) will agree closely enough with the average of results obtained from plotting the time-speed curves of an entire round trip, taking the grades and curves into account and placing the stops exactly. It would seem reasonable that the effects of grades in one direction should balance those in the opposite direction when calculating the general results of a run plotted for a round trip when the time of a single run is not greater than one hour, as in this case. If the results of train runs plotted complete be compared with typical run curve results, and if this comparison is generally favorable under varying conditions of grade and length of run, it is safe to assume that typical run curves can be used in place of plotted runs for purposes of general estimate and comparison of different types of equipment when used. The data given simply shows that under ordinary circumstances it is reasonable to use this short method and thus dispense with a vast amount of tedious calculating.

*Schedule Speed Requirements and Limitations.*—The operating conditions of a steam railroad introduce limitations which cut down the possible speed of the motive power equipment. Many of these are conditions over which the engineman has no control and which do not relate to the nature of the equipment; that is, curves, road crossings, junction points, yard limitations, meeting points on single track lines, time to handle baggage and express matter, etc. There are delays at stations and delays during runs, some of which occur regularly, but many of which are intermittent. Because of the complicated service these delays are greater on the suburban lines of a steam road than usually occur in interurban or elevated electric service. It is, therefore, evident that in the electrical operation of such suburban service the loading of the motors will differ materially from the loading in an ideal run which might be made with the conditions removed.

After considering various methods of providing for these conditions it was decided to make a series of tests of the present steam

Tables 2 and 3.—Long Island Railroad.

Table 2.
Long Island City to Valley Stream via Far Rockaway (Eastbound). Length of run, 22.97 miles.

| Train No. | 1287. | 1303. | 1321. | Average. |
|---|---|---|---|---|
| Locomotive number | 72 | 34 | ..... | ..... |
| Locomotive weight | 179,000 | 154,500 | ..... | ..... |
| Number of cars | 3 | 6 | 5 | 4 |
| Total weight of train, tons | 175.1 | 186.55 | ..... | ..... |
| Schedule time of run | 56:00 | 55:00 | 58:00 | 56:00 |
| Actual time of run | 52:30 | 74:20 | 59:00 | 62:00 |
| Schedule number of stops | 9 | 10 | 12 | 10 |
| Actual number of stops | 10 | 11 | 12 | 11 |
| Maximum acceleration | 0.6 | 0.7 | 0.65 | 0.65 |
| Grade on which made | —1.00 | —0.08 | —0.08 | —0.38 |
| Maximum retardation | 1.6 | 1.8 | 1.9 | 1.76 |
| Grade on which made | Level. | Level. | Level. | Level. |
| Average acceleration | 0.47 | 0.46 | 0.35 | 0.426 |
| Average retardation | 1.04 | 1.06 | 1.22 | 1.11 |
| Maximum speed | 56.5 | 52.5 | 50.0 | 53.0 |
| Average length of run | 2.08 | 1.91 | 1.77 | 1.92 |
| Average time of run | 4:03 | 4:48 | 4:10 | 4:20 |
| Average maximum speed | 39.9 | 34.8 | 33.5 | 36.1 |
| Length of longest run | 7.77 | ..... | ..... | ..... |
| Time of longest run | 11:20 | ..... | ..... | ..... |
| Average time of stops | 0:49 | 1.55 | 0:25 | 0:63 |
| Average speed between stops | 30.8 | 23.9 | 25.5 | 26.5 |
| Possible average speed from curve. | 34.5 | 33.7 | 32.7 | 33.8 |
| Ratio av. to possible av. speed, %. | 89.4 | 71.0 | 76.0 | 78.5 |

Table 3.
Whitestone Division (Westbound). Length of run, 11.75 miles.

| | 346. | 360. | 318. | Average |
|---|---|---|---|---|
| | 59 | 35 | 20 | ..... |
| | 177,000 | 154,500 | 139,500 | ..... |
| | 3 | 3 | 5 | 4 |
| | 171.9 | 162.85 | 217.85 | 184.2 |
| | 28:00 | 28:00 | 31:00 | 29:00 |
| | 28:34 | 27:34 | 35:15 | 30:27 |
| | 7 | 7 | 7 | 7 |
| | 7 | 7 | 7 | 7 |
| | 0.9 | 0.95 | 0.5 | 0.78 |
| | —0.65 | —0.65 | —0.75 | —0.68 |
| | 1.8 | 2.0 | 1.9 | 1.9 |
| | 1.07 | 0.69 | 1.28 | 1.01 |
| | 0.44 | 0.35 | 0.29 | 0.36 |
| | 1.43 | 1.5 | 1.2 | 1.38 |
| | 52.0 | 50.0 | 44.5 | 48.8 |
| | 1.47 | 1.47 | 1.47 | 1.47 |
| | 3:08 | 3:14 | 3:55 | 3:26 |
| | 41.0 | 38.3 | 33.5 | 37.6 |
| | ..... | ..... | 1:63 | ..... |
| | ..... | ..... | 3:47 | ..... |
| | 0:29 | 0:15 | 0:33 | 0:26 |
| | 28.1 | 27.3 | 22.5 | 25.9 |
| | 30.8 | 30.8 | 30.8 | 30.8 |
| | 91.3 | 88.6 | 73.0 | 84.2 |

operated under similar conditions. The comparisons have, therefore, been made for a given equipment by making plotted runs in opposite directions over the same grades on certain routes of the Long Island R. R. both on the comparatively level runs of the Manhattan Beach and Rockaway Beach divisions and on the more hilly runs from Long Island City to Port Washington.

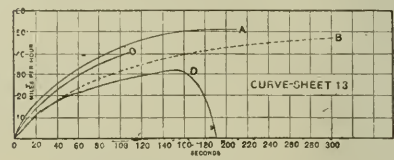
These runs were calculated for the purpose of comparing the determination of square root of mean square current. It is possible to make similar comparisons for kilowatt-hours per car-mile and watt-hours per ton-mile, but it is safe to assume that a check made on the comparative determinations for square root of mean square current will indicate the correctness of the assumptions for the determination of the other requirements.

In general it will be noted that the differences between typical run results and the plotted runs, even in the case of the North Side Division, on which conditions of grade are most severe, do not exceed 5 per cent. for the square root of mean square current and about 4 per cent. for speed. For preliminary determinations of motor characteristics, reasonably close results are obtained by this method, except possibly where very unusual conditions exist. No claim is made that the method is new; in fact, it is quite generally

equipment to determine the speed-time characteristics of the steam trains and the degree to which these characteristics are affected by the local conditions. To this end a test car was equipped with a speed-recording device and runs were made over various routes with this car attached to regular trains. Complete records were obtained of the movement of each train throughout a round trip, and observations made of local conditions which affect speed. These records were carefully analyzed and the results tabulated. In some instances the engineers were requested to make the best time possible; in other cases they were not advised that a test was in progress.

In summarizing these test runs comparisons were made between the average speed between stops as actually attained and the possible average speed if best acceleration had been made for each run. The character of record obtained is illustrated in Tables 2 and 3. It was found that the ratio of the actual speed to the possible speed without local limitations is from 71 to 91.3 per cent. Even when the engineers were requested to do their best they were able in only one or two instances to exceed 90 per cent. of the speed which appeared to be possible from the test. On runs 335 and 346 of the Whitestone Division, in which locomotive No. 59 made the best single record, the average speed for the run was also nearest to the maximum limit.

From these records the four best single accelerations were selected. Curve sheet 13 shows the speed time characteristics of these accelerations. Curve D illustrates the general character of record made by the instrument in these tests. This run, having been made on a level, conforms exactly with the record obtained. Curves A, B and C were obtained on grades, and the actual record has been corrected to illustrate the performance of these trains when reduced to a level. In each case the average acceleration over




Curve Sheet 13.

Time-Speed Curve of 3-Car Steam Train.

*A*.—From best locomotive performance reduced to level. Weight of train, including locomotive No. 59, 171.9 tons disregarding light live load. Weight of locomotive, including tender, 88.5 tons. Weight on drivers, 37.5 tons.

Time-Speed Curve of 5-Car Steam Train.

*B*.—From best locomotive performance reduced to level. Weight of train, including locomotive No. 64, 232.6 tons disregarding light live load.

Time-Speed Curve of 3-Car Steam Train.

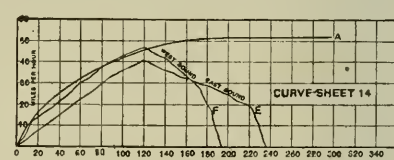
*C*.—From actual run made on a level. Weight of train, including locomotive No. 72, 175.1 tons, disregarding light live load.

Time-Speed Curve of 5-Car Steam Train.

*D*.—From actual run made on a level. Weight of train, including locomotive, No. 64, 232.6 tons disregarding light live load.

the run was less than the characteristic shows, but these curves illustrate the maximum that the steam equipment was able to do. The composition of trains and their estimated weights are indicated on the curve sheet. The live load on these runs was so light that it was disregarded. On curve sheet 14 will be found two curves (E and F) of actual runs on grades compared with run A of the curve sheet 13. According to curve E, a five-car train on a down grade was accelerated at a rate far below the best performance and even the three-car train with locomotive No. 35 (curve F) was not accelerated on a down grade with a rate any better than the best single performance on a level.

It will be noted that the curve *A* was made by a locomotive whose weight was 51.5 per cent. of the total weight of train. The officers of the railroad company were of the




Curve Sheet 14

Time-Speed Curve of 3-Car Steam Train

*A*.—Taken from curve sheet No. 13.

Time-Speed Curve of 5-Car Steam Train

*E*.—From College Point to Whitestone, made by 5-car steam train. Weight, including locomotive No. 18, 276.1 tons disregarding small live load. Acceleration made on average grade of —0.78 per cent.

Time-Speed Curve of 3-Car Steam Train.

*F*.—From Whitestone to College Point, made by 3-car steam train. Weight, including locomotive No. 35, 162.85 tons, disregarding small live load. Acceleration made on average grade of —0.74 per cent.

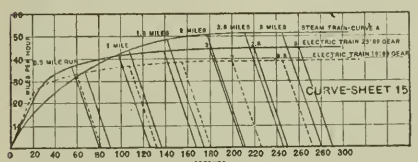
opinion that service equivalent to that which could be performed by this locomotive, No. 59, with only three cars would be a sufficient for the electric equipment. The best performance of this locomotive was, therefore, taken as the criterion by which to work in determining the proper characteristics for the electric equipment. The condition laid down was that the electrical equipment, operating a train with standing load in the cars, should be able to make the same average speed between stops as this particular steam equipment.

Taking curve A as a basis, determinations were made of what may be termed the "speed limit" for steam trains. This is a curve in-

dicating the average speed in miles per hour between stops with the rate of acceleration corresponding to curve A, without coasting; and with a braking rate of 1.5 miles per hour per second. On curve sheet 16 there will be found a characteristic speed-time curve of this steam train making runs of from one mile to three miles. From this curve the speed-limit curve No. 17 was plotted. Table No. 4 shows how this speed-limit of steam trains compares with the average speed between stops required to make various typical runs of the proposed suburban service. It will be noted that the average speed of the schedule runs is from 71.2 per cent. to 93¼ per cent. of the speed limit, with about 80 per cent. as a mean figure.

### SCHEDULE CONDITIONS OF PROPOSED ELECTRIC SERVICE.

Obviously, to make the same time, the speed characteristics of the electric equipment selected for this service must be such that the schedule can be maintained with similar speed reserve, unless the limiting conditions are removed. Elimination of grade crossings at roads and junction points, handling of baggage and express matter by special trains, improvement of yard facilities, etc., will make it possible to operate trains at speeds closer to the limit of the equipment. On the other hand, as the population along the road increases the tendency will be to increase the number of stops with as little increase in the running time as possible; therefore it was decided not to make any material allowance for improved conditions in the initial service. The probability of such improvement, however, suggests another precaution to be taken in the selection of equipment; namely, the provision of a suitable reserve in the capacity of the motors to carry the greater loads which will result from running at speeds closer to the limit.




CURVE SHEET 15.
TIME-SPEED CURVE OF STEAM TRAIN
Curve *A* of sheet No. 13
TIME-SPEED CURVES OF PROPOSED ELECTRIC TRAINS.
Best possible performance on level grade
Weight of train, 121 tons, without standing load.
(All 3-car trains.)

On curve sheet 15 are shown time-speed curves of a three-car electric train with two motor cars and one trailer, with standing load in the cars, which curves may be compared with the corresponding curve of the steam train shown on the same sheet. It will be noted that the electric equipment with the low gear ratio has a maximum speed on straight level track of approximately 45 miles an hour, and with the high gear ratio, 39 miles an hour; whereas the limit of the steam train on the level is 52 miles an hour. For a run of one mile or less between stations, however, the electric train with either the high or the low gear ratio makes better time than the steam train. For a run 1.5 miles long the electric train with high gear ratio falls behind the steam train, and at slightly over two miles the electric train with the lower gear ratio falls behind.

The comparative speeds of these trains are still better illustrated on the speed-limit curves of curve sheet No. 16. The general average length of run between stops for the suburban service is about 1⅔ miles. It is evident from the speed-limit curves on curve sheet 16 that a three-car electric train with two motor cars and gear ratio 23:59 will average slightly better as to speed than the three-car steam train, but that the same equipment with higher gear ratio falls considerably below the speed limit of the steam train. From this exhibit it is obvious that schedule requirements indicate that no gear ratio lower than 23:59 should be adopted.

It is also evident from these speed-limit curves that if 23:59 is the lowest gear ratio practicable as determined by the limitations, the three-car train unit will have to be made up of two motor cars and one trailer, in order that the requisite speeds may be reached. The weight per motor for this equipment is 30.3 tons, which on this basis of speed requirements is obviously close to the limit. To determine what equipment will be necessary for a two-car train, the speed-limit curves of curve sheet 17 have been prepared. In this case the two-car train is made up of one motor car and one trailer. It will be noted that such an electric train, with standing load, falls below the speed limit of the steam train at slightly over one mile between stops. As regards speed requirements, therefore, the two-car train with motor car and trailer has not sufficient motor capacity, and except in cases where speed limitations are slight, two-car trains will have to be made up of two motor cars in order to make the schedule. On this curve sheet, No. 17, the corresponding curve for train with seated load has been plotted to indicate the difference in schedule speed possible during the light traffic hours of the day, as compared with the hours of heavy load in the morning and evening. It will be noted that in the case of heavy equipment of this character, the changes in weight of live load do not materially affect the speed characteristics of the equipment.

Attention should be called to the columu in Table 6 showing the ratio between the average speed of steam train between stops on different runs according to schedule, and the speed-limit possible with the best steam train in each case. Another column of this table gives the ratio of average speed to the speed-limit of the three-car electric train for the same runs. The reserve speed in the electrical equipment corresponds closely with the reserve in the steam equipment throughout the list. It, therefore, seems evident that this three-car train unit fulfils the requirements laid down as to speed, and can be depended upon to make the required schedule with standing load in the cars, allowing for all the delays contemplated in the present schedule for steam equipment.

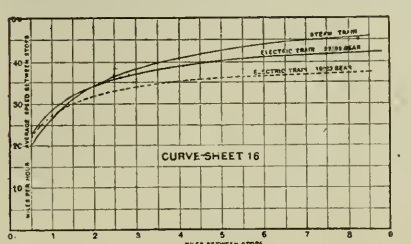
TABLE 6.
DATA FOR SUBURBAN RUNS L. I. R R
QUITTING RUNS WHERE NUMBER OF STOPS IS SAME AS HEREIN BUT TIME AT STOPS IS LESS

| Run. | Distance miles. | Time minutes. | Train sheet schedule speed entire run. | Intermediate No. of stops per trip. | Time out for stops. | Average Length of Run miles. | Time of average Run minutes. | *A* Average speed between stops miles pr hr | *B* Limit av. speed best steam train miles pr hr | Ratio of $\frac{A}{B}$ steam | *C* Limit average speed electric train 23:59 gear ratio. | Ratio $\frac{A}{C}$ Electric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long Island City Fort Washington | 18 18 | 41.5<br>43.0 | 26 3<br>25 4 | 7<br>8 | 4.5<br>5.0 | 2 27<br>2.02 | 4 82<br>4.22 | 29 5<br>28 7 | 36 0<br>34 0 | 81 9<br>84 4 | 35 5<br>34.0 | 83 2<br>84 5 |
| Long Island City Whitestone Landing | 11.75 | 31.0 | 22.8 | 7 | 3.5 | 1 47 | 3 44 | 25 6 | 30.8 | 83 2 | 31.8 | 80 5 |
| Long Island City Rockaway Park | 16 2 | 39.25<br>39 0<br>40 0<br>41.0<br>43 0<br>43 75<br>47.0 | 24.9<br>25 1<br>24.4<br>23 8<br>22 8<br>22 3<br>20 8 | 5<br>6<br>7<br>8<br>10<br>11<br>14 | 2.5<br>2.75<br>3.5<br>4.25<br>4.0<br>4 5<br>5.5 | 2 72<br>2 33<br>2 04<br>1 81<br>1.48<br>1.38<br>1 09 | 8.12<br>5 18<br>4 57<br>4 08<br>3.55<br>3.27<br>2.76 | 26 7<br>27 0<br>26 8<br>26 6<br>25.0<br>25.0<br>23 7 | 37 5<br>36 0<br>34 0<br>33 0<br>30 8<br>30 0<br>27 0 | 71 2<br>75 0<br>78 8<br>78 8<br>81 2<br>83 3<br>88.0 | 36 5<br>35 5<br>34 0<br>33 5<br>31 8<br>31 0<br>29 0 | 73 2<br>76 1<br>78 8<br>79 5<br>78 7<br>80.7<br>81 8 |
| Long Island City Valley Stream. | 22 97 | 59 5 | 23.1 | 11 | 7.5 | 1 91 | 4.33 | 28 4 | 33 7 | 78 4 | 33 7 | 78 3 |
| Long Island City Manhattan Beach | 16 1 | 37.0<br>38 0<br>40.0<br>44.0 | 28 1<br>25.4<br>24.2<br>22 0 | 3<br>4<br>6<br>11 | 3.0<br>2.5<br>3 76<br>6.5 | 4.03<br>3 22<br>2.68<br>1 34 | 8 5<br>7 1<br>5.87<br>3.12 | 28 5<br>27.2<br>27 4<br>25 8 | 41 0<br>39 0<br>37 5<br>29 8 | 69.5<br>69 8<br>73 2<br>86.5 | 39.0<br>37 5<br>36 5<br>31 3 | 73 0<br>72 6<br>75 0<br>82 5 |
| Flatbush Rockaway Park | 15 88 | 39 5<br>44.75<br>45 5<br>47 0<br>48 0 | 24 5<br>21.5<br>20 9<br>20 2<br>19 8 | 7<br>11<br>12<br>15<br>16 | 4.0<br>5.0<br>5.75<br>6 5<br>6 75 | 1.98<br>1 32<br>1 22<br>0 99<br>0 93 | 4 56<br>3 31<br>3 06<br>2 53<br>2 43 | 26 0<br>23 9<br>23 9<br>23.5<br>23 0 | 34 0<br>29 5<br>28 5<br>26 5<br>26 0 | 76 5<br>81 2<br>84 0<br>88 6<br>88 5 | 34 0<br>31.0<br>30 0<br>28 5<br>28 0 | 76 5<br>77.2<br>79 6<br>82.5<br>82 2 |
| Flatbush Jamaica. | 9 63 | 19 0<br>23 0 | 30 4<br>25.1 | 1<br>5 | 1.0<br>3.0 | 4 81<br>1 61 | 9 0<br>3 33 | 32 0<br>29 0 | 42 5<br>31 5 | 75 3<br>92 1 | 40.0<br>32 5 | 80 0<br>89 2 |
| Flatbush Valley Stream | 22 55 | 60 5 | 22 4 | 13 | 9.0 | 1 61 | 3 68 | 26 1 | 31 8 | 82 0 | 32 0 | 82 4 |

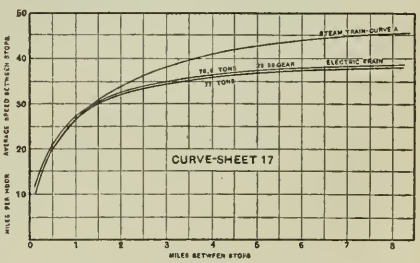
It is obvious that trains made up into combinations of motor-cars and trailers that give less weight per motor will be able to make better speeds than indicated for this three-car train. Furthermore, as the number of cars per train increases, the relative effect of head resistance decreases. For these longer trains it is, therefore, possible that a greater proportion of trailer cars may be used in some instances without reducing the speed-limit to such an extent as to prevent the train from making schedule time.

It is not the purpose of this paper to follow out all the technical processes by which final conclusions were deduced as to size and characteristics of motor equipments for the project referred to. Sufficient illustrations have been given to show:

*First*, that a study of the operating conditions of even a complex project quickly narrows the selection of motors down to one or two sizes, and that these conditions also largely determine the speed characteristics of the equipment; *second*, that theoretical methods are now developed to a point of sufficient accuracy to be considered reliable for purposes of selecting equipment; *third*, that short methods may be used with discrimination, at least for preliminary determinations.




CURVE SHEET 16.
SPEED LIMIT CURVES FOR 3-CAR TRAINS
Showing best possible speed between stops over various lengths of run, without coasting
Steam train based on curve *A* for acceleration
Electric train with standing load weighs 121 tons.




CURVE SHEET 17.
SPEED LIMIT CURVES FOR MOTOR CAR AND TRAILER
Compared with steam train.
Electric train weighs 70.6 tons, seated load.
Electric train weighs 77 tons, standing load.
Steam train based on curve *A* for acceleration.

## Testing Steam Boilers.*

The accepted method of conducting tests of steam-generating apparatus determines the results of the performance of the combined apparatus and its manipulation. Such experiments are referred to as "boiler" tests, yet they are not properly tests of the boiler, nor do such experiments show the results of the performance of the fire or the furnace feature, except as measured through a more or less inefficient boiler. Basing results on the coal supplied to the grate less that which goes to the ash pit or is removed from the fire in cleaning, is a step toward determining the efficiency of the boiler, but, with present methods, it is assumed that the effect of the fire is constant or uniform, although gas analysis is required which shows that fires differ in quality, but this fact is neglected in considering the efficiency of the boiler, yet, any performance is dependent on the condition of combustion, or, in other words, the temperature of the fire.

The purpose of the boiler is to receive heat from the gases, which is supplied to them by the process of combustion. As heat only flows from a region of higher to one of lower temperature, and as its rate of flow is governed by the difference between the temperatures, it necessarily follows that most heat will flow to the boiler when its temperature is highest. It is useful in this connection to consider that heat and temperature are two entirely different things, temperature being the condition under which the heat is present. If a given quantity of heat is contained in a large amount of gas, it will be at a low temperature, but if in a small amount, it will be present at high temperature. That this is true may be determined according to the formula,

$$\text{Temperature} = \frac{\text{Heat developed}}{\text{Weight of gas} \times \text{its specific heat.}}$$

Thus the performance of a boiler is influenced by the temperature at which the heat is supplied; also, when a large quantity of heat is furnished, its absorption is less complete than with a small quantity, the temperature being the same in each case. Therefore, if boilers are to be compared with each other, so their heat efficiency can be determined, it could be accomplished if supplied with the same relative quantity of heat at the same temperature. These conditions would be fulfilled if a uniform number of heat units be supplied for each square foot of heating surface per unit of time and at some accepted standard temperature.

Gaging the required quantity of heat to be supplied would present several difficulties. The heating power of the fuel could be determined by sampling an analysis previous to instead of after the test, which would enable the proper amount of heat in the coal to be furnished to the grate, but fuel lost in the ash-pit, removed in cleaning the fire or carried over the bridge wall, and incomplete combustion, would have a varying influence on the quantity of heat generated, and the percentage of such heat, undeveloped, must be known and provided for in the supply of the fuel to the grate. The use of a standard high-grade coal would, of course, very largely reduce these difficulties.

As different steam pressures have an influence on the amount of heat flowing to a boiler, it would be necessary to use some standard pressure, which need not be that which would be employed in service. And the loss of heat by radiation would be determined or not, as circumstances require, but with well-set apparatus it could be assumed to be constant at rated capacity.

* Abstract of a paper by A. Bement read before the American Society of Mechanical Engineers, December, 1904.

The supply of a certain predetermined amount of heat would be a very difficult matter, and a less efficient boiler would absorb a smaller quantity of heat than a more efficient one, although the same quantity be supplied per unit of surface and time, and at the same temperature, therefore, the less efficient boiler would do less work. Thus the capacity would not be the same for each, and instead of there being simply a difference in efficiency there would be a difference in both efficiency and capacity. It would probably be better to produce a uniform capacity as measured in equivalent pounds of water evaporated from and at 212 deg. per square foot of heating surface per hour, or, in other words, operate the boiler at its rated horse-power capacity. This would be a simpler method than that of affecting uniform supply of heat, and a standard condition of combustion as shown by the gas analysis would insure that the heat be developed at the required temperature. Owing, however, to slight varying composition of fuels, it would be desirable to use coals in which the ratio between carbon and hydrogen is approximately the same. Thus with standard conditions of developed capacity, initial temperature and steam pressure, the heat developed referred to the heat absorbed, will show the efficiency of the boiler, so that comparisons may be made.

The efficiency of any particular boiler is a fixed quantity, which once ascertained according to some standard applies to any number of reproductions, and thus need only be determined once. It does not follow, however, that the efficiency of different sizes of the same kind of boiler is the same. For example, there is a horizontal water tube type which is usually made from 9 to 14 tubes in height, the travel of the gases being three times across the tubes. The higher boilers are more efficient than the lower ones. For the reason that the gases pass across the tubes at a volume dependent on their temperature, and as the temperature drops, the volume becomes less, which results in a portion of the tube surface of the second and third passes especially not being in the path of the flowing gases, therefore the fixed path of the gases passes across 27 tubes in the boiler which is nine tubes high, and across 42 tubes in the one which is 14 tubes high.

Purchasers' requirements will demand in the future as in the past that tests of the combined apparatus with the fuel to be used be made to demonstrate if a certain efficiency and capacity are obtainable. The results of such tests, however, are confusing when an attempt is made to determine the efficiency of boilers or of any portion of the apparatus. It is the author's opinion that there is a greater difference in the efficiency of different boilers than is generally realized. In this connection, experiments on two boilers to determine their relative efficiency may be of value.

These boilers of a horizontal water tube type adjoined each other in one battery. With each the gases were discharged to the same flue and steam at 175 lbs. pressure to the same steam header. A chain grate stoker was located under each, and the furnace feature of the apparatus was well developed by fire brick tile suspended from the bottom tubes of the boiler, which extends approximately 12 ft. back from the front, corresponding to a brick arch of that length, in addition to the ignition arch of the stoker. These boilers are designated as *A* and *B*, and they and their associated features are exactly the same, except that of the path of travel of the gases among the tubes. With *A* the gases travel with the length of the tubes once and do not act on all of the tube surfaces. With *B* the travel is three times the length of the tubes, in separate passages, which caused the gases to come in contact with very much more of the tube surface than with the boiler *A*. Table No. 1 gives the relative final temperatures of escaping

*Table No. 1.*

| | Boilers A | Boilers B. |
|---|---|---|
| Condition of combustion, $CO_2$ | 10.7 | 10.3 |
| Horse-power developed | 564.3 | 580.4 |
| Heating surface, sq. ft. | 4,800 | 4,800 |
| Temperature of escaping gases: | | |
| Final | 657 | 469 |
| Above air supply | 582 | 394 |
| Above steam temperature | 278 | 93 |
| Greater than B. | 186 | ... |
| Temperature of steam | 379 | 377 |

gases at approximately the same capacity and condition of combustion. These experiments were not made at the same time, but the same kind of coal was used. The reason that the gas analysis was only carried to $CO_2$ is that, owing to the very efficient tile roof furnace, combustion was always complete. The horse-power developed placed each boiler nearly on the same basis, being about 3 per cent. to the disadvantage of *B*, therefore the work done by each was approximately the same. The condition of combustion was also slightly in favor of boiler *A*, but this may be considered as approximately the same for each. Thus all conditions were practically the same except that of temperature of escaping gases, which showed a considerable difference in the boilers as gas coolers.

If the specific heat of gases at high temperature were known, the gas analysis and an ultimate analysis of the fuel would afford data for calculating the quantity of heat in a pound of gas at initial temperature, and the heat remaining at final temperature could be calculated from direct temperature measurement, and the efficiency could be expressed according to the equation,

$$E = \frac{H_1 - H_2}{H_1},$$

and it would not be necessary to determine the quantity of fuel used in such an experiment as given in Table No. 1.

If the reduction in temperature of escaping gases from a boiler at 186 deg. may be taken as representing the work of an average economizer, then it appears boiler *B* possesses an efficiency equal to that of the combined efficiency of boiler *A* and an economizer; or, in other words, that *B* is as efficient without an economizer as the combined efficiency of boiler *A* with one, which serves to illustrate the great difference which may exist in different boilers.

These boilers were also tested by the alternate method of the standard code, which was feasible, because conditions could be exactly the same, and the object was to compare one with the other, and not with boilers in general. The tests were run at the same time, one being started 15 minutes before the other. Alternate wheelbarrows of coal from the same source were laid down before each boiler only as required. The thickness of the fire was the same. Each damper was full open and the speed of the stoker regulated so that the fuel bed extended to the end of the grate. The result is shown in Table No. 2.

*Table No. 2.*

| | Boilers A. | Boilers B. |
|---|---|---|
| Pounds pure coal burned per hr. | 1,765.75 | 1,446.56 |
| " water evap. per hour | 13,210.34 | 13,629.24 |
| " water evaporated per lb of pure coal burned | 7.47 | 9.42 |
| Hlg power, pure coal, B.T.U., lb. | 13,633 | 13,633 |
| Temperature: | | |
| Feed water | 212 | 212 |
| Gases, final | 594 | 442 |
| " above air supply | 514 | 362 |
| " above steam tempertre | 217 | 65 |
| " greater than B. | 152 | ... |
| Saturated steam | 377 | 377 |
| Draft over fire, inches of water. | 0.38 | 0.22 |
| Horse power | 383 | 395 |
| Efficiency, per cent. of heat absorbed by boiler | 52.93 | 66.73 |
| Fuel saving of boiler B over A, per cent. | ... | 20.68 |

Pure coal is an expression which the

author prefers to use instead of that of combustible, because the fuel free from ash and moisture contains oxygen and nitrogen, which are not combustibles. The capacities were lower than those in Table No. 1, because the coal used was a less favorable size. This latter test shows the effect of the difference in efficiency of the two boilers in ordinary service.

The author prefers to recognize a steam generating apparatus as being composed of separate features as follows: As boiler and grate, with this combination, the gases flow in contact with the heating surface immediately as they leave the fire. Also, as boiler, grate and furnace, the latter feature consisting of a refractory roof over the fire which extends back a considerable distance, its presence making it possible for the gases to be mixed together a sufficient extent while at high temperature, so that no combustible escapes oxidation. Such feature here designated as a furnace, if of a length of about 14 ft., will produce an ideal mixture of the gases if the coal is supplied to the grate at a uniform rate, but, if not, its ability to effect mixture of the gases is not sufficient for complete combustion. With the thick fire of a chain grate stoker feeding bituminous coals, a considerable amount of combustible gas escapes from the front of the fire, such a quantity, in fact, that an ignition arch alone, although 5 ft. in length, does not cause sufficient mixture of the gas and air to produce complete combustion, therefore, if the maximum requirement of the furnace is to thoroughly mix together the gases from a chain grate fire, then the efficiency of such furnace feature as fitted under boilers *A* and *B* is ideal, because proper regulation of the quantities of air and fuel supplied by the grate resulted in the production of 18 per cent. $CO_2$ with complete combustion and no smoke.

The performance of the chain grate stokers under boilers *A* and *B* are unsatisfactory in two respects: First, that with desirable strength of draft the available thickness of fuel bed does not supply sufficient combustible to satisfy the air supply. Second, fuel is wasted by passing over the end of the grate with the ash. This latter fault may be remedied by running the grate at a speed which will allow the fuel to burn away before it reaches the end, but this results in increased excess of air, therefore the chain grate stoker, in combination with the above described furnace feature, is inefficient to the extent by which it fails to supply a sufficient thickness of fire or quantity of combustible, and the loss of fuel with the ash is not a fault of the stoker, because if the supply of combustible was sufficient to satisfy the air the grate could be run at a speed which would insure that the fuel all be burned.

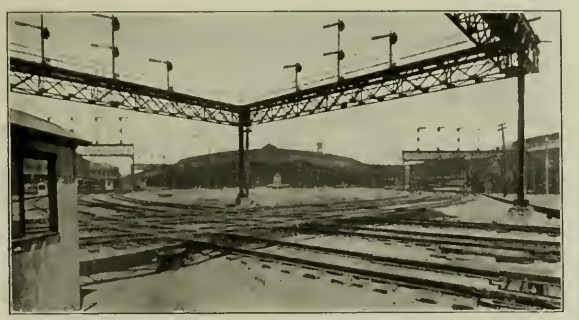


*Fig. 1. Grand Crossing under Signal Bridge No. 8. Three tracks leading to each throat.*

*Fig. 4. East Throat, showing Three Double Slips and Bridge No. 4.*

*Fig. 2. Tower No. 1 and Bridge No. 8. New power house beyond Bridge.*

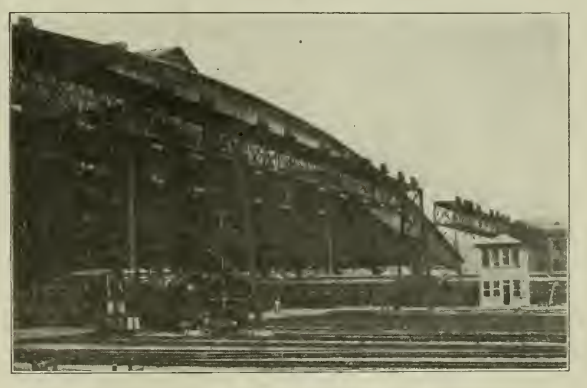


*Fig. 3. Signal Bridges carrying Starting Signals for Outward Trains.*

## Electro-Pneumatic Signals at Union Station, St. Louis.

### Signals at St. Louis Union Station.

The accompanying illustrations, Figs. 1, 2, 3 and 4, show the more interesting outward features of the extensive electro-pneumatic interlocking erected at the Union Station, St. Louis, by the Union Switch and Signal Company this year as a part of the elaborate enlargement which was made necessary at that city to accommodate the great increase of traffic in connection with the World's Fair. From the plan heretofore printed in the *Railroad Gaette* (March 20, 1903, page 212), the reader will recall that the tracks in the great train shed, which is 600 ft. wide, are divided into two groups of 16 each, with a separate throat for each group. Each "throat" has three tracks. Going out from the shed (southward), after reaching the narrowest point in the throat, which is about 400 ft. from the outer ends of the platforms, each throat is divided; three tracks turn to the west and three tracks to the east. The three eastern tracks from the western throat cross the three western tracks from the eastern throat at the "grand crossing," shown in Fig. 1. The four signal bridges required at this crossing are combined in a single rectangular structure, 75 ft. square, shown in the illustration.

The starting signal for outward trains are all "suspended signals"; the signal arms are at the lower end of the tubular post which contains the vertical operating rods, and the pneumatic valve is at the top of the post. Some of these are shown in Fig. 3. The combined length of the two bridges in this view is 488 ft.

Tower No. 1, which is just south of the rectangular signal bridge and between that and the east and west main tracks, controls all of the tracks leading to the station and all of the tracks eastward and westward in each direction from the tower for about 1,200 ft. Beyond this limit on the west is tower No. 2, and on the east is tower No. 3. The functions worked at the different towers are as follows:

*Tower No.* 1.—One-arm home signals, 9; two-arm home signals, 1; one-arm bridge signals, 21; two-arm bridge signals, 37; three-arm bridge signals, 2; one-arm suspended signals, 20; two-arm suspended signals, 12; dwarf signals, 37; single switches, 35; cross-overs, 15; double slips with m. p. f., 48. One hundred and three levers work 35 single switches, 15 cross-overs and 48 double slips with m. p. frogs. Seventy-eight levers work 194 signals. Total number of working levers, 181; spare spaces, 34; capacity of frame, 215 levers.

*Tower No.* 2.—One-arm bridge signals, 14; two-arm bridge signals, 18; dwarf signals, 3; single switches, 11; cross-over, 1; movable point frogs, 2; double slips with m. p. f., 9. Nineteen levers work 11 single switches, 1 cross-over, 2 movable point frogs and 9 double slips with m. p. f. Twenty-five levers

work 53 signals. Capacity of frame, 59 levers (44 working levers, 15 spare).

*Tower No. 3.*—One-arm bridge signals, 10; two-arm bridge signals, 9; dwarf signals, 3; three-arm bridge signals, 2; single switches, 10; cross-over, 1; double slips with m. p. f., 8. Fourteen levers work 10 single switches, 1 cross-over and 8 double slips with m. p. f. Twenty-one levers work, 37 signals. Total working levers, 35; spare spaces, 12.

## Road Tests of Brooks Passenger Locomotives.*

As the Hocking Valley desired to draw comparisons between the two types of engines used at the time in their passenger service between Columbus and Toledo, it was decided to conduct at least four trials under as near as possible identical conditions, two on each locomotive.

The locomotives were built by the Brooks works of the American Locomotive Company, the dimensions of which are given in the following pages, the greatest difference, however, being the Belpaire type of boiler, with 72-in. drivers on No. 73, and the wagon top boiler, with 66-in. drivers, on No. 80. No. 73 had been in service several years, but was thoroughly overhauled nine months previous to the trials, and had been in continuous service from that time, while No. 80 was practically new, having been in service only two months before the trial. In each case, however, where needed, the engines were given new piston rings, the valve seats were put in good condition and valves reset so that each engine worked "square."

*Apparatus and Preparation.*

The apparatus used was as follows: A gage glass and scale on each side of each tank for determining the amount of feed water. A Barrus calorimeter connected to the dome. A Hohmann and Maurer mercury pyrometer inserted in the front-end. Draft gages in the cab to indicate fire drafts at front-end, fire-box and ash pan. The same flue gas-sampling and collecting apparatus was used as in the previous year, and also the same combustible collector at the stack. A continuous counter was driven from the reducing motion, and also an indicator tachometer from the forward truck axle. Two indicators were used on each cylinder, with ¾-in. pipes, 9 in. long, well lagged, connecting to each end of each cylinder. The indicators used were American Thomson and Star brass outside spring. Slotted pendulum reducing motion was used, with exception of on one side of No. 80, where a pantograph was substituted on account of the air tank interfering with the other form of reducing motion, this tank being located underneath the running board. A continuous stroke counter connected with the air pump, received its motion from a small plunger working in a brass cylinder.

*Method of Conducting Trials.*

Since these trials extended over the whole division, a distance of 124 miles, the total amount of coal used from the time the fires were first started in raising steam until the end of the run was easily obtained. The thickness of the fire was noted at the commencement of the trial, and also the amount of coal used up to that time, when at end of trial the fire was left as near as possible in same condition. It was then allowed to burn out, then dumped and the ash pan thoroughly cleaned, so that the refuse obtained in the ash pan was from the total coal burned. The sack method was used for determining accurately the amount of coal used.

The number of injector applications was noted, so as to make correction for loss at overflow, also the number of times and length of popping of safety valve, the loss of steam in this direction being determined from a test of the pop valve while in place on the engine. The steam used by the air pump was computed from the data furnished by the New York Air-Brake Company. All readings and indicator cards were taken at intervals of four minutes, with the exception of the sample of flue gas, which was taken practically every eight minutes. On account of the risk involved, it was considered advisable to attempt to read the calorimeter only when going into the station or in pulling out; so that, probably, there would be some variation between the amount of moisture determined and the true average.

The stack-refuse sampling apparatus was constructed so that the collecting pipe could be fastened at three different points on a radius of the stack. It was clamped in each of those positions for practically one-third of the run.

### General Dimensions.

*Hocking Valley Passenger Locomotive.*

| | No. 73. | No. 80. |
|---|---|---|
| Weight on drivers, lbs | 84,000 | 87,000 |
| Weight on truck wheels, lbs | 44,000 | 46,000 |
| Total weight, lbs | 128,000 | 133,000 |
| Weight of tender, lbs | 95,000 | 102,000 |
| Wheelbase, rigid | 8′ 9″ | 8′ 9″ |
| Wheelbase, total of engine | 24′ 1½″ | 24′ 0″ |
| Length of engine | 36′ 1½″ | 36′ 0½″ |
| Length of eng. and tender | 59′ 3½″ | 59′ 4″ |
| Height, cen. of boiler abv rails | 8′ 7½″ | 8′ 4½″ |
| Height, top stack above rails | 14′ 11″ | 14′ 8″ |
| Heating, surf., fire-box, sq. ft. | 161 | 170 |
| " " tubes | 1,813 | 1,776 |
| " " total | 1,974 | 1,946 |
| Grate area, sq. ft. | 30.8 | 29 |
| Drivers, diameter | 72-in. | 66-in. |
| Drivers, material of centers | Cast-steel. | Cast-steel. |
| Main wheel fit | 8⅜-in. | 8⅜-in. |
| Truck wheels, diameter | 36-in. | 30-in. |
| Journals, driving axle, diam | 8½x11 in. | 8½x11 in. |
| Journals, truck axle, diam | 5½x12 in. | 5½x12 in. |
| Main crank-pin, diameter | 5½-in. | 5½-in. |
| Main crank-pin, length | 5½ in. | 5½ in. |
| Cylinder, diameter | 18 15/32-in. | 18-in. |
| Piston stroke | 26 in. | 26 in. |
| Piston rod, diameter | 3½-in. | 3½-in. |
| Kind piston-rod packing | Jerome. | Downing. |
| Length, main rod, c. to c. | 7 ft. 9 in. | 7 ft. 9 in. |
| Steam ports, length | 17 in. | 17 in. |
| Steam ports, width | 1¾ in. | 1¾ in. |
| Exhaust ports, length | 17 in. | 17 in. |
| Exhaust ports, width | 3 in. | 3 in. |
| Bridge, width | 1¾ in. | 1¾ in. |
| Valves, kind | American. | Richards'n |
| Valves, greatest travel | 6¼ in. | 6¼ in. |
| Valves, outside lap | 1 in. | 1 in. |
| Valves, inside lap | 0 in. | 0 in. |
| Boiler, type | Belpaire. | Wagon top |
| Material in barrel | Carbn st'l. | Otis steel |
| Thickness of material | 9/16, 5/8, 9/16 & ½" | 5/8, 5/8, 9/16, and ½". |
| Barrel, outside diameters | 62-in. | 62½-in. |
| Kind of seams, longitudinal | Quintuple lap. | Sextuple butt. |
| Kind of seams, circumferentl | Double lap | Double lap |
| Tube sheet, thickness | ¾ in. | ⅝ in. |
| Kind of crown sheet stays | Tenn. iron. | Tenn. iron. |
| Dome, diameter outside | 31½ in. | 31¼ in. |
| Fire-box, length | 108 in. | 107½ in. |
| " width | 42 " | 39½ " |
| " depth, front | 75 " | 75 " |
| " depth, back | 57 " | 62 " |
| " material | Carbn st'l. | Otis steel |
| " thickness of sheets | ¾, 7/16, 3/16, 5/16" | 5/8, 7/16, 3/16, 5/16" |
| " width of water space: | | |
| 4" front, sides & back | 3½" | 4" all around |
| Grate, length | 107 in. | 106¾ in. |
| " width | 34 " | 34 " |
| " kind | Rocking | finger. |
| " No. of bars | 10 | 10 |
| Tubes, No. | 301 | 295 |
| " material | Shelby st'l | Shelby st'l |
| " outside diameter | 2-in. | 2-in. |
| " length over sheets | 11 ft. 7 in. | 11′ 7 1/16″ |
| Smoke-box, outside diameter | 65 in. | 65 in. |
| Smoke-box, length | 60 in. | 60 in. |
| Exhaust nozzle: | | |
| Single or double | Single. | Single. |
| Fixed or variable | Fixed. | Fixed. |
| Diameter | 4 5/16-in. | 5-in. |
| Dist., tip from c. of boiler | 2½" abv. | 7 in. betw. |
| Netting, size of mesh | ¼ x1 ¼-in. | ¼ x1 ½-in. |
| Stack, kind | Tank steel | C. I., taper |
| Stack, diameter in | 12½, 15⅞ | 14½, 17⅞ |
| Stack, height abv smoke-box | 43 in. | 43 in. |
| Ratio, air space to grate area | 45% | 45% |
| Width of air space | ⅝-in. | ⅝-in. |
| Tender, type | 8-wheeled. | 8-wheeled. |
| Wheels, diameter | 33 in. | 33 in. |
| Journals, diameter | 5 " | 5 " |
| Journals, length | 9 " | 9 " |
| Distance between centers | 76 " | 76 " |
| Diameter of center of axle | 5¾" | 5¾" |
| Length, tndr. over bumper bar | 22′ 10¾" | 23 ft. |
| Tank capacity, gal. | 5,000 | 5,000 |
| Kind of material | Steel. | Steel. |
| Length of tank | 19 ft. 6 in. | 19 ft. 6 in. |
| Width of tank | 9 " 10 " | 9 " 10 " |
| Height of tank to collar | 4 " 6 " | 4 " 6 " |
| Tires, make | Midvale. | S. St'l Co. |
| Sight feed lubricator | Michigan | triple. |
| Front and back couplers: | | |
| Buckeye; shank | Short | Long. |
| Safety valve (each 3-in.) | Coale. | Hayden. |
| Sanding devices | Leach "D" 2 double. | Leach "A" double. |
| Injectors, two each | Ohio No. 8. | Ohio No. 9. |
| Air-brake equipment | New York. | New York. |
| Tender brake-beam | Monarch. | Simplex. |
| Tender brake shoe | Brooks. | A. L. Co.'s |
| Steam gages | Ashcroft. | Star. |

### General Results.

*Boiler Performance.*

| | No. 80. | No. 80. |
|---|---|---|
| 1. No. of trial | 2 | 3 |
| 2. Date of trials | May 3, '04 | May 6, '04 |
| 3. Duration trials, total, hrs. | 2.96 | 2.64 |
| 4. Running time | 2.58 | 2.36 |
| 5. Steaming time | 2.31 | 2.09 |
| 6. Number of stops | 13 | 11 |
| 7. Kind of fuel | Hocking. | Hocking. |
| 8. State of weather | Clear. | Clear. |
| 9. Direction of wind | E. & S. | E. & S. |
| 10. Velocity wind, miles pr hr | 8 | 6 |

*Average Pressures.*

| | | |
|---|---|---|
| 11. Steam press. at dome, lbs. | 166 | 157 |
| 12. Barometer, in. | 28.07 | 29.21 |
| 13. Absolute steam press., lbs | 180 | 171 |
| Force of draft: | | |
| 14. Front end, in. | 2.05 | 2.31 |
| 15. Fire-box, in. | 1.19 | 1.5 |
| 16. Ash-pan, in. | 0.11 | 0.1 |

*Average Temperatures.*

| | Degs. Fahr. | |
|---|---|---|
| 17. External air | 65 | 75 |
| 18. Escaping gases | 728.3 | 733 |
| 19. Feed-water in tank | 58 | 62 |

*Fuel.*

| | | |
|---|---|---|
| 20. Size | Lump. | Lump. |
| 21. Thickness of fire, in | 11 to 14 | 11 to 14 |
| Weight of coal: | | |
| 22. Fired, lbs. | 7,568 | 7,508 |
| 23. Before start, lbs | 1,164 | 1,067 |
| 24. During run, lbs. | 6,404 | 6,441 |
| 26. Percentage of moisture in coal by analysis, per. ct. | 7.20 | 7.28 |
| 26. Weight dry coal fired, lbs | 5,943 | 5,972 |
| 27. Weight, refuse in pan, lbs. | 715 | 769 |
| 28. Percentage of refuse in pan to coal, per cent. | 9.45 | 10.22 |
| 29. Combustible in refuse, lbs. | 309 | 371 |
| 30. Total combustible minus comb. in pan, lbs. | 6,131 | 5,786 |
| 31. Total ash by analysis, lbs. | 583 | 655 |
| 32. W't. ash passing flues, lbs. | 177 | 257 |
| 33. T'l refuse pass'g flues, lbs. | 730 | 959 |
| Percentage: | | |
| 34. Ash lost to total ash, p.c. | 30.4 | 39.25 |
| 35. Refuse through stock to coal, per cent. | 9.65 | 12.78 |
| 36. Equivalent coal actually burned, lbs. | 5,743 | 5,566 |
| 37. Net dry coal burned, lbs. | 5,320 | 5,160 |
| 38. Net combustible burned, lbs | 4,890 | 4,565 |

*Fuel Analysis—Proximate Analysis.*

| | Per cent. | |
|---|---|---|
| 39. Fixed carbon | 49.24 | 49.70 |
| 40. Volatile matter | 35.86 | 34.30 |
| 41. Moisture | 7.20 | 7.28 |
| 42. Ash | 7.70 | 8.72 |

*Ultimate Analysis.*

| | Per cent. | |
|---|---|---|
| 43. Carbon | 68.9 | 68.58 |
| 44. Hydrogen | 5.45 | 5.45 |
| 45. Oxygen | 16.0 | 15.0 |
| 46. Nitrogen | 1.2 | 1.2 |
| 47. Sulphur | 0.75 | 1.05 |
| 48. Ash | 7.70 | 8.72 |

*Analysis of Pan Refuse.*

| | Per cent. | |
|---|---|---|
| 49. Combustible | 43.28 | 48.18 |
| 50. Ash | 56.72 | 51.82 |

*Analysis of Stack Refuse.*

| | Per cent. | |
|---|---|---|
| 51. Combustible | 75.77 | 73.20 |
| 52. Ash | 24.23 | 26.80 |

*Fuel per Hour Steaming Time.*

| | | |
|---|---|---|
| 53. Actual coal fired, lbs. | 2,772 | 3,081 |
| 54. Equiv. coal burned, lbs | 2,486 | 2,663 |
| 55. Combustible burned, lbs | 2,112 | 2,187 |
| 56. Actual coal fired, per sq. ft. grate | 95.6 | 106.2 |
| 57. Equivalent coal burned, per sq. ft. grate | 85.7 | 91.8 |
| 58. Combustible burned per sq. ft. grate | 72.7 | 75.4 |
| 59. Combustible burned per sq. ft. heating surface | 1.08 | 1.12 |

*Calorific Value of Fuel.*

| | | |
|---|---|---|
| Calorific value per pound: | | |
| 60. Of actual coal by Mahler Calorimeter | 12,135 | 12,184 |
| 61. Of dry coal | 13,080 | 13,120 |
| 62. Of combustible | 14,265 | 14,854 |
| 63. Of stack refuse | 10,750 | 10,390 |

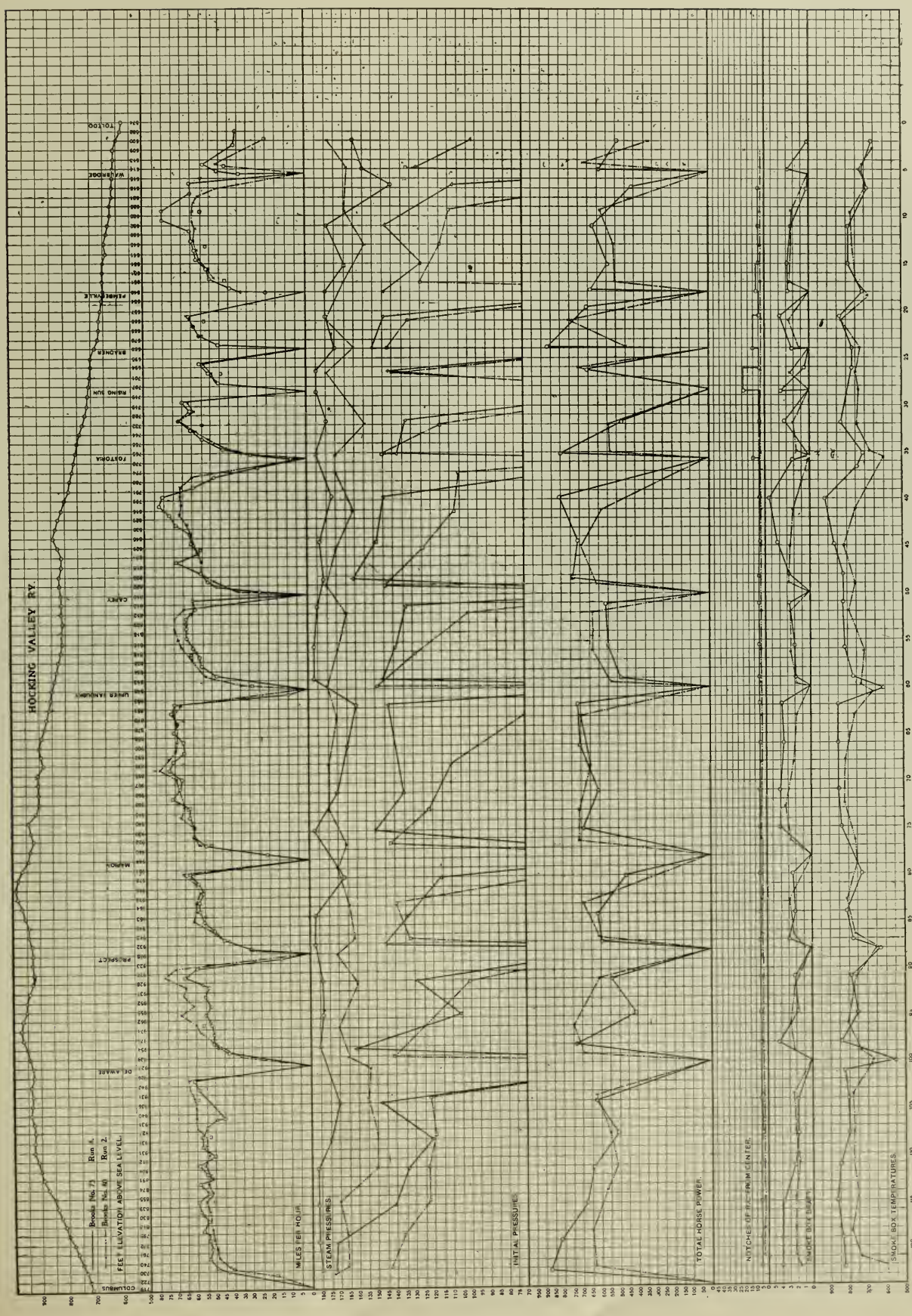
*Quality of Steam.*

| | | |
|---|---|---|
| 64. At dome, dry steam-unity | 0.9774 | 0.983 |
| 65. Quality correction | 0.9843 | 0.988 |

*Water.*

| | | |
|---|---|---|
| 66. Actual weight, water fed to boiler, lbs | 38,580 | 40,785 |
| 67. Equiv. weight of water actually evaporated into dry steam, lbs. | 37,963 | 40,275 |

* From a paper by L. A. Hawkins read before the American Society of Mechanical Engineers, December, 1904.




Graphical Record of Tests of Brooks Passenger Locomotives, Hocking Valley.

| | | | |
|---|---|---|---|
| 68. | Factor of evaporation .... | 1.21 | 1.207 |
| 69. | Equiv. water evaporated into dry steam. from and at 212 degs..... | 45,935 | 48,612 |

*Water per Hour Steaming Time.*

| | | | |
|---|---|---|---|
| | Equivalent evaporation per hour: | | |
| 70. | From and at 212 degs.. | 15.500 | 18,400 |
| 71. | From and at 212 degs. per sq. ft. heatg surf. | 7.97 | 9.45 |
| 72. | H.p. developed by boiler (34.5-lb. rating) ..... | 449 | 533 |

*Economic Results.*

| | | | |
|---|---|---|---|
| 73. | Water apparently evap. under actual conditions, per lb. of coal as fired.. | 6.02 | 6.33 |
| | Equiv. evap. from and at 212 degrees: | | |
| 74. | Per lb. actual coal fired. | 7.18 | 7.55 |
| 75. | Per lb. of dry coal fired. | 7.73 | 8.14 |
| 76. | Per lb. of combustible, minus pan combustible | 8.85 | 9.81 |
| 77. | Per lb. equiv. coal b'rn'd | 8.00 | 8.73 |
| 78. | Per lb. dry coal burned. | 8.63 | 9.42 |
| 79. | Per lb. combustible brnd | 9.4 | 10.6 |

*Efficiencies.*

| | | | |
|---|---|---|---|
| | Efficiency of boiler: | | |
| 80. | From combustible, minus pan combustible.. | 60 | 64 |
| 81. | From combustible brnd. | 63.7 | 69.0 |
| 82. | And furnace from coal fired. ..... | 57.2 | 59.8 |

*Fuel Gas Analysis by Weight.*

| | | | |
|---|---|---|---|
| 83. | $CO_2$ = Carbon dioxide .. | 15.41 | 15.45 |
| 84. | O = Oxygen ..... | 7.25 | 8.54 |
| 85. | CO = Carbon monoxide.. | 1.14 | 0.01 |
| 86. | N = Nitrogen ..... | 76.20 | 76.0 |
| 87. | Percentages of air excess. | 46.44 | 59.09 |

*Heat Balance.*

| | | B.t.u. | P. ct. | B.t.u. | P. ct. |
|---|---|---|---|---|---|
| | Loss pr lb. coal due to: | | | | |
| 88. | Products of combstn | 1,371 | 11.3 | 1,343 | 11.03 |
| 89. | Air excess ..... | 539 | 4.44 | 683 | 5.61 |
| 90. | Latent heat ..... | 497 | 4.09 | 492 | 4.04 |
| 91. | Unbrnd. coal in pan | 538 | 4.44 | 657 | 5.40 |
| 92. | The same, passing out stack ..... | 1,140 | 9.39 | 1,320 | 10.83 |
| 93. | CO. ..... | 671 | 5.53 | 5 | 0.04 |
| 94. | Radiation, etc ..... | 439 | 3.61 | 394 | 3.24 |
| 95. | Heat used in evap.. | 6,940 | 57.2 | 7.290 | 59.81 |
| 96. | Total heat supplied... | 12,135 | | 12,184 | |

*Engine Performance.*

| | | | |
|---|---|---|---|
| | No. of cars in train..... | 4 | 4 |
| | Gross load in tons ..... | 143 | 143 |
| | Total miles ..... | 123.7 | 123.7 |
| | Total revolutions ..... | ... | 37,830 |
| | Average speed in miles per hr. | 47.9 | 52.4 |
| | Average revs. per min..... | 244 | 266 |
| | Steam pressure by gage..... | 166 | 157 |
| | H.-p., right cylinder, head end | 148 | 169 |
| | " " " crank end | 140 | 161 |
| | " left " head end | 157 | 183 |
| | " " " crank end | 169 | 192 |
| | Total ..... | 614 | 705 |
| | Safety valve: | | |
| | No. times popped ..... | 9 | 3 |
| | No. of seconds on ..... | 705 | 150 |
| | Pounds of steam escaped.. | 1,596 | 340 |
| | Steam lost at calorimeter and aspirator ..... | 229 | 224 |
| | Dry steam lost by pop. calorimeters and aspirator.... | 1,825 | 564 |
| | Dry steam used by engine and air pump. ..... | 36,138 | 39,711 |
| | Total hours throttle open.... | 2.31 | 2.09 |
| | Indicated horse-power. hours. | 1,420 | 1,472 |
| | Lbs. dry steam per i.h.p. per hour, including air pump | 25.6 | 27 |
| | Total strokes of air pump... | 5,010 | 5,136 |
| | Dry steam used by air pump.. | 731 | 750 |
| | Lbs. dry steam per i.h.p. per engine alone ..... | 24.94 | 26.41 |
| | Ton miles ..... | 17,690 | 17,690 |
| | Coal per ton-mile, lbs..... | 0.362 | 0.364 |
| | Steam per ton-mile, lbs..... | 2 | 2.2 |

*Boiler Performance.*

| | | No. 73. | No. 73. |
|---|---|---|---|
| 1. | No. of trial ..... | 4 | 5 |
| 2. | Date of trials ..... | May 13,'04 | May 21,'04 |
| | Duration of trials: | | |
| 3. | Total, hours ..... | 3.09 | 3.02 |
| 4. | Running time..... | 2.61 | 2.65 |
| 5. | Steaming time ..... | 2.34 | 2.34 |
| 6. | No. of stops ..... | 13 | 13 |
| 7. | Kind of fuel..... | Hocking. | Hocking. |
| 8. | State of weather ..... | Clear | Cloudy. Clear. |
| 9. | Direction of wind..... | S. W. | N. W. |
| 10. | Velocity wind, miles pr hr | 17 | 8 |

*Average Pressures.*

| | | | |
|---|---|---|---|
| 11. | Steam press. at dome, lbs. | 174 | 170 |
| 12. | Barometer, in. ..... | 29.13 | 29.21 |
| 13. | Absolute steam press., lbs. | 188 | 184 |
| 14. | Force of draft, frnt end, in. | 2.5 | 3.0 |
| 15. | " " fire box, in. | 1.91 | 1.8 |
| 16. | " " ash pan, in. | 0.17 | 0.2 |

*Average Temperatures*

| | | | |
|---|---|---|---|
| 17. | External air ... degs. F. | 68 | 69 |
| 18. | Escaping gases. " | 778 | 775 |
| 19. | Feed water in tank " | 76 | 67 |

*Fuel*

| | | | |
|---|---|---|---|
| 20. | Size ..... | Lump | Lump |
| 21 | Thickness of fire in..... | 11 to 14 | 11 to 14 |
| 22 | Weight of coal fired, lbs.. | 8,195 | 8,867 |
| 23. | Wt. coal before start, lbs. | 1,746 | 1,746 |
| 24. | Wt. coal during run, lbs. | 6,151 | 7,119 |
| 25. | Moisture in coal, analysis, % | 6.81 | 6.70 |
| 26. | Wt. dry coal fired, lbs.... | 6,040 | 6,642 |
| 27. | Wt. of refuse in pan, lbs. | 952 | 851 |
| 28. | Refuse in pan to coal, p.ct. | 11.62 | 9.35 |
| 29. | Combustible in refuse, lbs. | 396 | 289 |
| 30. | Total combustible minus comb. in pan, lbs..... | 6,403 | 7,113 |
| 31. | Total ash by analysis, lbs.. | 838 | 869 |
| 32. | Weight of ash passing flues, lbs. ..... | 282 | 328 |
| 33. | Total refuse passg flues, lbs | 874 | 1,285 |
| 34. | Percentage of ash lost to total ash, per cent..... | 33.66 | 37.8 |
| 35. | Percentage refuse through stack to coal, per cent | 10.66 | 14.5 |
| 36. | Equivalent coal actually burned, lbs. ..... | 5,667 | 5,996 |
| 37. | Net dry coal burned, lbs... | 5,280 | 5,585 |
| 38. | Net combustible brnd, lbs. | 4,698 | 5,000 |

*Fuel Analysis—Proximate Analysis.*

| | | Per cent. | |
|---|---|---|---|
| 39. | Fixed carbon ..... | 48.78 | 47.84 |
| 40. | Volatile matter ..... | 34.16 | 35.66 |
| 41. | Moisture ..... | 6.84 | 6.70 |
| 42. | Ash ..... | 10.22 | 9.80 |

*Ultimate Analysis.*

| | | | |
|---|---|---|---|
| 43. | Carbon ..... | 69.13 | 68.08 |
| 44. | Hydrogen ..... | 5.40 | 5.40 |
| 45. | Oxygen ..... | 13.0 | 14.0 |
| 46. | Nitrogen ..... | 1.2 | 1.2 |
| 47. | Sulphur ..... | 1.05 | 1.52 |
| 48. | Ash ..... | 10.22 | 9.80 |

*Analysis of Pan Refuse.*

| | | Per cent. | |
|---|---|---|---|
| 49. | Combustible ..... | 41.62 | 34.86 |
| 50. | Ash ..... | 58.38 | 65.14 |

*Analysis of Stack Refuse.*

| | | Per cent. | |
|---|---|---|---|
| 51. | Combustible ..... | 67.68 | 74.47 |
| 52. | Ash ..... | 32.32 | 25.53 |

*Fuel per Hour Steaming Time.*

| | | | |
|---|---|---|---|
| 53. | Actual coal fired, lbs..... | 2,757 | 3,042 |
| 54. | Equiv. coal burned, lbs... | 2,421 | 2,562 |
| 55. | Combustible burned, lbs.. | 2,007 | 2,136 |
| 56. | Actual coal fired per sq. ft. grate, lbs..... | 89.5 | 98.7 |
| 57. | Equiv. coal burned per sq. ft. grate ..... | 78.6 | 83.2 |
| 58. | Combustible burned per sq. ft. grate ..... | 65.1 | 69.3 |
| 59. | Combustible burned per sq. ft. heating surface.... | 1.01 | 1.08 |

*Calorific Value of Fuel.*

| | | | |
|---|---|---|---|
| | Calorific value per pound: | | |
| 60. | Of actual coal by Mahler Calorimeter ..... | 12,230 | 12,151 |
| 61. | Of dry coal ..... | 13,130 | 13,020 |
| 62. | Of combustible ..... | 14,775 | 14,560 |
| 63. | Of stack refuse ..... | 9,590 | 10,550 |

*Quality of Steam.*

| | | | |
|---|---|---|---|
| 64. | At dome, dry steam-unity | 0.9824 | 0.9824 |
| 65. | Quality correction ..... | 0.987 | 0.9871 |

*Water.*

| | | | |
|---|---|---|---|
| 66. | Actual weight of water fed to boiler, lbs. ..... | 43,940 | 43,950 |
| 67. | Equiv. w't of water actually evap. into dry stm. | 43,369 | 43,383 |
| 68. | Factor of evaporation ... | 1.195 | 1,202 |
| 69. | Equiv. water evap. into dry steam from and at 212 degs..... | 51,826 | 52,146 |

*Water per Hour Steaming Time.*

| | | | |
|---|---|---|---|
| | Equivalent evaporation per hr.: | | |
| 70. | From and at 212 degs. | 16,770 | 17,270 |
| 71. | From and at 212 degs per sq.ft. heating surf | 8.49 | 8.75 |
| 72. | H.-p. developed by boiler (34.5-lb. rating) ..... | 486 | 500 |

*Economic Results.*

| | | | |
|---|---|---|---|
| 73. | Water apparently evaporated under actual conditions pr lb. coal as fired | 6.81 | 6.17 |
| | Equiv. evap. from and at 212 degs per lb. of: | | |
| 74. | Actual coal fired..... | 8.03 | 7.32 |
| 75. | Dry coal fired..... | 8.62 | 7.86 |
| 76. | Comb. minus pan comb. | 10.3 | 9.13 |
| 77. | Equiv. coal burned..... | 9.14 | 8.71 |
| 78. | Dry coal burned ..... | 9.82 | 9.35 |
| 79. | Combustible burned .... | 11.1 | 10.4 |

*Efficiencies.*

| | | | |
|---|---|---|---|
| | Efficiency of boiler: | | |
| 80. | From combustible minus pan combustible ..... | 67.5 | 60.6 |
| 81. | From combustible burnd | 72.0 | 69.3 |
| 82. | And furnace from coal fired ..... | 63.4 | 58.2 |

*Flue Gas Analysis by Weight.*

| | | | |
|---|---|---|---|
| 83. | $CO_2$ Carbon dioxide ... | 16.53 | 16.11 |
| 84. | O Oxygen ..... | 7.4 | 7.56 |
| 85. | CO Carbon monoxide . | 0.02 | 0.28 |
| 86. | N Nitrogen ..... | 76.05 | 76.05 |
| 87. | Percentage of air excess.. | 48.11 | 49.53 |

*Heat Balance.*

| | | B.t.u. | P. ct. | B.t.u. | P. ct. |
|---|---|---|---|---|---|
| | Loss per lb. coal due to: | | | | |
| 88. | Products of combstn | 1,528 | 12.48 | 1,419 | 11.67 |
| 89. | Air excess ..... | 628 | 5.13 | 595 | 4.9 |
| 90. | Latent heat ..... | 488 | 3.99 | 496 | 4.08 |
| 91. | Unbrnd coal in pan | 660 | 5.39 | 439 | 3.61 |
| 92. | The same, passing out stack ..... | 1,018 | 8.32 | 1,653 | 13.6 |
| 93. | CO ..... | 11 | 0.09 | 147 | 1.21 |
| 94. | Radiation, etc..... | 137 | 1.12 | 327 | 2.66 |
| 95. | Heat used in evaporin | 7,760 | 63.48 | 7,075 | 58.27 |
| 96. | Total heat supplied. | 12,230 | | 12,151 | |

*Engine Performance.*

| | | No. 73. | No. 73. |
|---|---|---|---|
| | No. of cars in train..... | 4 | 4 |
| | Gross load in tons ..... | 143 | 143 |
| | Total miles ..... | 123.7 | 123.7 |
| | Total revolutions ..... | 34,201 | ... |
| | Average speed in miles per hr | 47.4 | 46.6 |
| | Average revs. per min:..... | 221 | 218 |
| | Steam pressure by gauge .... | 174 | 170 |
| | H.-p. right cylinder, head end. | 143 | 163 |
| | " " " crank end | 148 | 167 |
| | " left " head end.. | 167 | 174 |
| | " " " crank end | 171 | 169 |
| | Total ..... | 629 | 673 |
| | Safety valve: | | |
| | No. times popped..... | 29 | 14 |
| | No. of seconds on..... | 1,630 | 580 |
| | Lbs. of steam escaped..... | 1,596 | 568 |
| | Steam lost at calorimeters, dome and aspirator..... | 227 | 236 |
| | Dry steam lost by pop. calorimeters and aspirator..... | 1,823 | 804 |
| | Dry steam used by engine and air pump ..... | 41,544 | 42,579 |
| | Total hours throttle open.... | 2.34 | 2.34 |
| | Indicated horse-power hrs.... | 1,472 | 1,576 |
| | Lbs. dry steam per i.h.p. per hr., including air pump.... | 28.2 | 27.2 |
| | Total strokes of air pump.... | 5,040 | 5,408, |
| | Dry steam used by air pump.. | 753 | 790 |
| | Lbs. dry steam per i.h.p. per engine alone ..... | 27.7 | 26.5 |
| | Ton-miles ..... | 17,690 | 17,690 |
| | Coal per ton-mile, lbs..... | 0.364 | 0.402 |
| | Steam per ton-mile, lbs. .... | 2.31 | 2.36 |

GENERAL RESULTS.

From the readings taken curves are plotted between mile posts as abscissæ and the following: Feet elevation of road; miles per hour; steam pressure; initial pressure in cylinder; total horse-power; notches of reverse lever from center, smoke-box draft and smoke-box temperature. There are two sets of curves on each sheet (one sheet only shown herewith—Editor), one set for each engine, thereby showing at once the relative workings of the two at any point in the road.

Although the results of four trials are given, five runs were made in all; the results of the first one on number 80 not being given, as it served as a practice trial in many respects, some of the observations not being complete, and then, also, on account of the cool weather it was necessary to have steam on the train, which fact, however, when the following runs were made, gave some figures on the amount of steam required to heat the train, made up of four vestibule cars; that is, one combined baggage and mail car, two coaches and one parlor car.

The total water used on this run was about 4,200 lbs. more than on the following trials, all conditions being very nearly the same, with the exception of wind and outside temperature, which was 11 miles per hour from the north, with a temperature of 43 deg. Fahr., as against eight miles per hour from the southeast at a temperature of 65 deg. Fahr. All the general results lie quite closely together, or as close as could be expected, when consideration is taken of the irregularities that are bound to creep in on a regular service test. In comparing runs 2 and 3, in the latter case the speed was much higher and consequently the amount of steam used greater. This was due to lateness in starting, thereby making an average speed in miles per hour of 52.4 and a maximum indicated horse-power at one point of 1,383, yet the maximum speed for No. 80 was on trial No. 2 78 miles per hour. On trials 4 and 5, with engine No. 73, the maximum speed attained was very nearly 82 miles per hour and the maximum indicated horse-power 935, there not being such a variation as in the trials on No. 80 since the time in motion were almost identical. In every case the highest speeds, as shown on the curve, were reached at the same points in the road, between mile posts 90 and 91, also between mile posts 68 and 69.

In comparing the several heat balances, although as a whole they are quite similar, the slight variations that do exist may be explained. With trials 2 and 3 the greater loss out of the stack in trial 3 is due to the

much higher speed. Trial 2 shows a much greater loss, due to formation of CO. If that factor had been practically eliminated, as in trial No. 3, although the loss due to air excess would probably have increased, due to more free oxygen in the escaping gases, yet there would be a consequent increase in the boiler efficiency, putting it above that of trial No. 3, on account of the less loss from the stack. Therefore, with the same losses out the stack the efficiencies would be very nearly the same. In trials 4 and 5 the greatest difference is in the loss from the stack, with also about the same difference between the boiler efficiencies, but when the difference in the loss due to unburned coal in the pan is taken into account, the boiler efficiency for some reason on trial 4 is too high. This is accounted for by the fact that during trial No. 4 the mud ring started to leak and, as this could not very conveniently be gaged, or very accurately estimated, the total amount of feedwater to boiler used in computing the final results, the evaporating and consequently the boiler efficiency would run higher than the true value, with a consequent reduction, as found, in the loss due to radiation, etc.

Considering this loss on trial 4 as unreliable and taking the average unaccountable loss of the other trials and comparing with the same losses obtained in the same way on the consolidation freight referred to before, the passenger runs give 3.18 per cent. and 1.55 per cent. for the freight, which figures would not necessarily indicate that the loss in this direction was less in case of the consolidation engines, in view of the way this loss is determined, that is, by difference, thereby containing all errors of observation, sampling, etc., and thereby a small percentage of difference in one large item of the heat balance would make a large percentage in that of the "unaccountable loss and radiation." All the heat balance results obtained thus far seem to indicate that the loss referred to would be about 3 per cent., which is about what might be expected for that type of boiler working under the conditions found.

It is also of interest to note that the average loss due to unburned coal out the stack for the two trials with Hocking coal on the freight engine was 14.48 per cent., while for the passenger engine, with the same kind of coal, the average of the four trials is 10.53 per cent.

Interior of Observation Compartment.

Interior of Smoking Compartment.

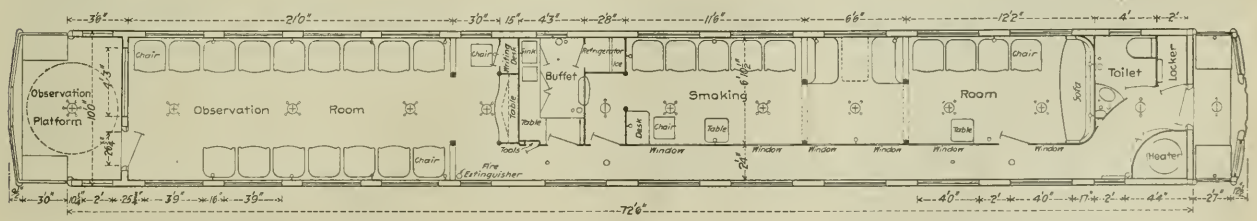
## Composite Observation Cars for the C., M. & St. P.

The "Overland Limited" trains of the Chicago, Milwaukee & St. Paul, running between Chicago and Omaha, will soon have added to their equipment a new design of observation car different in some ways from anything heretofore used. As may be seen from the floor plan it is a combination smoking and observation car, in which the smoking room is enclosed and separated from the observation end. The comfort of women passengers was the primary object of the design.

It will be observed that the observation room is reached by a corridor along one side of the car as in compartment sleeping cars. The car, which is 72 ft. 6 in. long over end sills, contains only the two rooms, and both are therefore spacious. The interior design and finish is artistic and pleasing, the treatment being in the new L'Art Noveau style. The woodwork is St. Jago mahogany and is inlaid with marquetry designs. Many rare woods have been used in this ornamentation, including tulip, amaranth, saffron, olive, boxwood, satinwood, English oak, white holly, prima vera and cocobola. The carpets are woven to a special design to conform to the ornamentation of the car. The upholstering in the observation room is frieze plush and in the smoking room Spanish effects in leather are used. All of the hardware, lamps, etc., were specially designed for the car.

A buffet is placed between the two compartments and is accessible from either. At the forward end of the smoking room is a large lounge, above which is a handsome mirror surrounded by a frame of Tiffany illuminated glass. Both rooms have writing desks and in the observation room is a library, and cases for periodicals. Particular attention was paid to the lighting of the car and each passenger will have ample light for reading purposes. The smoking room has specially designed exhaust ventilators to draw out the smoke rapidly.

The cars are built with the heaviest framing the builders have ever used. In addition




Floor Plan of New Observation Smoking Cars for the Overland Limited, C., M. & St. P.

to the usual framing for cars of this kind, the ends are further reinforced with a composite iron and steel structure reaching from the end plate to the sill with steel plates laid in parallel with the end posts. The whole structure is tied together with a plate in the end sills. In the underframing there are four steel plates running the full length of the car and connected to the plates in the end sill, forming an unusually strong and rigid construction. The builders are the Barney & Smith Car Company.

## Fuel Consumption of Locomotives.*

The fuel bills of a railroad constitute ordinarily about 10 per cent. of the total expense of operation, or from 30 to 40 per cent. of the actual cost of running the locomotive. On important systems the gross amount of coal burned assumes a very large figure—running into millions of tons. Each engine will probably consume $5,000 worth of coal in a year on the average, so that for 1,000 locomotives the annual coal bill would approximate $5,000,000. While this is one of the largest items of expense, there is probably less actually known about it than any other account. We may know in a general way that an engine of a certain class, loaded with a definite tonnage, will haul its train in a given direction over a particular division with a consumption of so many pounds of coal per 100 ton miles, but here our knowledge stops, and if it should be asked how much is used in ascending the maximum grade, how much on the subordinate grades, and what quantity on the level, there is little likelihood of receiving a correct answer.

The reason for this lack of definite information is not hard to find; in fact it is quite obvious. While it is a comparatively simple matter to determine the quantity of coal used on a trip throughout a run, by means of track scales and measured supplies taken en route, it is very difficult and laborious to sub-divide it between terminal points, in the proper proportion to the work done on each of the various grades. An approximation is sometimes obtained by counting the shovelfuls thrown into the fire-box between different points, but this, of course, cannot be considered an accurate method. The ordinary exigencies of railroad traffic are so many and varied that it is almost impossible to maintain fixed conditions for a length of time sufficient to determine factors of unquestioned value.

The same comments apply equally to the consumption of water. Even if meters be placed in the feed pipes, the inconvenient location for observation and the variable methods of working the injector by allowing different heights of water in the boiler, not to speak of leaks and wastes, militate against accurate measurements. Thanks, however, to the "Locomotive Testing Plant," we are now able to work an engine for a long period under constant conditions, and at the same time make accurate measurements of the fuel and water consumed.

Several years ago, when connected with the Chicago & North Western Railway, the author was able to make a complete set of tests with the standard heavy freight engine of that road, first upon the testing plant and afterwards in road service with a dynamometer car. Using the results of these tests as a foundation, it has been found possible to elaborate a diagram for practically any particular locomotive whose general dimensions are known, which will give at once the coal consumption per mile or per hour for various grades and speeds or train loads. This diagram is based upon theoretical as well as practical considerations, and will, it is believed, give values agreeing closely with actual conditions.

The construction of the diagram and the method of using it can, perhaps, be made most clear, by assuming a locomotive of certain proportions, and developing the study for this engine. We will therefore consider a consolidation locomotive or 2-8-0 type having the following general dimensions:

| | |
|---|---|
| Diameter of cylinders | 21 in. |
| Stroke of piston | 32 in. |
| Diameter of drivers | 56 in. |
| Boiler pressure | 200 lbs. |
| Grate area | 40 sq. ft. |
| Heating surface | 3,200 sq. ft. |
| Weight of engine and tender | 150 tons |

The theoretical tractive force of such a locomotive will be

$$T.\ T.\ F. = \frac{P\ d^2\ s}{D} \quad \ldots\ldots\ldots\ldots 1$$

where $P$ = Boiler pressure in pounds per sq. in.
$d$ = Diameter of cylinder in inches.
$s$ = Stroke of piston in inches.
$D$ = Diameter of drivers in inches.

When we allow for drop in steam pressure and internal resistance, we find that the available tractive force at circumference of the drivers is only eight-tenths of the theoretical tractive force, or,

$$A.\ T.\ F. = \frac{.8\ P\ d^2\ s}{D} \quad \ldots\ldots\ldots\ldots 2$$

for simple engines, when working at slow speeds with the reverse lever in the corner notch.

For the engine under consideration we therefore find as follows:

$$T.\ T.\ F. = \frac{200 \times 441 \times 32}{56} = 50{,}000 \text{ lbs. approx.}$$

$A.T.F. = .8 \times 50{,}000 = 40{,}000$ lbs. approx. As the speed of the locomotive increases, however, beyond the point where the boiler can supply the complete volume of the cylinders at each stroke, an earlier cut-off must be used, and it is necessary to determine the effect of such a change. In order that this may occur at the maximum possible speed, the boiler must be worked to its full capacity, which is limited by its ability to burn fuel. From various tests it seems as if this limit might be considered as stated below, the quantities being expressed in pounds of coal per square foot of grate area per hour:

| | |
|---|---|
| Bituminous coal | 200 lbs. |
| Anthracite, large sizes | 100 " |
| Anthracite, small sizes | 60 " |

We will assume that our engine is burning Pennsylvania or Virginia semi-bituminous coal, therefore the maximum combustion will be $40 \times 200 = 8{,}000$ lbs. coal per hour. We admit that this is a large amount to be handled by one man for any great length of time, but there is no doubt that it could be burnt, if supplied.

In order to determine the quantity of steam generated by this amount of fuel in the boiler which we have assumed, Fig. 1 is introduced. This has been compiled from various sources of information, and, it is thought, fairly represents the average practice in this country. In this figure, the ordinates give the maximum evaporation in pounds of water from and at 212 deg. Fahrenheit per square foot of heating surface per hour that can be expected under ordinary conditions, as stated above, the abscissæ denoting the ratio of heating surface to grate area. For the engine in question this will be

$$\frac{3200}{40} = 80,$$

and for semi-bituminous coal, curve $c$, we find that with a ratio of 80, 15 pounds of water, from and at 212 deg., may be evaporated per hour from each square foot of heating surface, or for the boiler as a whole, $3{,}200 \times 15 = 48{,}000$ lbs. per hour.

The factor of evaporation from ordinary temperatures of feed water, will be about 1.2, so that we shall have at boiler pressure,

$$\frac{48{,}000}{1.2} = 40{,}000 \text{ lbs. per hour.}$$

The steam will be somewhat reduced in pressure at the cut-off point, however, and the table here given indicates the probable relation of this pressure to the boiler pressure, when the reverse lever is in the corner notch, and the throttle wide open.

*Ratios of Cut-Off Pressure to Boiler Pressure.*

| Revs. per min. | Starting. | 50. | 100. | 150. | 200. |
|---|---|---|---|---|---|
| Long ports | .98 | .94 | .88 | .83 | .78 |
| Short ports | .98 | .92 | .85 | .77 | .72 |
| Medium ports | .98 | .96 | .86 | .80 | .75 |

By long ports is meant those in which

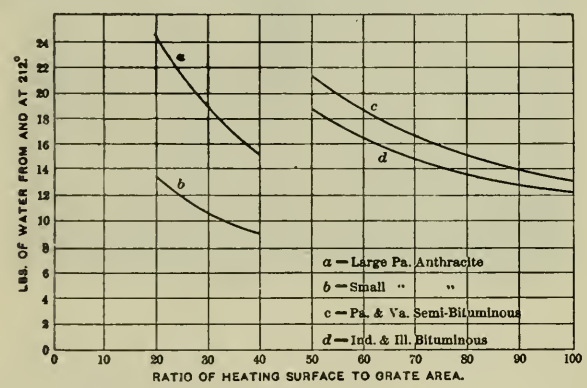

LBS. OF WATER FROM AND AT 212°
RATIO OF HEATING SURFACE TO GRATE AREA.
a — Large Pa. Anthracite
b — Small " "
c — Pa. & Va. Semi-Bituminous
d — Ind. & Ill. Bituminous

Fig. 1—Maximum Hourly Evaporation per Square Foot of Heating Surface.

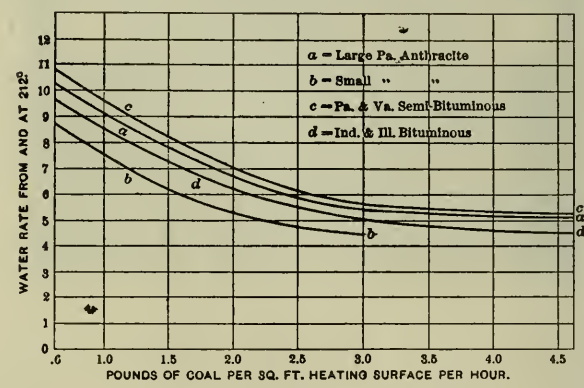

WATER RATE FROM AND AT 212°
POUNDS OF COAL PER SQ. FT. HEATING SURFACE PER HOUR.
a — Large Pa. Anthracite
b — Small " "
c — Pa. & Va. Semi-Bituminous
d — Ind. & Ill. Bituminous

Fig. 3—Evaporative Value of Coal.

*From a paper by Mr. G. R. Henderson, read before the American Society of Mechanical Engineers, December 1904.

the length of port in inches divided by the area of the cylinder in square inches is approximately .12, and by short ports, where this ratio is about .05. If we assume .90 for the ratio in the case in hand, we shall have $200 \times .90 = 180$ lbs. at cut-off, which steam will weigh .432 lbs. per cu. ft. The volume of a cylinder 21 in. diameter and 32 in. long is 6.4 cu. ft., or for one revolution four times this amount or 25.6 cu. ft. No allowance is made for clearance, as the cut-off, with lever in the corner, is usually about 90 or 92 per cent. of stroke. For each revolution, then, the steam consumption will be

$$25.6 \times .432 = 11.06 \text{ lbs.}$$

and

$$\frac{40{,}000}{60 \times 11.06} = 60 \text{ revolutions per minute.}$$

as the maximum speed at which the boiler will furnish steam at full stroke. The speeds in miles per hour corresponding to the revolutions per minute for a 56-in. wheel are as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 miles per hour. |
| 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 revs. per min. |

therefore it is plain at above 10 miles an hour, the cut-off must be reduced, diminishing the available tractive force of the engine.

A study of the variation in tractive force due to speed indicates that the method explained below gives a close approximation to actual results.

In Fig. 2 the ordinates represent the tractive force in pounds, and the abscissæ the speed in miles per hour. As the maximum speed at full stroke was found to be 60 revolutions per minute or 10 miles an hour, we find the intersection of this speed with the theoretical tractive force at *A*. We therefore construct an equilateral hyperbola through this point, that is a curve the product of whose ordinates will always have the same value, viz., $50{,}000 \times 10 = 500{,}000$. As we have seen, the available tractive force, however, cannot exceed 40,000 lbs. By drawing from the point *B* a tangent to the hyperbola, we then have a locus consisting of a straight line and a curve, and this locus gives us the maximum available tractive force (at circumference of the drivers) for which the boiler will supply the cylinders at any speed. But to do this, we must burn 8,000 lbs. of coal an hour, so that the locus *BC* also gives the combinations of speed and available tractive force which may be obtained by the combustion of 8,000 lbs. of coal an hour.

The rate of combustion per sq. ft. of heating surface per hour is $\frac{8{,}000}{3{,}200} = 2.5$ and from Fig. 3 (curve *c*) we should expect 6 lbs. of water per pound of coal from and at 212 deg., or a total steam production of 8,000 $\times$ 6 = 48,000 lbs., which is the same as our first figure. If the rate of combustion be reduced, however, there will be more steam generated per pound of coal, as indicated by Fig. 3. For instance, if three-quarters the amount be consumed, or 6,000 lbs., the rate of combustion will be $\frac{6{,}000}{3{,}200} = 1.87$ lbs. per sq. ft. of heating surface, and from Fig. 3 the evaporation will be about 7 or $7 \times 1.87 = 13.09$ lbs. of water per sq. ft. of heating surface per hour, instead of 15 lbs. as before. This would supply the cylinders at full stroke for 15: 13.09:: 10: 8.7 miles an hour. From this, as a starting point, we construct a new hyperbola and tangent as before, which locus gives the combinations of speed and tractive force for 6,000 lbs. of coal an hour. In the figure, the loci have been drawn for each thousand pounds per hour from 1,000 to 8,000.

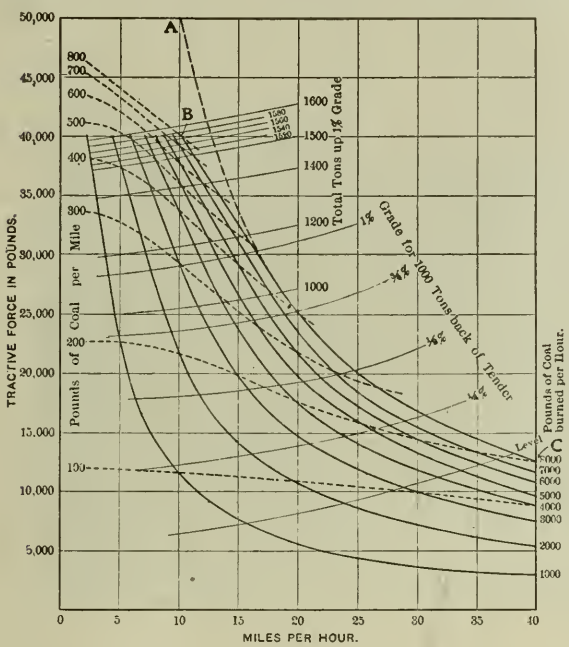



Fig. 2—Coal Consumption of Locomotives.

If, now, we divide the quantities per hour by the speed, we obtain the fuel consumption per mile, and this is shown by the dotted lines. Thus with a tractive force of 20,000 lbs. and a speed of 15 miles an hour, we should expect an hourly consumption of 3,000 lbs. or 200 lbs. per mile.

But as our diagram (Fig. 2) is based on speed and tractive force as co-ordinates, we can construct additional curves, which may represent the force needed to pull various trains at different speeds or up grades. For instance, if we consider a train of 1,000 tons weight back of tender, or 1,150 tons total weight, we can lay down the curves of resistance for a level, ¼, ½, ¾ and 1 per cent. grade, as shown in the diagram. By this means we can determine the quantity of coal that would be used on different portions of a division.

If there were 40 miles each of level, ½ and 1 per cent. grade, the fuel consumption would run as follows:

| | Lbs. |
|---|---|
| 40 miles @ 38 miles an hr., 210 lbs. pr mile = | 8,400 |
| 40 miles @ 24 miles an hr., 330 lbs. pr mile = | 13,200 |
| 40 miles @ 17 miles an hr., 490 lbs. pr mile = | 19,600 |
| Total | 41,200 |

It will be noticed that this considers the train to be run at the maximum speed which the engine can make on each grade or portion of track. If the speed be limited to 15 miles an hour uniformly, we should expect consumption as follows:

| | Lbs. |
|---|---|
| 40 miles on level @ 50 lbs. per mile = | 2,000 |
| 40 miles on ½% grade @ 190 lbs. per mile = | 7,600 |
| 40 miles on 1% grade @ 430 lbs. per mile = | 17,200 |
| Total | 26,800 |

This trip of 120 miles will, however, require eight hours for its completion, whereas the first schedule is a trifle over five hours. The coal consumption in the first case is over 50 per cent. greater than in the second case. The effect of speed upon the coal pile is clearly shown by following any of the grade lines in the diagram. The rate per mile on a ½ per cent. grade will be about as given below:

| | | | | |
|---|---|---|---|---|
| Miles per hour ..... | 5 | 10 | 15 | 20 |
| Coal per mile, lbs... | 150 | 160 | 185 | 250 |

The influence of loading is shown by the curves marked "Total tons up 1 per cent. grade."

At 10 miles an hr., 250 lbs. per mile for 1,000 tons.
" 10 " " " 325 " " " " 1,200 "
" 10 " " " 500 " " " " 1,400 "

When we near the limit of capacity of the engine, the difference is still more marked.

At 10 miles an hr., 630 lbs. per mile for 1,500 tons.
" 10 " " " 680 " " " " 1,520 "
" 10 " " " 720 " " " " 1,540 "
" 10 " " " 780 " " " " 1,560 "

Again, 1,600 tons can be hauled at five miles an hour with a consumption of 500 lbs. per mile, whereas 1,570 tons at 10 miles an hour will require 800 lbs. per mile, both cases being the maximum that the engine can do.

These examples give an idea of the variety of problems in fuel consumption which can be quickly solved by the aid of this diagram. It is true that a different diagram must be made for each class of engine, but this is a comparatively small matter. With the increase in speed and loads of the present day, the coal consumption becomes a topic of great interest, and when comparisons are made with previous schedules, there is an apparent decrease in the economy of fuel, unless the various points are duly considered, and as explained by the chart.

## Wind Pressure Involved in the Wreck of a High Bridge.*

BY C. A. P. TURNER, M. AM. SOC. C. E.

In view of the fact that the wreck of a well-braced iron or steel structure by wind is exceedingly rare, if, indeed, there is any previous record of such, the destruction of part of the so-called High Bridge over the Mississipi river at Smith avenue, St. Paul, Minn., is of special interest to the professional bridge engineer. This structure was designed supposedly to meet, with a reasonable factor of safety, the maximum wind loads required by a standard specification; and the utter destruction of a portion of it by wind pressure alone, in view of this supposed margin of safety, would lead to the presumption that the standard requirements do not produce a safe structure, unless it can be shown by reasonable computation that there was some weak joint or detail in the frame which would insure its destruction under the action of forces not materially greater than those which, nominally, it was designed to withstand.

The structure was built in 1887, according to general plans prepared by the City Engineering Department of St. Paul. Detailed drawings were made by the contractor, C. L. Strobel, M. Am. Soc. C. E., and the work was erected by Horace E. Horton, M. Am. Soc. C. E., of Chicago, Ill. The bridge is a deck structure of wrought iron, 2,770 ft. long and runs northwest and southeast. The northwest portion of the bridge is of the viaduct type, with riveted spans of 80 ft. and plate-girder tower spans of 40 ft. Four-leg towers alternate with two-leg bents. The portion of the viaduct over the river consists of four 250-ft. pin-connected deck spans of the subdivided Warren type, 30 ft. deep and 22 ft. from center to center of trusses. The floor beams are at 12 ft. 6 in. centers. The tower

*A paper presented at the meeting of the American Society of Civil Engineers, Dec. 7, 1904.

supporting the shore end of the southeast 250-ft. span has a base of 55 ft. transversely, and of 50 ft. longitudinally, and a height of 129 ft. from the top of the pier to the bottom chord of the truss. As these trusses were 30 ft. deep, the roadway at this point was 160 ft. above the pier and about 180 ft. above the water. From this tower toward the bluff there was one 170-ft. pin span and two 60-ft. plate-girder spans. These girder spans, the 150-ft. pin span, the supporting tower, and the 250-ft. pin span were overthrown.

The bridge carries a 25-ft. roadway and two 8-ft. walks. The flooring for the roadway consists of a sub-floor of 3¾-in. fir plank and a wearing floor 1¾ in. thick. The plank for the walks is 2¾-in. pine. The stringers are of steel, the roadway of nine lines of 12-in. built stringers; the flanges are each two L's, 2 by 2 by 5/16-in., with 5/16-in. webs. The stringers for the walks are 6-in. I's.

The trusses were designed for a live load of 80 lbs. for the roadway and for the walks of the 250-ft. spans, 90 lbs. for the 170-ft. span and 100 lbs. per sq. ft. for all shorter spans. The lateral bracing was designed for a pressure of 450 lbs. per lin. ft. of bridge, two-thirds of which was assumed to act on the loaded (upper) chord. The towers and bents were assumed to have a wind pressure of 150 lbs. per lin. ft. acting against them.

In addition to the top and bottom lateral systems, a fairly efficient system of sway rods was provided in the 250-ft. span, and all the details of the lateral and sway bracing seem to have been well worked out for the type of bracing used.

The 250-ft. span fell on its side, except at the end torn from its support on the two-leg bent (still standing), and this end was given a quarter twist in addition and fell or was blown a considerable distance from the tower. The plate-girder spans were pulled down the bank, and lay but little out of the line of the viaduct. The tower frame which was overthrown was badly twisted, and the position in which the columns fell, together with the manner in which the bolts were bent and broken, would seem to indicate that the end of the 250-ft. span resting on the two-leg bent was first pushed off its support, and that the wind, acting on the loose span with its 10,000 or 11,000 sq. ft. of exposed area (the planking was well fastened) and an extreme leverage of 250 ft., twisted from its base the tower bent supporting the other end, and the falling mass, in its descent, pulled the girder spans down the hill.

If the collapse occurred as outlined, a few figures on the twisting moment on the top of the tower may be interesting. Supposing the floor to be at such an angle to the wind that the effective pressure is, say, 10 lbs. per sq. ft., then the twisting moment $= 10 \times 10{,}000 \times 125$ ft. $= 12{,}500{,}000$ ft. lbs., an amount far in excess of the ultimate resistance of the tower.

The next point which would seem to invite attention is the detail of the connection of the end of the wrecked 250-ft. span to the two-leg bent, and the strength, or resistance of this connection to uplift and to lateral sliding of the shoe. There was a two-leg bent, similar to the one that supported the end of the wrecked span, nearer the other shore, and, as this seat was easily accessible by a trap in the floor, a suspended platform and an iron ladder leading down to the shoe, it was examined first. The end of the 250-ft. span corresponding to that which was wrecked was found to rest on a nest of eight rollers each about 2⅞ in. in diameter with the usual spacing bars on the sides. The only resistance to the lateral motion of the rollers was a bar riveted to the cap on each side and a recess in the shoe above, about ⅝ or ¾ in. deep, as nearly as could be readily determined. Provision was made for a 1½-in. guard bolt on each side of the shoe, a hole was provided in the column cap and a long slot in the side of the shoe. No bolts, however, were in place.

The column cap from which the 250-ft. span slid off on the leeward side of the bridge was also examined. But one roller was left on the windward cap, while seven of the eight remained on the leeward cap. Careful examination showed that this span was anchored down somewhat better than the one referred to above, and instead of having no bolts at all, there was one on the outside of the windward shoe which was splintered and broken in place. The appearance of the other three holes was positive evidence that there were no bolts in any of them.

There is, then, the resistance of this end of the span, reduced to the dead weight, and the value of this bolt. If the wind tended to raise the windward truss, as it is pin-connected with the eye-bar bottom chord and diagonals, the truss would furnish little resistance to upward forces, and the bolt at the end, being a cantilever from 3½ to 4 in. from the center of the shoe plate to the center of the bearing in the cap, would not develop its shear value, but only its bending value, an insignificant amount of 3,000 or 4,000 lbs. or less. An uplift on the windward side would be accompanied by a reversal of stress in the bottom chord, the probable buckling of the chord, and, with the slight resistance of the bolt, the shoe would be pulled from the cap and the rollers displaced, and this was what actually happened.

A rough approximate estimate of the weight of the span and floor would be in the neighborhood of 2,200 lbs. per lin. ft., giving a reaction of, roughly, 140,000 lbs. at each support. As the storm was a severe one, it will be assumed, for purposes of computation, that the very severe wind pressure of 30 lbs. per sq. ft. was acting at an upward angle to the floor of 30 deg., and the pressures will be calculated with Unwin's table.

Let $a$ = Angle of surface with direction of wind;

$F$ = Force of wind, in pounds per square foot (assumed at 30 lbs. per sq. ft.);

$A$ = Pressure normal to surface $= F \sin. a^{1.84 \cos. a - 1}$;

$C$ = Pressure parallel to direction of wind $= F \sin. a^{1.84 \cos. a}$.

For $a = 30$ deg., $A = 0.66$ and $C = 0.33$.

The direct uplift at each shoe $= 20.5 \times 125 \times 0.66 \times 30$ lbs. $= 50{,}100$ lbs. from the wind on the floor.

The overturning force, $C$, at each end of the bridge $= 0.33 \times 30$ lbs. $\times 41 \times 125 = 51{,}200$ lbs. from the wind on the floor.

The uplift from $C$ on the windward shoe $= \frac{51{,}200 \times 30}{22} = 70{,}000$ lbs.

The direct pressure on the side of the truss top chord, approximately, $= 30 \times 7 = 210$ lbs. per lin. ft., and $\frac{210 \times 125 \times 30}{22} = 36{,}000$ lbs. the uplift from the same.

As the wind has been assumed to be blowing upward, this component on the vertical area would give an additional uplift of some 6,000 lbs.

Now, the sum of these computed uplifts is 162,100 lbs., or about 15 per cent. greater than the reaction due to weight. Evidently, if the windward shoe is raised, there being no bolts to hold down the leeward shoe, it would turn sufficiently for the recess in the shoe to clear the corner of the rolls and then slide off the cap. Allowing some slight resistance for the expansion connection of the stringers to the beam, it would seem safe to conclude that the wind pressure assumed is 10 per cent. greater than would have been necessary to cause the wreck. Rough computations on the laterals, taking into consideration the sway rods and the action of the four planes of bracing, would indicate that they were not strained much beyond 23,000 to 25,000 lbs. under the assumed forces.

Bearing in mind the fact that the floor is on a steep up grade, it may well be that the angle of action of the wind on the floor was greater than has been assumed, and, if so, the necessary pressure to cause the wreck might be considerably less than the 27 lbs. per sq. ft. calculated. Again, the probability is that the assumption of a uniform pressure is materially in error. Judging somewhat by the contour of the bluff and the path of the storm, it would seem likely that the maximum pressure was in the vicinity of the northwest end of the wrecked 250-ft. span, and that the adjoining span was saved by its rigid connection to the two-leg rocker bent. If the pressure were greater at the end, it is evident that the average pressure necessary to cause the wreck would be materially less.

Such moderate pressures as have been figured on, when their cumulative effect is concentrated upon a weak detail, may evidently produce results that cause astonishment, and the rash assumption, by those whose training should lend better judgment, that the pressures involved are "exceedingly great."

Evidently, whether dealing with bridges or roofs, stiff riveted construction, with bottom chords and diagonals capable of taking reverse stresses is to be preferred, and, in view of the fact that, by the exercise of reasonable skill in design, they can be fabricated for a sufficiently smaller cost than the pin type to offset the additional expense of riveting in the field, they should be preferred for all moderate spans, such as 250 ft. or less, unless the work is exceptionally heavy.

In the provision for temperature stress, the expensive and frequently weak details often worked out to avoid a harmless little amount of temperature strain, in an effort to eliminate it entirely, are indeed surprising; perfect double-action toggle connections are too often introduced at the shortest possible intervals, and dignified by the name of expansion joints. In the present instance, for example, an ordinary sliding plate fitted with a compression grease cup would probably move as easily as the badly rusted rolls on a rusty base and cap; while the guard bolts would be brought into actual shear and tension under forces tending to displace the shoe instead of inbending as with the detail adopted. From a careful examination of the 2½-in. anchor bolts of the windward column of the fixed bent under the 250-ft. span, it would seem that they were without nuts, though this fact appears to have no material influence on the wreck.

## A Concrete Wall Eleven Years Old.

The photographic engraving shown herewith affords an interesting example of a durable concrete retaining wall, the structure having stood now eleven years and having shown no indication of cracks or signs of failure of any kind. It is a combined dam and tunnel portal, on the line of the Coast division of the Southern Pacific between Wright's and Laurel, 62 miles south of San Francisco, in the Santa Cruz mountains. The photograph has been sent to us by Mr. John D. Isaacs, Engineer of Bridges of the Southern Pacific, who, with the late W. G. Curtis, Engineer of Maintenance of Way, planned and carried out the work in 1893-4.

The tunnel is 1.16 miles long, and the portal is a short artificial tunnel joining the original tunnel where the latter enters the bedrock. As a result of the heavy rains in the winter of 1892-3 a landslide destroyed about 200 ft. of the tunnel at the north end, and

traffic was suspended for several months. At this place, a tributary to Los Gatos creek, which flows due east, is joined by a side creek flowing north. Both creeks are nearly dry in summer, but become torrents in stormy weather. The railroad track prior to the landslide crossed the side creek just at the mouth of the tunnel, and a few feet away from its junction with the north creek. At the time of the landslide the two creeks cut through the clay bed to the rock below, and the whole hillside, for some 300 feet back, slid forward toward Wright's station, filling the narrow throat between the points of rock at the tunnel portal. The entire mass seemed to be afloat on a film of water between the clay and bedrock, and the first 200 feet of tunnel was completely crushed in and taken with the slide. Numerous attempts to reconstruct the end of the tunnel and portal with heavy timber and iron all proved absolute failures. It was evident that the next winter would again bring trouble, so after much discussion it was finally resolved to re-establish and maintain the toe of the slide by raising the beds of the two creeks, and by constructing a concrete masonry retaining-wall or dam from the rock points, across the mouth of the tunnel. Accordingly a concrete retaining-wall was built, pierced by a tunnel running into and forming a part of the tunnel proper. The toe of the slide in question was re-established by filling in the beds of the two creeks, and by carrying the side creek from the south, behind the wall over the top of the tunnel and making it join Los Gatos creek at a spillway in the westerly side of the retaining-wall. Through this spillway the combined streams now discharge. The retaining-wall is about 28 ft. high from base of rail, 14 ft. thick at bottom and 2 ft. thick at the top. The tunnel through the same is oval in shape, and of varying thickness. To avoid hydrostatic pressure on the retaining-wall, it was backed by rubble masonry, covered with clay puddle, well rammed; and separate drains were run from the rubble and from the slide behind it through the retaining-wall. The same arrangement was followed with the masonry tunnel. As the tunnel cut through the slide it had to be arranged to transmit the thrust of the slide from south to north. The sides of the barrel were therefore carried down to bedrock, and a key-piece put in under the track. The earth was well tamped and rammed on both sides of the barrel, and the top of the tunnel was loaded with earth from 15 ft. deep, at a point 42 ft. back from the retaining-wall, to 25 ft. deep at its further end. In effect, the barrel was made part of the slide, and the slide provided with a toe.

The masonry is a concrete monolith, and all the concrete is mixed in the following proportion, by volume: One part Portland cement, two parts sand, three parts gravel and four parts rock broken small enough to pass through a 2-in. ring. All of that portion below the base of rail, except the key-piece under the track, has placed in it large pieces of rock varying from one-quarter to one cubic yard, as follows: A layer of concrete, 6 in. thick, having been first laid, and while yet soft, large rocks were placed upon it, with their best bed down, the rocks usually standing on one of their ends, leaving a clear space of about 18 in. between them, into which the concrete was afterwards rammed until the spaces were filled. Smaller stones were thrown in whenever room permitted, and rammed with the filling, but care was always taken to surround all rock with concrete. By placing the large stones smaller side down, it was thought that they would bed themselves better in the soft concrete. This method was carried out until the height of base of rail was reached; above that the same concrete mixture was used minus the large stones. The rock is a strong heavy blue trap, taken from the side of the road nearby. About one month was required for putting in the concrete. Segments and lagging were made of 2-in. plank; falsework, of 12 in. x 12 in timber. The tunnel is made large enough for a standard gage track. The entire wall, including the dam, contains about 108,000 cu. ft. of concrete. The falsework was allowed to remain in position during the winter of 1893-4, but was removed the following summer. The main point for engineering consideration regarding this work is, that it is now eleven years since the wall was built, and up to the present time the structure shows absolutely no indications of cracks or other sign of failure, and is apparently solid and good for all time. The white matter on the face of the wall in the photograph is the lime emission, not water or ice, as might be supposed.

A Concrete Portal and Spillway Eleven Years Old.

We are indebted to John D. Isaacs, Engineer of Bridges on the Southern Pacific, for the above data.

## The President on Railroad Questions.*

*Employers' Liability Law.*—The wage-workers are peculiarly entitled to the protection and the encouragement of the law. From the very nature of their occupation railroad men, for instance, are liable to be maimed in doing the legitimate work of their profession, unless the railroad companies are required by law to make ample provision for their safety. The Administration has been zealous in enforcing the existing law for this purpose. That law should be amended and strengthened. Wherever the national Government has power there should be a stringent employers' liability law, which should apply to the Government itself where the Government is an employer of labor. . . . I recommend that the Congress appoint a commission to make a comprehensive study of employers' liability, with the view of extending the provisions of a great and constitutional law to all employments within the scope of Federal power.

*Medals of Honor.*—The Government has recognized herosim upon the water, and bestows medals of honor upon those persons who by extreme and heroic daring have endangered their lives in saving, or endeavoring to save, lives from the perils of the sea. This recognition should be extended to cover cases of conspicuous bravery and self-sacrifice in the saving of life in private employments under the jurisdiction of the United States, and particularly in the land commerce of the nation.

*Prevention of Accidents.*—The ever-increasing casualty list upon our railroads is a matter of grave public concern, and urgently calls for action by the Congress. In the matter of speed and comfort of railway travel our railroads give at least as good service as those of any other nation, and there is no reason why this service should not also be as safe as human ingenuity can make it. Many of our leading roads have been foremost in the adoption of the most approved safeguards for the protection of travelers and employees, yet the list of clearly avoidable accidents continues unduly large. The passage of a law requiring the adoption of a block-signal system has been proposed to the Congress. I earnestly concur in that recommendation, and would also point out to the Congress the urgent need of legislation in the interest of the public safety limiting the hours of labor for railroad employees in train service upon railroads engaged in interstate commerce, and providing that only trained and experienced persons be employed in positions of responsibility connected with the operation of trains. Of course nothing can ever prevent accidents caused by human weakness or misconduct; and there should be drastic punishment for any railroad employee, whether officer or man, who by issuance of wrong orders or by disobedience of orders causes disaster. The law of 1901, requiring interstate railroads to make monthly reports of all accidents to passengers and employees on duty, should also be amended so as to empower the Government to make a personal investigation, through proper officers, of all accidents involving loss of life which seem to require investigation, with a requirement that the results of such investigation be made public. The Safety Appliance law has proved beneficial to railway employees, and the force of inspectors provided for by appropriation should be largely increased. This service has passed the experimental stage and demonstrated its utility, and should receive generous recognition by the Congress.

*Freight Rates.*—We must strive to keep the highways of commerce open to all on equal terms; and to do this it is necessary to put a complete stop to all rebates. Whether the shipper or the railroad is to blame makes no difference; the rebate must be stopped, the abuses of the private car and private terminal track and side-track systems

*Extracts from the annual message to Congress of President Theodore Roosevelt.

must be stopped, and the law which declares it to be unlawful for any person or corporation to offer, grant, give, solicit, accept, or receive any rebate, concession, or discrimination . . . must be enforced. . . . As the law now stands the commission simply possess the bare power to denounce a particular rate as unreasonable. While I am of the opinion that at present it would be undesirable, if it were not impracticable, finally to clothe the commission with general authority to fix railroad rates, I do believe that, as a fair security to shippers, the commission should be vested with the power, where a given rate has been challenged and after full hearing found to be unreasonable, to decide, subject to judicial review, what shall be a reasonable rate to take its place; the ruling of the commission to take effect immediately, and to obtain, unless and until it is reversed by the court of review. The Government must in increasing degree supervise and regulate the workings of the railroads engaged in interstate commerce, and such increased supervision is the only alternative to an increase of the present evils on the one hand or a still more radical policy on the other. In my judgment the most important legislative act now needed as regards the regulation of corporations is this act to confer on the Interstate Commerce Commission the power to revise rates and regulations, the revised rate to at once go into effect, and to stay in effect unless and until the court of review reverses it.

Steamship companies engaged in interstate commerce and protected in our coastwise trade, should be held to a strict observance of the interstate commerce act.

## Railroad Shop Tools.

*(Continued.)*

### LOCOMOTIVE FRAME DRILL.

The four-spindle lomocotive frame drill, Fig. 1, is made by the Niles-Bement-Pond Company, New York. Each head is driven by an independent motor, thus making it possible to drive each drill at its most economical speed. The speed range is obtained by gearing and by field control in the motors. The spindle heads are mounted on arms projecting from the cross-rail and have an in-and-out adjustment of 20 in. The arms can also be adjusted along the cross-rail so that when a locomotive frame is once clamped, holes may be drilled in any position. One of the heads is arranged to swivel so that work may be drilled at any angle. The spindles are counterweighted and have variable power feeds.

The maximum distance between the spindles is 24 ft. The spindles have a 20-in. traverse, six positive gear feeds and speeds from 15 to 250 revolutions per minute. The swiveling saddle has an adjustment in-and-out from the cross-rail of 16 in., and the plain saddles an adjustment of 20 in. The table is 26 ft. long and the top and vertical faces have T slots for holding frames in a horizontal plane.

The motors are of 5 h.p. capacity and have

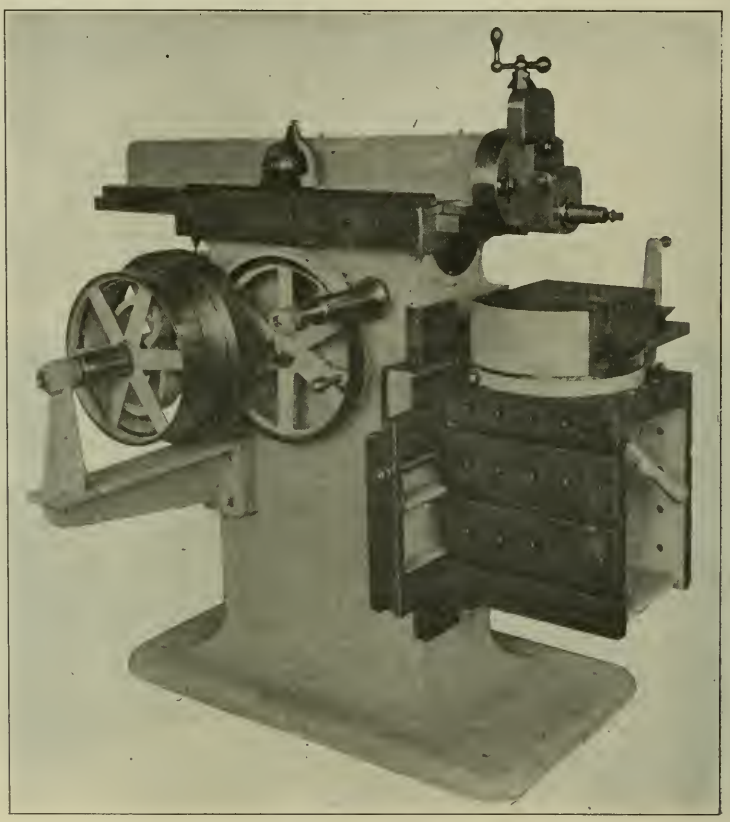


Fig. 2—The Hendey 24-in. Shaper.

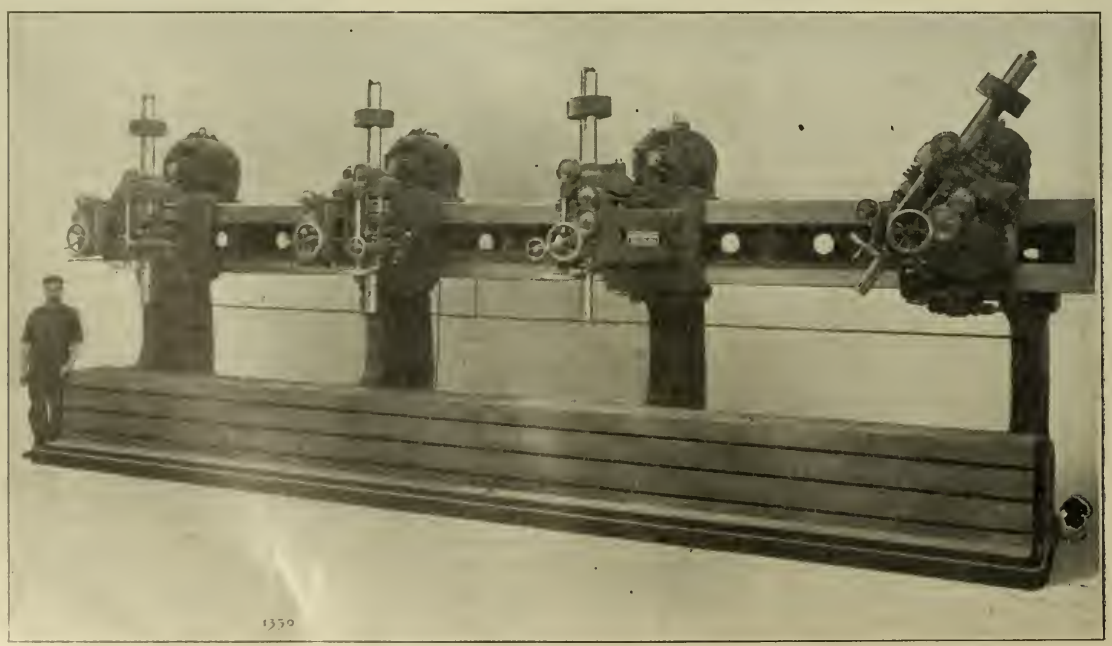


Fig. 1—Niles-Bement-Pond 4-Spindle Locomotive Frame Drill.

a speed range of 1 to 2 by field control. The machine illustrated was built for the Canadian Pacific Railway.

SHAPING MACHINES.

For planing small pieces the shaping machine is much quicker and easier to handle than the planer, and aside from this it takes less floor space, and when fitted with tilting table, swivel vise, index centers and a cone mandrel having a power rotary motion this type of machine may be used to advantage for a great many special purposes. In the ordinary pillar shaping machines the work is fed under the tool by movement of the table. In the traverse or traveling-head shaping machines the cutter bar is carried in the head which travels along the bed. The head is usually supplied with both hand adjustment and variable power feed. The traveling head shaping machines are made with either one or two heads and as a rule the cutter bars in all types of shapers have quick return and are adjustable for any length or position of stroke. The tool slides have a vertical adjustment, and swivel to any angle.

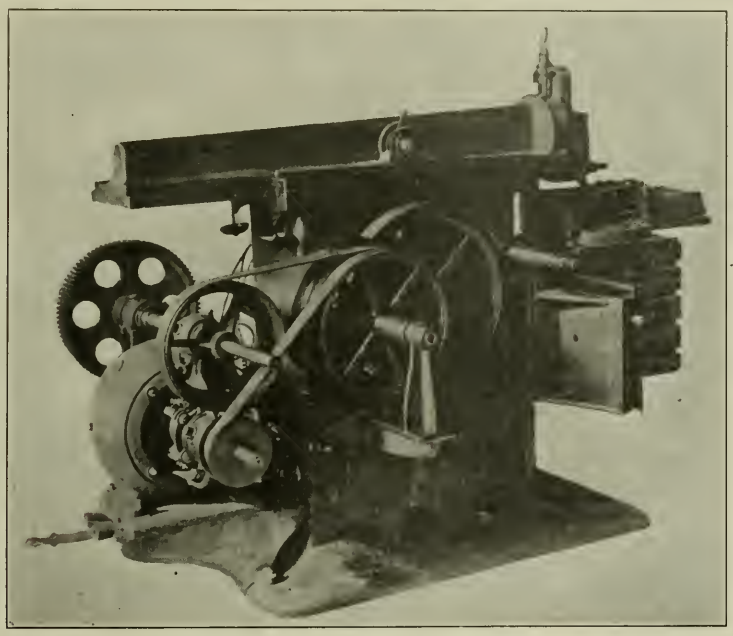


Fig. 3—The Hendey 24-in. Shaper.

The 24-in. pillar shaper shown in Fig. 2 is made by the Hendey Machine Company, Torrington, Conn. It is suitable for both light and heavy work, has a stroke of 24 in., and will plane work 17 in high. A cross feed of 23 in. is provided for the table and the tool has a vertical adjustment of 5 in. The minimum stroke at which the machine will reverse and feed is ½ in. The cutting speed is uniform through the entire stroke. The feed mechanism and the dogs for changing the length of stroke are easily accessible and can be adjusted by the operator from his position in front of the machine. Automatic, horizontal, vertical and angular feeds are provided and there is a space under the cutter bar large enough to admit the passing through of a piece of work 3¼ in. in diameter. This will be found useful when cutting key seats and other work of like nature. The table is a solid casting 16½ in. x 12 in. It has bolt slots ¾ in. wide on each side as well as on the top. The driving shaft has an extra outside support, which relieves the bearings of all undue strain. The vise swings in a ring; it is graduated and has steel-faced jaws, and will take in work 9½ in. wide. The tool post of this machine will take a tool ⅝ in. x 1¼ in. The size of the tight and loose pulleys on the countershaft is 12 in. x 3¼ in., and they should run at 225 r.p.m. The weight of the machine is 2,470 lbs. The method of applying an individual motor drive to the machine is shown in Fig. 3. The motor used is of the back-geared type and it is belted direct from the high-geared commutator shaft to the reversing pulley of the shaper. The motor is run at constant speed and changes of speeds for the cutting stroke of the ram are obtained by means of the two-step-cone pulley on the shaper and back gear shafts. The bracket carrying the motor is bolted to the rear of the shaper base as shown. It has a sliding plate upon which the motor is mounted and which affords a quick means of tightening the belts. This method of mounting the motor practically takes no additional working space as the ram at its full return stroke overhangs the motor and bracket at the rear.

These shapers are made in four sizes, as follows: 15 in., 20 in., 24 in. and 28 in. respectively. A one h.p. motor is required to drive the 15-in., 2 h.p. for the 20 and 24-in. and a 3 h.p. for the 28-in.

The 25-in. back geared crank shaper shown in Fig. 4 is made by The John Steptoe Shaper Company, Cincinnati, Ohio. This machine can be operated either as a single-geared or a back-geared shaper; changes from one run of gears to the other are made by a lever in the back of the machine and within easy reach of the operator. There are 10 changes of cutting speed to the ram and the ram has a bearing in the column of 36 in. An opening under the ram admits shafts up to 3½ in. in diameter. The stroke of the ram can be changed or adjusted while the machine is in motion and a graduated index which shows the length of the stroke the machine is taking, is attached to the top of the column. The head is graduated and can be loosened and swiveled to any angle, by pushing the lever at the back of the head and can again be fastened by pulling the lever towards the operator. This will be found an improvement over the method of fastening the head with bolts, as it saves the time of the operator looking for wrenches and the time of opening and fastening the bolts. The top of the table is 16 in. x 25 in. It is slotted on all three sides and can be readily removed, allowing work to be fastened to the slotted apron to which the table is attached. An outer support is attached to the bottom of the table; it can be removed when desired and is provided with a screw adjustment, locknut and swivel base which slides freely along the planed surface on the base of the machine. The table has an automatic cross feed of 27½ in. and a vertical adjustment of 14 in. A 9-in. feed is provided for the tool block. All feeds are automatic and can be changed while the machine is in motion. The vise is graduated and will swivel to any angle. The steel-faced jaws are 2¼ in. deep x 12 in. wide, and have a maximum opening of 15 in. The cone-pulley has five steps for a 3¼ in. belt. The tight and loose pulleys on the countershaft are 14 in. in diameter for a 4 in. belt and should run at 125 r.p.m.

*(To be Continued.)*

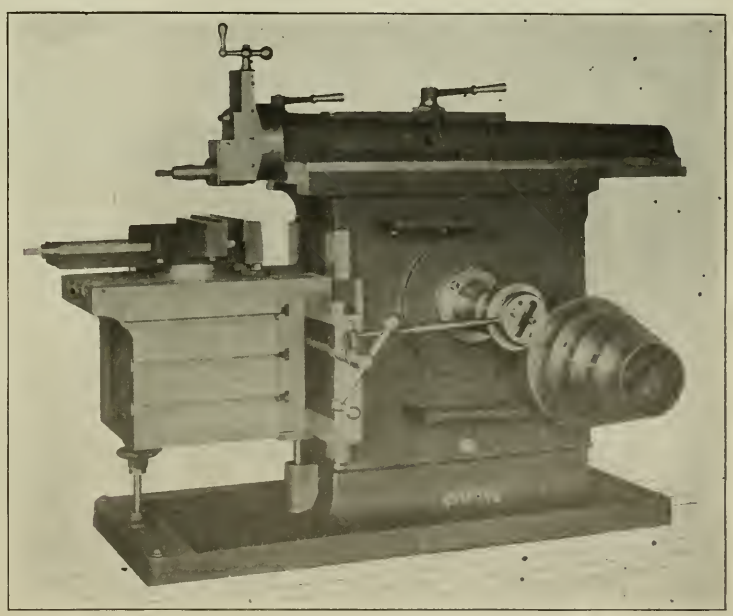


Fig. 4—The Steptoe Back Geared Crank Shaper.

## A Twist Drill Dynamometer.*

The introduction of the high-speed twist drill into modern machine shop practice has brought with it many new problems, and to supply some of the data necessary for their solution the machine which is the subject of this paper was designed and constructed. It was taken as a thesis subject by Mr. George F. Read, Jr., of the class of 1904 at the Worcester Polytechnic Institute, and some of the preliminary work was done by him. All the experiments here reported, however, were conducted by the authors at the Washburn shops of the institute.

The machine is really a double dynamometer, measuring the twist or moment and the thrust of the drill. It consists of a chuck with trunnions, mounted or roller bearings so that it is free to revolve about its axis at the same time it is free to move in the direction of its axis, being mounted on a carriage which is on rolls resting on the frame of the machine. This frame was placed on the table of a milling machine so that the axis coincided with the center line of the drill, which was driven by the spindle of the milling machine. The thrust of the drill is transmitted through the trunnion of the chuck to a plunger which is fitted into a long cylinder filled with oil. At the end of this cylinder is a smaller one also carrying a plunger. This small plunger is attached to a ball-bearing piston in a regular indicator. The drum of the indicator moves proportionately to the feed so that the card taken is a record of the thrust during the drilling of a hole. The chuck is held from turning by a steel band which is attached by a yoke to a second indicator, and a card from this one shows the twisting moment at each stage of the operation. Both indicators were calibrated before and after the tests. The correct moments were obtained by hanging known weights over the chuck and noting the rise and fall of the pencil point. The thrust cylinder was placed in an Emery testing machine and known loads applied and a corresponding record taken on the cards. From these tests, curves were plotted so that readings from the cards could be readily reduced to pounds.

It was decided to take up first the drilling of cast iron with high-speed steel. Blocks of soft gray iron were obtained and tested in the machine itself so as to get a number for each set of experiments as near the same degree of hardness as possible. A ⅝-in. Novo steel drill was taken as a good representative of the new steels. The first experiments were on the effect of speed or number of revolutions per minute, all other conditions remaining the same. The revolutions were varied, from 140 to 600, but no material difference was shown by the cards in either thrust or twist. In other words, the power required to turn the drill varies directly with the number of revolutions, while the thrust does not increase with the speed, but depends upon the feed or the advance per revolution.

The next set of experiments was made to determine the relation between thrust and feed, the revolutions per minute remaining constant. From the first set of experiments it was shown that the limit of speed would depend upon the endurance of the drill, and with heavy feeds 420 revolutions was not far from this limit. Accordingly the second set was run at this speed, which for a ⅝-in. drill is about 70 ft. per minute for the cutting rate for the outer edges and for .020-in. feed a rate of drilling of about 8 in. per minute. The range of feed was taken from .004 to .020 in. per revolution, the drill at the coarsest feed being somewhere near its limit. These feeds were all positive, a train of gears being substituted for the regular belt drive. The following table shows the results:

*Table* 1.

| Feed, in.† | .004 | .006 | .008 | .010 | .012 | .014 | .016 | .018 | .020 |
|---|---|---|---|---|---|---|---|---|---|
| Thrust,‡ | 240 | 280 | 330 | 360 | 410 | 460 | 525 | 620 | 725 |
| Moment§ | 55 | 67 | 83 | 92 | 103 | 115 | 124 | 132 | 138 |

†Per revolution. ‡Total in lbs. §Total in in.-lbs.

Fig. 1 gives the same data for thrust and feed in the form of a curve and shows that the thrust increases very rapidly with the coarser feeds. Fig. 2 is a curve giving the relation between moment and feed, and shows that the moment does not increase at the same rate as the thrust. This would seem to indicate that less power is required to drill a given hole in a given time by increasing the feed per revolution rather than by increasing the revolutions. For example, to drill a hole in a 1-in. plate in 10 seconds could be done by running the drill 600 r.p.m. and feeding .010 in. per revolution, but would require more power than by running at 300 revolutions with a feed of .020 in.

The question of the proper angle of the drill was next considered, and a set of experiments made with a constant speed and feed, the half-angle varying from 37 deg. to 70 deg., 22 deg. less and 11 deg. more than the standard 59 deg. The following table shows the results:

*Table* 2.

| Angle of drill, degs | 37 | 45 | 50 | 55 | 59 | 65 | 70 |
|---|---|---|---|---|---|---|---|
| Thrust in lbs. | 215 | 225 | 240 | 260 | 290 | 325 | 375 |

Fig. 3 is a curve for the same and shows that the thrust would be decreased by having more of a point on the drill. With an angle of 37 deg., however, the drill would not stand up on repeated work. At 45 deg. it seems to do the work as well as at 59 deg. and with much less thrust. This would suggest a change in the standard angle for the new steels. The moment for the various angles remained practically constant, so that the driving power does not change with the angles of the drill.

Another interesting point in drilling which was shown with this machine is the effect of first removing the center of a hole by the use of a small drill. Ten holes were drilled in a bar of cast iron with small drills, ranging from No. 53 to ½ in. in diameter and then each one counterbored with a ⅝-in. drill at 420 r.p.m. and a feed of .008 in. per revolution.

Table 3 gives the thrust in each case and shows that a hole $^1/_{10}$ in. in diameter takes off about one-half the thrust for a ⅝-in. drill.

*Table* 3.

| Size of first hole: | .060 | .0595 | .076 | .0935 | .120 | .157 | .189 | .221 | .250 | .375 | .50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Thrust for counterbore: | 340 | 190 | 180 | 170 | 155 | 145 | 130 | 120 | 90 | 70 | 30 |

The range of experiments is almost limitless, and to cover the entire field for feed,

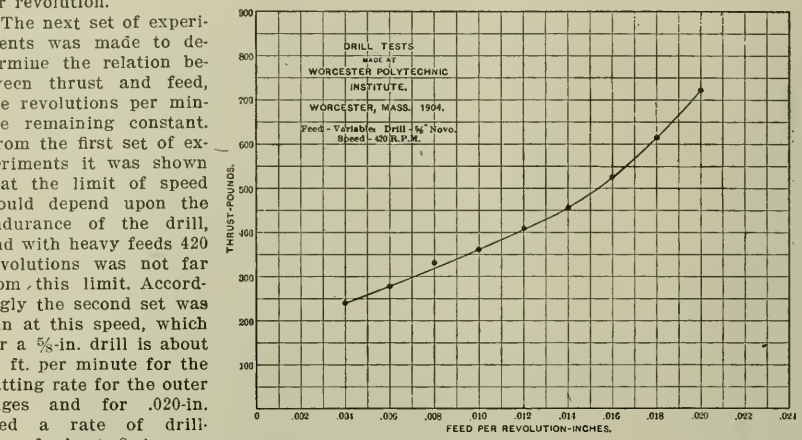



*Fig.* 1.

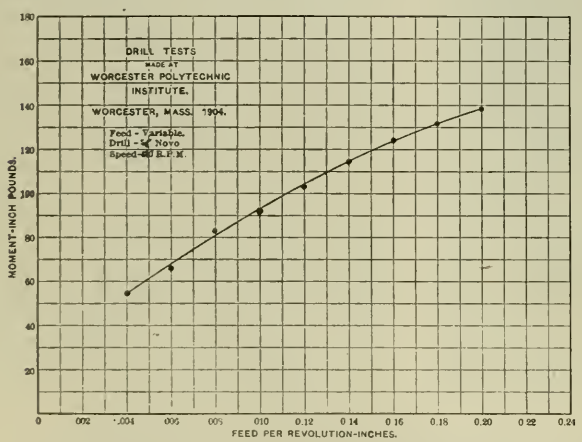



*Fig.* 2.

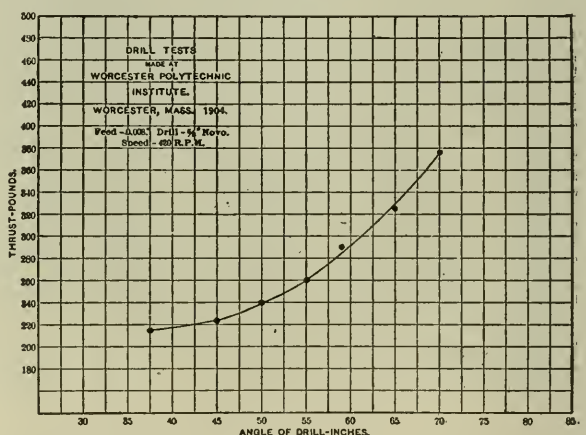



*Fig.* 3.

Results of Twist Drill Dynamometer Test.

*Extract from a paper by William W. Bird and Howard P. Fairchild read at the New York meeting of the American Society of Mechanical Engineers, December, 1904.

speed, angle of drill, etc., for various materials and all kinds and sizes of drills will require much time and many tests. Some of the data so far acquired are here reported with the hope that others may add to it, as well as suggesting lines for further experiments.

## Pro-Rating with Shippers' Railroads.

The decision of the Interstate Commerce Commission concerning the excessive divisions allowed by certain railroads in Chicago to short industrial railroads owned by large manufacturers, holding that such divisions are unlawful, was given in the *Railroad Gazette* of November 18 (page 156, News Section). From the full text of the report, which is now at hand, we quote the following paragraphs, in which the reasoning of the decision is more fully set forth.

The vice in the present case is to be found in the thing done, not in the manner of doing it. A cardinal purpose of the Act to regulate commerce is to prohibit all preference between shippers, and the framers of that Act and its amendments have evidently attempted to make the language sufficiently comprehensive to render every sort of preference, by whatever means attempted, unlawful. The second section of the original Act provides that no greater compensation shall be collected of one shipper than of another "by any special rate, rabate, drawback, or other device." The third section provides that it shall be unlawful for a common carrier subject to the Act to grant any undue preference to any individual or any specie of traffic "in any respect whatsoever." The amendment of the Act, approved February 19, 1903, commonly known as the Elkins Bill, requires carriers in all cases to publish their tariffs, and prohibits, under severe penalty, any practice upon the part of the carrier "whereby any such property shall, by any device whatever, be transported at a less rate than that named in the tariff, * * * or *whereby any other advantage is given or discrimination is practiced.*"

We think these divisions, if not in violation of the express language of the second section of the original Act, are plainly within the prohibiton of the Elkins Bill. When the Santa Fe pays to the Illinois Central $12 for moving a car loaded with the traffic of the International Harvester Company from the McCormack works to its Corwith yard, a service for the performance of which $3 is a reasonable compensation, which was never exceeded previous to January 1, 1904; and when it does this in order to obtain the traffic of the International Harvester Company, it thereby grants that company in effect a rebate of $9 upon that carload of freight. It certainly is guilty of an act by which an advantage is given and a discrimination is produced in favor of the International Harvester Company. The manifest intention of the Act to regulate commerce, especially as expressed in the Elkins amendments, is to strike through all pretense, all ingenious device, to the substance of the transaction itself; and where excessive divisions of rates are granted by a carrier to another carrier owned and controlled by a shipper, for the purpose of obtaining the traffic of that shipper, they benefit the shipper and operate as a rebate or other device to cut the tariff charge in violation of the law.

It is urged that all this is simply an arrangement betwen two connecting railroads; that there is no negotiation with the shipper, and no payment to the shipper. This is a mere play upon words. The Illinois Northern Railroad Company and the International Harvester Company are one and the same thing. It is entirely immaterial whether this money goes in the first instance into the treasury of the International Harvester Company or that of its creature, the Illinois Northern Railroad Company. That subterfuges of this sort cannot avail has been often decided, and was affirmed within the year by the Supreme Court of the United States in Interstate Commerce Commision v. Baird, 194 U. S. 25, 48 L. ed. 860, 24 Sup. Ct. Rep. 563, in which it was held that it made no difference whether certain contracts were entered into with a railroad company itself or with a coal company the stock of which was entirely owned by the railroad company.

The Chicago, Lake Shore & Eastern, as found, is the creature of the United States Steel Corporation. The questions presented by its operations differ from those already discussed, chiefly in that the practices are of longer continuance and of wider scope. The International Harvester Company, through the medium of its railroads, obtains no divisions whatever from eastern lines; but the United States Steel Corporation, with its greater power, has been able to force from eastern connections divisions on all business. The International Harvester Company has not yet been able to compel the railroads which handle its traffic to maintain its tracks or perform its switching service within its iron working plant at South Chicago; but the Illinois Steel Company has for the last eight years obtained from the railways transporting its traffic compensation for the maintenance and operation of the miles of track which are located within its private works. In this respect the Steel Trust, to use the popular expression, is as far in advance of the Harvester Trust as the latter company is ahead of the ordinary shipper.

## The Block System on the Vandalia Line.*

About two and one-half years ago our freight traffic became very heavy and we found that on certain portions of our road we were moving 70 trains a day. Between Indianapolis and Terre Haute, 73 miles, with two coal mine districts, traffic is always heavy. We found that we were moving as much traffic as certain double-track lines, though we had not one inch of double-track, even in the yards. All of a sudden, hardships began to rain on us thick and fast. The good luck with which the Vandalia Line is credited, seemed to have left us entirely; our oldest and best conductors and enginemen forgot their orders and overlooked trains of superior right, and with very disastrous results. In one case an operator failed to deliver an order and caused one of the greatest disasters the Vandalia Line has ever seen in the way of a collision.

Things got into bad shape. Enginemen seemed over-cautious and passenger trains lost time. Engine failures became numerous and side tracks and yards were packed with cars. The train despatchers became discouraged because they were unable to keep up with their work. Finally it was decided at least to put an end to the collisions, and the use of the block system on a number of other roads was investigated.

Mr. Davis then goes on to describe what he found on the Chicago & Alton, the Cincinnati, New Orleans & Texas Pacific, the Chicago, Milwaukee & St. Paul and the Philadelphia & Reading. On those parts of the Alton where automatic signals are used, the switches have audible indicators. On all Alton passenger trains a speeder (three-wheel velocipede hand-car) is carried, and whenever a train is stopped by a signal the flagman immediately goes ahead on the speeder and the train follows a safe distance behind at the rate of 15 miles an hour.

The C., N. O. & T. P. also has audible indicators and uses the Alton method of flagging. "Now and then the flagmen will meet on their speeders, shake hands and compare orders, and find that someone has made a pretty serious error." The officers of the company are of the opinion that the automatic signals have saved for their company many times their cost by the prevention of collisions.

On the C., M. & St. P. Mr. Davis found blinders over the lights in signals for a diverging route, which does away with running enginemen against red lights when the main line is clear. The Philadelphia & Reading has manual block signals in only one place; this is at a gauntlet over a bridge. With automatic signals the Reading uses a visual indicator at switches. For train orders a small semaphore is used, and it is so connected with the nearest automatic (disk) block signal that when put on it causes the latter to indicate caution.

Mr. Davis then briefly described the signaling on the single-track line crossing the Louisville bridge between Louisville, Ky., and New Albany, Ind., which has been in use 22 years (described in the *Railroad Gazette* of Feb. 19, 1886). During this time there has been no failure of any kind on account of the method of blocking. In one day of 24 hours 225 trains have been handled. On this short single-track line all signals are given on orders from a single train despatcher, who, besides his train sheet, has a graphic record in the shape of a board, with plugs stuck in holes to indicate trains. Except in one crooked block (No. 4) trains are run under permissive signals, when necessary.

On the Nashville, Chattanooga & St. Louis, where the block system is in use for six miles, between Chattanooga and Wauhatchie, the clearing of a signal causes a red disk to drop in front of the operators at both ends of the block section which is thus cleared. If, while this disk is visible, either operator attempts to admit another train, he sounds an alarm bell, warning him of his mistake. Mr. Davis speaks well of the block signaling on the Erie lines in Ohio, where all movements of the block operators are directed by the train despatchers, the despatchers having their territories made very short in order to permit this. Train orders, train rights and train rules prevail, however, just the same as though no block system existed. Here is used the Mozier apparatus for cutting out the telegraph key during the time that the signal is clear, so that the operator cannot accept new orders from the despatcher. Mr. Davis went on to describe the practice on a number other roads, and mentioned the apparatus lately put in use on the Illinois Central between Belleville and Corbondale, Ill., and between Paducah and Central City, Ky. With this apparatus, made by the General Railway Signal Company, the operators at the opposite ends of a block control each other, but the signals are not controlled by the trains.

The Vandalia did not feel able to put in automatic block signals, and so the manual block system was adopted. It is worked according to the rules prescribed by the American Railway Association. Signal towers were erected at suitable places, and as fast as four or five of these were completed Mr. Davis instructed the operators in the method of signaling. By connecting one wire to a number of offices he could sit at a central office and watch the work of the several operators. Three-position semaphore signals are used.

Before the work of installation was entire-

*Abstract of an address delivered before the St. Louis Railway Club, Nov. 12, by John L. Davis, Division Operator and Chief Train Despatcher, Vandalia Line.

ly completed there was noticeable a great difference in the movement of trains: it seemed the men realized all at once that they were protected, and faster time resulted from that time on. Our overtime began to decrease and continues to decrease. During the months of August and September of this year we decreased our overtime to the extent of fifteen hundred dollars each month, as compared with the same months of last year. The actual figures taken from our train sheets show that the number of freight trains handled in the six months, ending with September 30, 1904, decreased 301 over the corresponding period of last year. At the same time, the number of passenger trains run increased 923 (from 2,627 to 3,560). With that enormous increase in passenger traffic, it would only be reasonable to expect slower movement on a single track road, but the movement of our freight trains and the movement of our passenger trains has been accelerated to a remarkable degree.

It is proper to say, however, that this is not entirely due to the introduction of block signals, as three miles of double track was laid at Terre Haute, 2½ miles at Indianapolis and 10.8 miles entering East St. Louis. Mr. Davis, however, says that the second track can have full credit and still leave enough glory for the block system; and he recommends it for use "on nearly any single track railroad in existence."

In closing, Mr. Davis reminded his hearers that the fact that numerous collisions occurred before the block system was adopted did not necessarily mean the worst record in the world; and he said that the only paying passenger ever killed on the Vandalia by a train accident, in its half century of existence, was one killed in 1895 in a derailment due to a broken rail. He thinks that the manual block system will be much more popular, for single track lines, than the automatic, for the reason that the operators are useful in handling the trains. A competent operator at each important side track means frequent saving of time for freight trains, which may amount to hours when the time of the whole of a trip is considered.

The reports of the traffic and extension of the Russian railroads in the first half of 1904 indicate much less disturbance by the war than might have been expected. The length worked was indeed 2,183 miles (nearly 6 per cent.) more than in 1903, and amounted to a total of nearly 40,000 miles, this including the Finnish and Manchurian as well as the Russian lines. Moreover, nearly 4,400 miles were under construction this year, which is 330 miles more than last year. The gross earnings of all the railroads increased a little more than 1 per cent., but there were great differences on different lines, the St. Petersburg & Moscow road, the greatest of Russian trunk lines, having a decrease of no less than 12 per cent. There was a decrease of more than 3 per cent. on the Siberian Railroad, and a large increase on the Asiatic Midland.

### Friestedt Steel Sheet Piling.

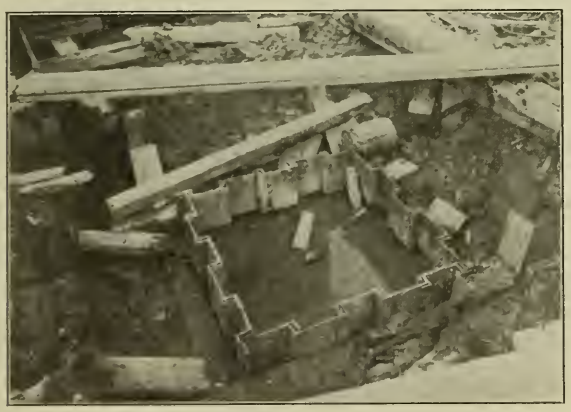
Open-cut sinking for foundation excavations has always been considered the safest and cheapest method possible to adopt. But in most every case where depths exceeding 50 ft. had to be reached, it was impracticable, owing to the instability of wood sheeting as a retaining, as well as a driving, device. Where quicksand, coarse gravel, hard-pan, small boulders or loose wreckage was encountered, wood sheeting could not be used on account of lack of penetration and impossibility to interlock the joints. The tongue-and-groove joints were inadequate and gave an imperfect alinement of the sheeting, leaving a loosely fitting joint through which water or quicksand could pass. This, and the constantly increasing cost of timber in lengths sufficient to make sheeting of the proper dimensions, became a cause of some concern to engineers and contractors, and a substitute for the wood sheeting was in demand. Of course, there remained the alternative method of the pneumatic caisson, but this is an expensive device, with its equipment of bulkheads, air system, etc.

It was in response to this demand that interlocking steel sheet piling first made its appearance. One of the earliest as well as most successful of the designs of this type of piling is the Friestedt system, and the accompanying illustrations show some of the varied uses to which it has been, and is being, put. One of the largest and most important applications was the construction of the cofferdam for the foundation of the power station of the Union Electric Light & Power Company on the Mississippi River at St. Louis. This dam was 360 ft. long, 40 ft. wide and 50 ft. deep. It is understood that the steel piling was resorted to after other methods had failed.

An equally interesting application was in connection with the construction of a 30-ft. core wall across the Hackensack River to form a reservoir for the Hackensack Water Company at Hillsdale Manor, N. J. The piling was driven to stop an underground flow through boulders and coarse gravel. The line of piping was 1,600 ft. long, 50 ft. lengths being used. A concrete retaining wall was built on top of and enclosing the piling. The engraving shows a part of the line, the irregularity of the tops being due to the fact that each pile was driven "until refusal."

Interlocking Piling Driven to Stop Leaks in a Reservoir Core Wall.

A nice piece of driving is shown in the illustration of the foundation work for Marshall Field & Company's warehouse in Chicago. Eight of these caissons were sunk, the size being 5 ft. 7 in. square by 40 ft. deep. Several railroads are making use of the piling, including the Burlington, the Missouri, Kansas & Texas and the Louisville & Nashville. The cofferdam construction used by the Burlington for the Cuivre River bridge on the Old Monroe-Mexico Cut-Off, described in our issue of the 2d inst., is included in the illustrations. The United States, Great Britain and the Dominion of Canada have adopted this piling in government work, and it was recently specified for over 1½ miles of breakwater construction shortly to be begun in the harbors of Toronto and Hamilton, Ontario. The Friestedt Interlocking Channel Bar Company has its office at 1410 Tribune Building, Chicago.



Interlocking Channel Foundation Caisson.

Cofferdam 360 ft. Long Built of Interlocking Channel Piling.

RAILROAD GAZETTE

## FEDERAL RATE REGULATION.

The question of Federal rate regulation has been a favorite theme for many years with the farmers of the Northwestern States and with the Interstate Commerce Commission, but this fall it received a new impetus, which started in Minnesota and Wisconsin and culminated in the President's message. The text furnished by Mr. Roosevelt, which has inspired so many sermons in the last few weeks, is as follows:

> While I am of the opinion that at present it would be undesirable, if it were not impracticable, finally to clothe the commission with general authority to fix railroad rates, I do believe that, as a fair security to shippers, the commission should be vested with the power, where a given rate has been challenged, and after full hearing found to be unreasonable, to decide, subject to judicial review, what shall be a reasonable rate to take its place; the ruling of the commission to take effect immediately, and to obtain unless and until it is reversed by the court of review. The government must in increasing degree supervise and regulate the workings of the railroads engaged in interstate commerce, and such increased supervision is the only alternative to an increase of the present evils on the one hand, or a still more radical policy on the other. In my judgment the most important legislative act now needed as regards the regulation of corporations is this act to confer on the Interstate Commerce Commission the power to revise rates and regulations, the revised rate to at once go into effect, and to stay in effect unless and until the court of review reverses it.

This paragraph from the message has been printed in the *Railroad Gazette* before, but it is well to have the President's exact words in mind, for it is foolish to ignore the fact that they are going to carry great weight with Congress. Much stress is laid upon the distinction between vesting the Commission with general authority to fix rates, which is called undesirable, and giving it power to say what shall be a reasonable rate, subject to judicial review, after it has investigated a previous rate with regard to which complaint had been made. This distinction is evidently intended to allay the fears of those who view extension of Federal control with alarm, but it is quite clear that it does not diminish the tremendous power which it is proposed to put in the hands of the Commission, for the right to make the original rate would, of course, be equally subject to review by the courts.

The objections to placing this rate-making power with Congress—for if the rates are to be established by a body created by Congress they are, of course, to be established by Congress—have been pointed out again and again. Here is a commission which cannot well contain a railroad man (the Interstate Commerce Commission never yet has contained one, and public opinion is strong that it should not), yet it must be responsible for the most technical question in regard to railroad traffic, with the all-important distinction from the work of actual railroad men, that any mistakes it makes must be paid for by some one else. Such a commission, as has been said in these columns, would have the power to destroy or to build up industries, lines of trade or communities, but would be itself subject to political appointment. After the Northern Securities decision, President Roosevelt virtually announced to the country through Attorney-General Knox, that he did not intend to run amuck, but when one considers the majority by which Mr. McKinley defeated Mr. Bryan in 1900, it is terrifying to think what the Interstate Commerce Commission might do in the hands of a president who did intend to run amuck. Corporations are always unpopular, and the railroads, as among the largest of corporations, are among the most unpopular. Suppose, for example, that the proposed power is given to the Commission, and then in 1908 some presidential candidate with Populistic tendencies bases a sensational campaign on what he is going to do to the railroads with the Interstate Commerce Commission when he gets into office—and suppose he gets into office! There is an astonishingly large number of people throughout the country who would support such a movement, and it must be squarely faced.

It still remains uncertain whether the power with which it is proposed to vest Congress through the Interstate Commerce Commission is constitutional under the fifth amendment. Mr. Aldace F. Walker, Chairman of the Atchison, Topeka & Santa Fe Board of Directors, discussed this point in 1898, and held that if a power to fix prices is derivable from the word "regulate" (in the phrase "regulate commerce"), it must apply as well to the sale and purchase as to the transportation of the subjects of commerce; and it is not perceived how any decision founded upon such a definition of the verb can stop short of including the price of cotton in its sale as well as the price of its transportation. This seems to be sound reasoning, but the point at issue is a somewhat academic one, and the risk of allowing the proposed law to be enacted without protest, on the chance of its being overthrown in the Supreme Court on the construction of a verb, is great.

What is important now is that those who believe that this centralization of Government power, with specific application to the making of rates, is highly inimical to the welfare of the country, should unite in presenting some substitute measure. It can do no good, or only a little good, to point out that the general rate situation, instead of being such as to demand attention, is in good condition, probably better than ever before; that rates, as compared with the prices of other commodities, have shown a steady decrease through a series of years (*Railroad Gazette*, August 19, 1904, page 250), and that it is better to let experts do their best in making rates that they have got to live on, and then use the courts for review, than it is to use the courts to reverse the work of non-experts who are making rates they have not got to live on. It will be only of moderate avail to compare the excellent work of the Massachusetts Railroad Commission, which has no power to make rates, with the revolutionary and socialistic regime of the commission in Texas, which has power to make rates. It seems altogether certain that popular outcry for some change in the status of Federal rate supervision will be so strong that the only way to avoid the radical fixing of vast power in the Commission will be to offer a constructive measure, in place of mere destructive criticism; a measure which will meet the objections to the present difficulties and delays which confront the shipper who believes an existing rate to be extortionate, without placing a highly dangerous power where it does not belong.

## PREVENTION OF COLLISIONS.

The very general agitation of the subject of railroad accidents during the last year has resulted in three notable magazine articles; one by Congressman John J. Esch, of Wisconsin, in the *North American Review* for November; one by Secretary Moseley, of the Interstate Commerce Commission, in the *American Monthly Review of Reviews* for the same month, and one by F. W. Haskell in the *Engineering Magazine* for December.

All of these writers make sensible recommendations, but not all of them have succeeded in fully grasping their difficult subject. Mr. Moseley's article is, in large measure, a review of facts which have appeared in the Government accident bulletins and which are, therefore, familiar to the readers of the *Railroad Gazette*. Ignoring the numerous misleading expositions of alleged statistics which have been published of late, he reminds his readers that the purpose of the Commission in gathering accident statistics is not to make dreary comparisons of columns of figures, but to get at the real causes of the deaths and injuries. Mr. Moseley proposes the extension of the block system and the restriction of the use of permissive block signaling; a radical reform in the train order system or the substitution for it of the electric staff; the introduction of rigid rules governing hours of labor; a third man on the engines of fast trains; a fare collector to relieve the conductor on heavy trains, and other things.

Mr. Esch has gathered a great mass of facts, but they are not well digested. He calls attention to the need of more numerous and better-organized repair forces to insure the safety of freight trains; the danger of excessive hours of work on trains; of youthful telegraph operators; of weak cars in passenger trains, and other things. He says that the general introduction of the block system would mean a large expenditure, yet he ends up by unequivocally approving a law making it compulsory. The summary of his recommendations reads much like Mr. Moseley's, but he adds a plea for a law to prevent the employment of youthful and incompetent men; for specifications requiring mail cars to be made of steel and for the requirement of steel frames for passenger cars.

Mr. Haskell's article, like Mr. Moseley's, eliminates as irrelevant many of the points which have filled newspaper articles on this subject, and goes straight to the main question—the prevention of collisions. His proposed remedies are in the main rational, though he ignores the radical difference between the time interval and the space interval theories of running trains. When he says that "there are perhaps more rear collisions on block signaled roads" than on others, he betrays a lack of familiarity with his subject. In endorsing the view that the underlying cause of the poor discipline on American railroads is "the peculiar national unrest which chafes at all restraint," he loses himself in a glittering generality which seems to be quite popular with many writers nowadays, but which is too vague to find place in a serious discussion. "Habitual contempt of orders" is given as a cause of the forgetfulness to which were due certain well-known collisions. This is rather inexact, to say the least; Mr. Haskell forgets that some of the worst cases of forget-

fulness are found among conductors and enginemen whose minds are far removed from that unruly state which is supposed to have been fostered by trade union influences and the disposition to rush things.

In his principal conclusion, Mr. Haskell sees straight; the universal need, he says, is for moral fiber in both officers and trainmen; with good discipline, carefully maintained, many of the delinquencies which now make up our terrible record could be done away with. The trouble with this recommendation is that no one has discovered any way by which to make railroad companies carry it out. The *Railroad Gazette* has preached this doctrine from time immemorial, but the great majority of the sinners seem still to be blinded by their own hardness of heart. In this situation the only recourse, as the readers of the *Railroad Gazette* have many times been told, is to make a radical change of system. The space interval would be the only rational *system* to advocate, whatever might be the state of the discipline or the condition of the men's moral or mental qualifications on any given railroad. This system requires competent men, and its advocates do not ignore the need of excluding the incompetent; but it remains true that, regardless of the question of individual competency, the system itself is the safest one. When Mr. Haskell says that without an improvement in the moral character of the men the advantage derived by the introduction of safety devices is more than counteracted by "the resulting division of responsibility," he is very wide of the mark. It is true that the continuance of the flagging rules where the block system is in use tends to impair the integrity of the block system; but even with this handicap, the system still maintains its superiority.

Mr. Haskell makes recommendations like those of the other two writers, and adds some technical details concerning train rules on single track. In proposing that trains shall not meet except at telegraph offices he is asking what many roads will not do without compulsion; and if they are to be compelled to keep operators on duty at all meeting places they may as well be compelled to use the block system. His other recommendations may be termed complicated remedies for evils which the block system would cure without complication. Evidently he has omitted to recommend the block system because of unfamiliarity with its simplicity and cheapness.

Now, we have called these magazine articles notable because their authors, all aiming to promote the general welfare, have studied their subject deeply and have made intelligent recommendations; two essential features, which, used as tests, compel the rejection of most of the articles on the prevention of accidents heretofore printed. Except among railroad officers, thorough students of the subject are rare, and those whose conclusions are both practicable and public spirited are rarer. But the articles now before us, will, we fear, fail to impress the Congressmen, editors and statesman for whose attention they have been prepared, because the fire of their guns is too much scattered. Questions of sound rails, substantial roadbed, strong cars and improved discipline cannot be lumped together and settled at one time. There are too many differences of opinion and financial or other practical obstacles. The one point now pressing for consideration is the prevention of collisions; and this, as we have said, involves first of all a change of system. Ask any candid railroad superintendent how he is going to improve his safeguards against collisions without introducing the block system and his answer will convincingly show that this is the case; that his problem is complex in the extreme. He must see that all his flagmen are A1, yet he cannot dismiss the doubtful ones; he must try to educate them—a slow process. He must "jack up" the vigilance and intelligence of his conductors, but will find so much prejudice and narrow mindedness that he will have to be careful to avoid stirring up the grievance committee. When he tries to improve his enginemen he will find that 25 to 50 per cent. of them have lately been promoted from the fireman's side without adequate training; this because business has been increasing so fast. We will not here take account of the fact, said to be patent on many roads, that in consequence of the severe physical strain of firing the largest engines the average intelligence and moral character of the firemen has notably deteriorated; good men will not take such jobs. The superintendent will desire to improve his telegraph operators but will find that his appropriation is so small that his best men will resign their places about the time that they have become thoroughly trained. He will find that trainmen who have passed well in a "school" make mistakes in actual work, necessitating the appointment of inspectors, travelling instructors and conscientious men to do surprise checking; and that on his whole road he cannot pick up enough competent men to do this work for his one division. After he has found them it will require much courage to put them on the pay roll, because of the strong feeling that the next great collision will happen on some other road.

These are a few of the superintendent's troubles. There are plenty more. While no sensible superintendent can think of abandoning the hope of some time getting rid of these defects in the personnel, many (who besides being sensible have more than average courage) have concluded that the process is so slow, and the demands of the time-interval and train-order system are so exacting, that the Gordian knot had best be cut by the adoption of the block system; and they have so cut it. But others still sit with folded hands. This condition has continued now for years and the public begin to see it in its true light. The time is surely comgraph Company versus the Pennsylvania ing, and should not be far distant, when a definite measure to make block signaling compulsory on lines subject to certain traffic conditions, will be brought before Congress. In spite of the grave and patent objections to governmental interference with railroad operation, the collision evil must be squarely met, and the only way of accomplishing this seems to be to extend the Safety Appliance act of 1893 to include the block system; which is one of the most effective of all safety "appliances."

## Metal Cross-Ties in Austria.

We are indebted to Mr. Hermann von Schrenk, Chief of the Forestry Bureau of the Agricultural Department, for some valuable statistical tables relating to the comparative economy of steel and wooden ties on a prominent railroad of Austria, from the reports of the Chief Engineer of the road. These tables are too voluminous to be printed here in full, but an abstract of the figures will serve to give the important facts and deductions.

In 1883 a length of 1.25 miles of main track was laid with steel ties of the Heindl type, and these have been continued in use since that time. At the same time a length of about 3½ miles of track was laid on wooden ties, which have since been maintained. Accurate and detailed account was kept of the cost of track maintenance on these two sections, and the tables before us give these accounts for the years 1884 to 1902 inclusive. The Heindl tie is of the modified inverted trough type and those here referred to were of the class A, or heaviest section made. Their length is 7.57 ft., top width 6 in., and bottom width 10.4 in. Their depth is 4 in. The thickness of top plate is 0.4 in., and the thickness of the sides varies from 0.32 in. to 0.28 in. The area of metal in the cross section is 5.69 sq. in., and the weight of each tie is 158 lbs. They are spaced in the track about three feet from center to center, except at the rail joints, where they are nearer together. The first cost of these ties with their rail-fastenings, etc., is given as $3.82 each. The rail in use on both sections weighs about 70 lbs. per yard. The wooden ties were 8.2 ft. long, 6 in. deep, with sloping sides, the bottom width being 11¾ in. No information as to the kind of wood, the spacing of the ties or their cost, is before us, but the average spacing seems to be 2.8 ft. It is usually estimated that in that country the cost of wooden ties is about one-half that of steel ties. About one-half the track on the steel tie section is ballasted with broken stone and the other half with "sifted" ballast, while the whole of the wooden tie section is on "sifted" ballast.

Data as to weight of rolling stock is not at hand, but it is probably about the same as on some other Austrian roads, where the passenger locomotives weigh about 35 tons, with about six tons on each driving wheel, and the freight locomotives weigh about 40 to 45 tons with about seven tons on each driving wheel. The maximum speed of passenger trains seems to be about 45 miles per hour. The tables before us show that during the 19 year period the total traffic was as follows:

| | Sections— | |
|---|---|---|
| No. of trains: | Steel tie. | Wooden tie. |
| Express | 38,294 | 38,331 |
| Passenger and mixed | 43,923 | 44,068 |
| Freight and express | 150,042 | 150,007 |
| Total | 232,259 | 232,406 |
| Total tonnage | 129,430,000 | 129,360,000 |

Each section was therefore subjected to practically the same burden.

Some of the more important facts relating to the track endurance are given in the following table:

*Table 1.*

| | —Ties— | |
|---|---|---|
| | Steel. | Wood. |
| Length of track observed, miles | 1.25 | 3.51 |
| No. rails renewed in 19 years: | | |
| Because of wear | 77 | 125 |
| Because of breakage | 80 | 57 |
| Total | 155 | 182 |
| No. rails removed per mile of track. | 124 | 52 |
| No. rails broken per mile of track. | 64 | 13½ |
| No. of ties used on section | 2,246 | 6,610 |
| No. of ties renewed in 19 years | 4 | 7,086 |

The most striking thing here shown is the great discrepancy between rail failures per mile over the two kinds of ties. How far the wearing-out of rails was due to the ties cannot be determined, but the fact that the breakages were, during the period of 19 years, 64 rails per mile on the steel ties and only 13½ on the wooden ties, is the best evidence of the comparative support offered by the two kinds of ties. When it is remembered that this trough-shaped steel tie is only 4 in. deep, and that the section is one that gives very little stiffness for the quantity of metal used, the excessive rail failure

is not surprising. This same lack of rigidity will help to account for the remarkable endurance of these ties. At the end of 19 years only four out of 2,426 of them had failed, and these were reported as worn out, not broken. We should expect such a tie to bend rather than to break.

The statistics of cost of track maintenance on the two sections are not very clear on some points, possibly because we do not fully understand them. They are abstracted and condensed in the table that follows:

*Table 2.*

| | Ties | |
|---|---|---|
| Cost of maintenance per mile for 19 years: | Steel. | Wood. |
| Wages | $1,453.30 | $1,284.60 |
| Materials, incidg. rails & blst | 250.56 | 1,350.67 |
| Ballast for repairs | 14.00 | 11.47 |
| Total | $1,717.86 | $2,646.74 |
| Cost per mile per year | $90.41 | $139.30 |
| Ballast, renewal per mile pr yr | 58.07 | 46.13 |
| Renewal, rails per mile per yr. | 10.74 | 4.44 |
| Total, cost per mile per yr | $159.22 | $189.87 |

From this it appears that the cost of maintenance was apparently materially less with the metal ties than with the wooden ties. But such a conclusion is erroneous for the reason, principally, that no part of the first cost of the steel ties enters into the computation, while the cost of wooden ties for at least one renewal is charged to maintenance. The figures given for cost of rail renewal do not seem compatible with the excessive rail failure, nor do they seem to be in harmony with the ratio of rail failure on the two kinds of track. If these rail failures per mile were as 64 to 13½, it is difficult to see how cost of rail renewals could be as $10.74 to $4.44 per mile. There are many other discrepancies in the tables which seem to require explanation. Whatever may be the comparative advantages of the steel tie on this road, it seems obvious that the one used is deficient in strength and rigidity, even for the comparatively light rolling stock of the Austrian railroads.

## Railroad Hospital Departments.

The railroad hospital idea originated in the West, and was the natural outcome of the conditions which attended the building and working of railroads through sparsely inhabited regions. With few large towns on the line, and these widely separated, a road would probably be without a single public hospital on its entire route. Some means of caring for injured passengers and sick and injured employees was a necessity, and the establishment of hospital service under railroad management was the result. It is not generally known that this measure of public service was inaugurated as far back as 1868, and the first hospital devoted exclusively to the care of railroad employees built the following year. To the Southern Pacific belongs the credit of being the pioneer in this movement; or, to be more exact, the old Central Pacific, for the hospital referred to was built at Sacramento. Some years later this road's example was followed by other large western systems, the Missouri Pacific next adopting the idea, and then the Santa Fe. Since that time the Wabash, Northern Pacific, 'Frisco, Plant System, Chesapeake & Ohio and Toledo, St. Louis & Western have established hospital departments and built from one to three hospitals each, while small hospitals have also been built by some of the Texas roads. The service in most, if not all, of these cases is maintained by hospital associations, which derive their funds from the employees by means of regular assessments, dependent in amount upon the salary each receives. In some cases the associations were formed, and are directly administered, by the railroad management, while in others they are entirely independent organizations. The Southern Pacific and other early associations are of the former type, but the employees were quick to realize and appreciate the benefits which the small monthly contribution assured them, and made no objection to the compulsory assessment. It has been said that in the absence of such hospital service as this system makes possible, many of the employees would probably pay out during a year to sick or unfortunate fellow-workmen more than they contribute to the hospital fund. The railroad companies also contribute generously to the fund and make up any deficiencies.

Although it would naturally be expected that a large railroad system with thousands of employees would have a good many patients on its hospital list in the course of a year, the following figures given by Dr. F. K. Ainsworth, Chief Surgeon and Manager of the Southern Pacific Hospital Department, in a paper presented to the Pacific Coast Railway Club, will surprise the uninformed. The figures are for 1903:

| | |
|---|---|
| Southern Pacific (Pacific System) | 58,220 |
| Missouri Pacific | 42,084 |
| Atchison, Topeka & Santa Fe | 39,171 |

The figures appear the more remarkable when it is known that the number of employees of the Southern Pacific, for instance, is upwards of 40,000, the ratio of cases treated to number of employees being therefore 165 to 100. Dr. Ainsworth also gives figures on the cost of this service, which for the first half of the last fiscal year amounted to about $129,000. The receipts were under $121,000, leaving a deficit of about $8,000. Conspicuous items on the list are: Salaries of surgeons, $20,210, and fees of emergency surgeons, $4,344. The surgeons of the department are paid in three ways—by transportation alone, by transportation and salary, and by fees. The latter are paid to emergency surgeons only; that is, surgeons at smaller points, where the service is irregular. For the $4,344 paid out in this way 1,276 visits were made, at an average cost of $3.40 a visit. Dr. Ainsworth says that if the regular surgeons were paid by fees as the emergency surgeons are, the cost for the same period would have been $331,000; but for the amount actually paid —$20,210—these surgeons realized an average of 20 7/10 cents a visit. In San Francisco the average is even much lower. Operations that in private practice command anywhere from a few hundred to many thousands of dollars, are performed for about 10 cents. Of course, the value of the transportation is not included in these estimates, but according to Dr. Ainsworth most of the surgeons rarely make use of their transportation. To those who have an impression that surgeons in railroad service receive high pay in proportion to the work they do, these figures will be illuminating.

The paper advocates the establishment of small emergency hospitals at shops and yards and at enough other points to insure prompt care to the seriously ill or injured and avoid the danger of moving such cases a long distance to the main hospital. This provision, it says, would be the means of saving many lives on western railroads. It is, of course, unnecessary on eastern lines, traversing thickly populated districts.

Some of the hospital associations maintain wards in public or private hospitals at important points along the line, as adjuncts to their own hospitals. A feature of the Northern Pacific Hospital at Brainerd, Minn., is a training school for nurses.

The trunk lines, and the other railroads in official classification territory, through their bill of lading committee, have announced that the date for putting the proposed new uniform bill of lading in effect has been postponed until April 1. This action appears to be the result of the hearing held by the Interstate Commerce Commission at Chicago last week. The agitation of this matter in the newspapers during the past few months has all the time appeared to be little more than a tempest in a teapot, and the present result indicates that appearances were correct. There were only two grievances worth mentioning, and the representative of the railroads seems to have been right in asserting that even these two would not have amounted to much but for the abnormal activity of two or three self-appointed shouters for the shippers. The first grievance was based on the threat to add 20 per cent. to what have been generally accepted as normal freight rates unless the shipper, by a written agreement for each shipment, would assume his own risks of damage on fragile articles or things not properly packed, and the second on the "not negotiable" clause. The railroads have practically backed down on both points. As to fixing bills of lading so that the shipper could not use them as a draft to get money on his goods through the banks, it is now asserted that there was never any intention of doing it; the "not negotiable" clause was to be scratched off whenever the individual road deemed it proper to do so. Of course it would have to do this whenever the interest of a good shipper demanded it, and that of course insured the concession to all shippers needing it. Evidently if the railroads had put this matter into the hands of their best diplomats the public agitation would not have occurred at all. The 20 per cent. addition was, of course, unreasonable from the beginning. The demand is not a new one; it has existed, on paper, for years, but everybody knew it was absurd. Probably two or three per cent. would more than cover the real risks of loss; the other 18 or 17 per cent. is penalty. Such a penalty is all right in theory; but besides being excessive in amount it was doomed to failure by the inconsistencies surrounding it. How can a railroad impose penalties when shippers everywhere look upon the railroads themselves as law-breakers? The imposition of penalties is a function of sovereignty; and the railroad officer who thinks that the public will tolerate anything original in that line from him is about 30 years behind the times. Then, again, this penalty business would be a move in the direction of stiffness and more business-like methods; but most of the large shippers of the country are accustomed to expect from railroad traffic men something of an opposite nature; evasion of salutary rules, and tricks to get business by giving something to the shipper instead of taking something from him. The situation in this matter appears to be somewhat parallel to that sometimes seen in the passenger department, where a railroad preaches regularity four days in the week through its agents' announcements and its press agents' interviews, and the other three days makes private concessions or works tricks by means of the scalpers' offices.

The complaint which Detroit, Cleveland and other cities that are about half way between the 75th and the 90th meridians make against standard time is just; indeed, it is more than just, if we may use such a paradoxical term; for not only is Central Time too slow for them; the people are too fast even for their own cherished local time, and ought to have the Eastern standard. This is the burden of an argument presented by Mr. E. C. Hargrave which we print in another column. Assuming that the normal working day is from 7 a.m. to 6 p.m. and that the desideratum is to so set our clocks that we shall secure, in the autumn, when everybody is busiest, the largest amount of daylight be-

tween those hours, he quickly shows that Detroit time is too slow for Detroit, and that the people of that city had better adopt Utica time (75th meridian or Eastern standard). On the same basis we in New York had better adopt Kennebunkport time; but perhaps to mention this at this time would be lugging in a side issue; so we will let it pass. Not having so warm a sympathy as we ought toward our brothers who live in Detroit, we had always thought that their proper course, if they didn't like to go to work at 7 o'clock by St. Louis time, was to go to work at 6:30 by St. Louis time. Living here in snug comfort, only four minutes from the 75th meridian, which is very close to the city that now rules the world (i.e., rules the greatest "world-power"), we had never thought that getting up at 6 o'clock became a hardship simply because the clock showed 5:30. But it appears that every suggestion to use the Central Standard in Detroit factories is met by the opposition of the labor unions—and no labor union is ever mistaken as to what it wants. The final and insurmountable difficulty with Central Time in Detroit is that the churches and theatres are determined to begin their evening services and entertainments at 8 o'clock, so that the poor shop man who ends his day's work at 5:30 has a half hour more time than he needs for putting on his evening suit. He loses a half hour at home in the morning, when he needs the time, and makes it up in the evening when he does not need it. The chief trouble, however, with Mr. Hargrave's plan, is that Chicago will not accept it. Could that proud city, after 21 years of normal and easy time-reckoning, think for a moment of having two clocks, an hour apart, in each of its great railroad stations (except the North Western)? Never!

The general manager of the Chicago & North Western has issued a circular to superintendents and yardmasters which reads as follows:

"See that a minimum time is absolutely afforded train and engine crews for rest as follows:

"Men ten hours or less on duty, eight hours' rest, minimum.

"Men twelve hours on duty, ten hours' rest, minimum.

"Men fourteen hours on duty or more, twelve hours' rest, minimum.

"Keep before the train dispatcher such record of movement of crews as absolutely will prevent an engineman or trainman from going out on a run without the full allotted time for rest.

"Check this matter up personally to see that the rule is being carried out, examining reports periodically as to rest actually allowed."

In order that a check may be maintained, the proper officials at terminals are being provided with what is known as a "rest book," in which records of every crew will be kept. The reporter who publishes this circular says that all of the Chicago superintendents are considering the subject and all are of opinion that rest must be assured "except in emergencies." But why this exception? Is not an emergency just the time when some man's judgment will fail? Occasions will arise when a conductor or an engineman will be unable to take his train to destination in less than, say, 20 hours; but should not such cases be subject to the rule, without exception? If the rule makes the work-time limit 15 hours, why not require the train to be sidetracked (or, if stalled, to be deprived of its main track rights) on the expiration of that time, unless the superintendent specifically suspends the rule in each case? The trainmaster and despatcher are under constant temptation to stretch the meaning of the term "emergency," and it would be salutary to require them to get their judgment confirmed, every time, by a higher officer, before allowing a man to work excessive hours. The modification of rest-rules should be made difficult. This would tend to cultivate in the minds of all concerned a sense of the dangers that it is desired to guard against and would help the runners and conductors themselves to realize the importance of taking special pains to keep themselves awake when working longer than usual. Cultivation of an adequate sense of dangers and responsibilities is, indeed, one of the main benefits of such a circular as that which the North Western has issued; for the mere correction of hours is not in itself an infallible corrective of practice. Men sometimes sleep when they have been on duty much less than 10 hours.

Senator Elkins, Chairman of the Senate Committee on Interstate Commerce, said at Washington this week that his committee would probably propose the creation of an interstate commerce court, to be composed of nine members, including one from each judicial circuit; but he does not think that Congress is likely to pass any law affecting rates of transportation at this session. The utterances of President Roosevelt in his annual message on the subject of railroad rate regulation have been the most prominent topic of discussion in Washington during the past ten days. All are agreed that the present Congress is not likely to act. Some of the observers say that this is due to the settled oppositon of the members of the commerce committees in both houses, who have prevented action each year for several years past; while others think that a majority of both houses of Congress is now convinced that action must be taken in order to meet the pressing demands of the West, but that the technical difficulties of the subject, when it comes to the drafting of a bill, will make it impossible to reach an agreement before March 4. When, at a committee meeting last week, it was proposed to order a series of hearings on the question, Mr. E. P. Bacon, the chief advocate of a law to give rate making powers to the Interstate Commerce Commission, said that hearings were not necessary; everybody knows the facts; the thing now is to act. In this Mr. Bacon is substantially correct. Congressman Steenerson, of Minnesota, has introduced a bill to give the Interstate Commerce Commission rate-making powers. It appears to contain nothing new or different from what is already embodied in the bills presented a year ago by Senator Quarles and Representative Cooper. Some of the gossips say that the President will send to Congress another message on this subject. It was announced in Washington this week that Mr. Paul Morton, Secretary of the Navy, would continue in the cabinet beyond the President's present term. It does not appear whether Mr. Morton is to remain at the head of the Navy Department or is to take one of the other portfolios; but it is said that the President desires to keep him as an adviser on the question of railroad rate legislation, on which Mr. Morton is said to believe that action is necessary. Comment on government control of rate-making will be found in another article in this issue.

## NEW PUBLICATIONS.

*The Roadmasters' Assistant.* New and Revised Edition. New York: 1904. The Railroad Gazette. Cloth, 290 pages. Price, $1.50.

Within the last five or six years the art of railroad track building and maintenance has made rapid strides forward, and the 1898 edition of The Roadmasters' Assistant having become out-of-date, a new and revised edition of this useful little guide and reference book was made necessary. No attempt has been made to change the arrangement or scope of the subject-matter in the present edition, but the text has been carefully edited and the illustrations revised, and new ones substituted in many places. The most important changes have been made in the chapters on Rails and Rail Fastenings, which have been entirely rewritten. The chapter on Water Supply has been added to and enlarged to include water softening plants and gasoline pumping engines. Other books have been written on track and allied subjects which are full of theory and opinion. The Roadmasters' Assistant has been written with a different object in view. The aim has been to make a practical book for practical men, convenient in size and arrangement and simple in language.

# CONTRIBUTIONS

### Suggested Changes in Standard Time.

Bay City, Mich., Dec. 1, 1904.

To the Editor of the Railroad Gazette:

The object of this article is to discuss whether the irregular division between eastern and central time should not have been farther west, and instead of being where shown by line No. 1, on the first diagram, should be about where line No. 2 is drawn.

In 1883 the railroad companies of the United States and Canada adopted what has since been known as Standard Time. The wisdom of its adoption has ever since been fully proven by its great convenience to the traveling public, as well as to the railroad companies. All who traveled previous to that time can well remember the great confusion of times at all places, not only where eastern and western roads met, but in almost all towns and cities through which such roads ran. For many years prior to this, the subject of some uniform standard of time that could be adopted by all the people or with which the time used in the different sections of the country could be compared, had been discussed.

Of course it is universally known, and is only mentioned here to get the subject clearly before us, that as we travel from any point westward time gets slower as compared with the starting point. Again, traveling in an easterly direction time is faster. The rate at which time changes is one hour for each 15 deg. of longitude. It makes a difference of about one hour between New York and Chicago, and three hours between New York and San Francisco. Because of the great difference between the eastern and western sections of our country, it would be practically impossible to use the same time; that is, to have the clocks in all parts of the country set at the same hour, because there would be too great a difference between part of the clocks and solar time. Before the adoption of standard time, in most cities the time due to their location on a certain meridian was in use, and in others, the time of a nearby observatory. This time was designated local time. The great difficulty and inconvenience of using local time grew out of the great magnitude and importance of the railroads. The managers of the different railroads selected for their use the time of the most important or the most central city on their line. Sometimes there was one standard for one part of the line, another for another part. It was almost im-

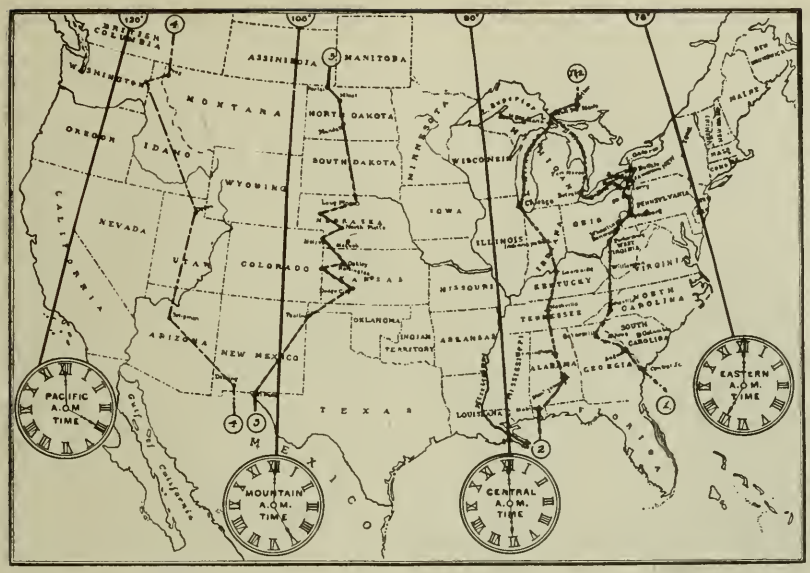



Fig. 1.

possible to keep track of the times of the railroads and connecting roads at junction points. There were about 75 different times in use on the railroads of the United States.

Before 1883 the railroads were in many localities running on a time of their own arbitrarily adopted, while the residents used local time; also, in many cities where local time was used by the inhabitants, different roads running into the same place would be using different times. Detroit, New Haven, and a number of other cities, had three times in general use by the citizens and railroads. In making a trip from Boston to Washington the time by which the railroads operated changed five times. Almost endless was the confusion of the traveler, and not much less that of the railroads. In 1883 all this was changed; a standard of time was adopted by the railroad companies; and now, while in the nature of things, changes of time must occur, each change is a difference of exactly one hour. The subject was discussed for years and finally the details of a plan were worked out by Mr. W. F. Allen, Secretary of the General and Southern Railway Time Conventions, held in New York and Chicago in April of 1883, where the following resolutions were adopted:

1. That all roads now using Boston, New York, Philadelphia, Baltimore, Toronto, Hamilton or Washington time as standard, based upon meridians east of these points, or adjacent thereto, shall be governed by the 75th meridian or eastern time (four minutes slower than New York time).

2. That all roads now using Columbus, Savannah, Indianapolis, Atlanta, Erie, Louisville, Chicago, Jefferson City, St. Paul or Kansas City time, or standards based upon meridians adjacent thereto, shall be run by 90th meridian time, to be called Central Time, one hour slower than Eastern time, and nine minutes slower than Chicago time.

3. That west of the above named section the roads shall be run by the 105th and 120th meridian times, respectively, two and three hours slower than Eastern time.

4. That all changes from one hour standard to another shall be made at the termini of roads or at the ends of divisions.

Standard time as agreed upon was adopted by most of the New England railroads October 7, and by nearly all the other railroads east of the Rocky Mountains Nov. 18, 1883. Most of the towns and cities soon followed the example of the railroads, but although Standard time has been largely adopted for general use, it must be clearly borne in mind that it was invented and adopted by the railroad companies solely for their convenience, without once consulting any community as to whether they would use it or not. How the clock time agreed with solar time or hours of daylight, or the convenience of the people along their lines, had nothing to do with its adoption. To quote from one of its principal advocates: "The people will have to travel by Standard time whether they eat and sleep by it or not."

The country was divided into four irregular sections. Commencing from the east, the first section takes the time of the 75th meridian, which is known as Eastern time; the second section, the time of the 90th meridian, known as Central time; the third section of the 105th, known as Mountain time; and the fourth of the 120th, known as Pacific time. The limits of these sections are not regular, because the railroads had to select certain places or cities as points at which it would suit their convenience for their lines to change from one time to another. These time change points in most cases were the railroad terminals, although a very few of them were simply important division points. This will best be understood by looking at the accompanying map (Fig. 1), a glance at which will show the different points where the changes in time are made.

It will be seen that four heavy lines, running north and south, mark the location of the 75th, 90th, 105th and 120th meridians, the ones from which the different sections take their time. Four other very irregular lines are shown, each line being numbered. These lines, except number two, mark as nearly as can be marked the division between the sections. No definite division can be made, because sometimes railroad lines will run close together, nearly parallel, and the places where they change may be many miles east or west of each other. To illustrate: The Lake Shore & Michigan Southern and Michigan Central Railways change from Eastern to Central time at Buffalo; the Grand Trunk changes at Detroit, 230 miles further west; one railroad changes at Columbia, S. C.; others at Gainesville, Ga. Note that line No. 3, which marks the western boundary of the section that takes its time from the 90th meridian, near the southern end, passes to the west of the 105th meridian, the time of which meridian is the standard for mountain time.

Between Eastern and Central time changes are made at Sault Ste. Marie, Cartier, Sarnia and Windsor, Ont.; Buffalo, Dunkirk, and Salamanca, N. Y.; Butler, Corry, Erie, Franklin, Newcastle, Oil City, Pittsburg, Titusville, Union City and Washington, Pa.; Benwood, Kenova, Parkersburg, Wheeling and Williamson, W. Va.; Asheville, N. C.; Columbia, S. C.; Athens, Augusta, Central Junction and Gainesville, Ga. The changes between Central and Mountain time are made at Mandan, Minot and Portal, N. Dak.; Alliance, Long Pine, McCook and North Platte, Neb.; Cheyenne Wells and Holyoke, Colo.; Dodge City, Hoisington and Oakley, Kan.; Texline and El Paso, Tex. Between Mountain and Pacific sections at Spokane, Wash.; Troy, Mont.; Huntington, Ore.; Ogden, Utah; Seligman, Ariz., and Deming, N. Mex. It is readily understood that in the part of any section lying east of the meridian from which it takes its time, the Standard time adopted is slower than the local time formerly used, and in the part lying west of the meridian Standard time is faster than local time. To illustrate: The following cities lie east of

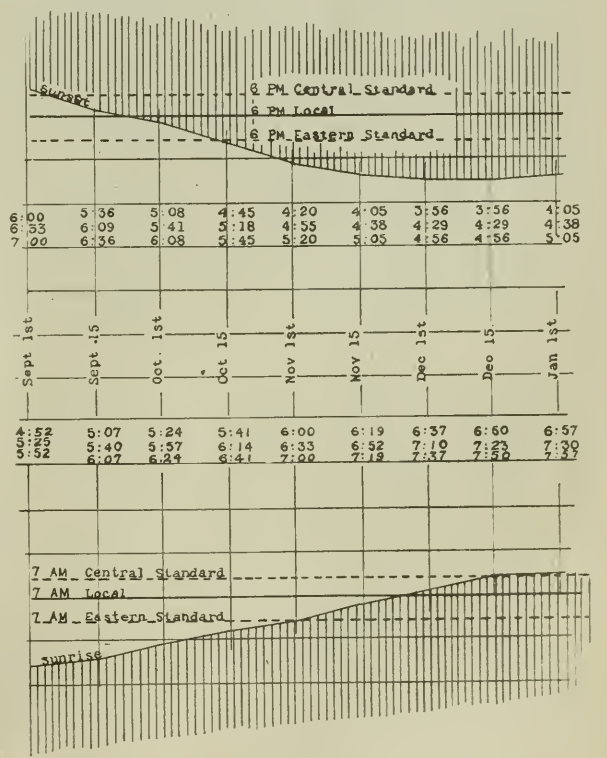



Fig. 2.

the 75th meridian, the time of which is used for Eastern standard. The numbers set opposite each city show the number of minutes Standard time is slower than local: Portland, 18 minutes; Boston, 16; New Haven, 9; Albany, 5; New York, 4.

The following large cities lie west of the meridian, so that Standard time is faster, as follows: Syracuse, 5 minutes; Rochester, 10; Buffalo, 15; Erie, 22; Pittsburg, 20; Wheeling, 23; Washington, 9; Richmond, 10; Columbia, 24; Windsor, Ont., 30.

In the following cities lying in the eastern part of the section using Central time, Standard time is slower than local time, as follows: Cleveland, 34 minutes, Columbus, 28; Detroit, 28; Dayton, 23; Cincinnati, 21; Indianapolis, 15; Chicago, 10.

Local time is often spoken of as "God's time," while Standard time is called "man's time." As a matter of fact, "God's time," or true local time, is never used because it is too irregular, which irregularity is caused by the variation of the earth in its orbit and its inclination from or toward the sun. This variation from the time known as local time amounts to over one-half hour during the course of a year, as will be seen below. The time set opposite the day of the month is the local time when the sun is directly over the meridian; 12 o'clock:

| | | | |
|---|---|---|---|
| Jan. 1 | 12:03:24 | July 1 | 12:03:26 |
| Jan. 15 | 12:09:21 | July 15 | 12:05:35 |
| Feb. 1 | 12:13:41 | August 1 | 12:06:11 |
| Feb. 15 | 12:14:21 | August 15 | 12:04:29 |
| March 1 | 12:12:40 | Sept. 1 | 12:00:10 |
| March 15 | 12:09:17 | Sept. 15 | 11:55:27 |
| April 1 | 12:04:11 | Oct. 1 | 11:49:56 |
| April 15 | 12:00:14 | Oct. 15 | 11:46:00 |
| May 1 | 11:57:07 | Nov. 1 | 11:43:42 |
| May 15 | 11:56:11 | Nov. 15 | 11:44:34 |
| June 1 | 11:57:29 | Dec. 1 | 11:48:52 |
| June 15 | 12:00:02 | Dec. 15 | 11:54:54 |

It will be seen that a large variation from actual sun time was averaged up by man, when what is known as local time was adopted. Our method of keeping time was designed and adopted for man's convenience. This was better understood, and the direct object when Standard time was adopted. Yet with this in view, at many points, Standard time makes worse a defect that has always existed in local time, that is, the center of the period of light does not come at the middle of the working day. It does not make much difference in the summer time, when there is always more light than is used, but in the months when daylight is the shortest, and especially in the fall, when there is much work to do, it is serious.

This causes the most inconvenience where there is much work to do, and it is difficult or undesirable to have artificial light. This includes a great deal of labor. To illustrate: October 1st the sun rises at 5.57 and sets at 5.41. As most work commences at 7 a.m. and stops at 6 p.m., it is seen that the sun rises 1 hour 4 minutes before time to commence work and sets four minutes before time to stop work. October 15th the sun rises at 6.14 and sets at 5.18. November 1st it rises at 6.33 and sets at 4.58. November 15th it rises at 6.52 and sets at 4.38; that is, it rises eight minutes before time to commence work and sets 1 hour and 22 minutes before time to stop work.

It has been the practice in many places where large numbers of men are employed to set the clocks one-half hour faster than the local time, when the days begin to shorten. In mining regions and in communities largely dominated by one or a few large manufacturing plants, it is at the present time the custom to change the clocks and blow the morning, noon and night whistles without regard to either standard or local time, and simply make the noon hour the middle daylight point, to the end of getting all of the fall and winter daylight within the working hours. The writer visited a town north of Detroit containing a number of lumber, manufacturing and finishing works belonging to one company. The works and all the people were using Eastern Standard time, while the railroads were using Central Standard time. It gave great satisfaction but would have been much better had the railroads used the same time.

When Standard time was adopted in the cities lying east of the meridian from which their time is reckoned, the length of the period of daylight before the time to commence work, and the period of darkness before time to stop work, were greatly increased. To illustrate: Take the case of Cleveland, which uses Central time. October 1st the sun rises by Standard time at 5.24 and sets at 5.12; it rises 1 hour and 37 minutes before time to go to work and sets 49 minutes before time to stop. October 15th the sun rises at 5.41 and sets at 4.45. November 1st it rises at 6 and sets at 4.20. November 15th it rises at 6.19 and sets at 4.05. It is readily seen how great an inconvenience this causes. As a result, in cities situated as are Cleveland, Columbus, Toledo and others about on the same meridian, all the enterprises that employ labor either run by local time, or—which is the same thing—commence one-half hour earlier by the clock, keeping Standard time. Some cities, like Detroit, refuse to adopt Standard time, and the reason for not adopting it is always because of the protest of the laboring classes.

The Mayor of Detroit writes: "Many efforts have been made by various interests to have the city government adopt the Central Standard time, but on each occasion there has been such a protest from labor organizations, some of our merchants and others, that the plan has been overwhelmingly defeated."

The argument is often advanced, if the clock is set back, soon everything adjusts itself to the new order, and no one knows the difference. One of the main things, the sun, refuses to be adjusted by it, and factories and other industries will run approximately to the time that gives the most light during the period of work. Again, the argument is advanced, suppose work starts at 6.30 instead of 7 and stops at 5.30 instead of 6, is that not practically the same for the men? Granted, as far as that goes, and it would be the same if the trades people and professional men would do their work one-half hour earlier, and if the churches, theatres and evening meetings would also start by time one-half hour sooner; but they do not and will not, and the only reason that can be given is that they have been accustomed to certain hours and will not change. As a result, the men who do most of the work go to and from work by a time one-half hour earlier than in general use. After leaving their place of employment, every other place goes by the slower time, resulting in the loss of one-half hour's time in the evening, which half hour has to be made up by getting up one-half hour earlier to go to work by the faster time. There is no doubt but this is a considerable hardship and that their objections are well taken.

In some cities the schools either run on local time or have their sessions commenced earlier by Standard time. This brings the noon hour at 11.30 instead of 12, which again, in all families, except of the working people referred to above, deranges the noon day meal. In the schools which run on Standard time and usual hours the noon day meal comes at the wrong time for those using the faster time, and it is also difficult to get sufficient light for the pupils to study by late in the afternoon of the short days. In many places where artificial light cannot be had during short days, darkness comes on before the time for the men to stop work, causing loss to the employees and employers; loss also, because less work can be performed, and probably what is done is of inferior quality.

The writer wrote to nearly all the cities located about on the same meridian as Detroit, Toledo, Cincinnati, etc., and from the answers received it was found that practically all the factories run on either local time or one-half hour faster of Standard time; that the time as now used causes confusion, and is not satisfactory. These letters were addressed to the mayors of the different cities.

As a remedy for the troubles here recounted the writer suggests that the railroads move the division between Eastern and Central time farther west, and instead of having it where described above, it be made about on the line of Lake Michigan, Chicago, Indianapolis, Louisville, Nashville, Birmingham, Montgomery and Mobile. That would make Standard time the number of minutes faster than local time indicated by the figure set opposite the names of the cities given:

| | | | |
|---|---|---|---|
| Detroit | 32 | Columbus | 32 |
| Toledo | 34 | Cincinnati | 39 |
| Cleveland | 26 | Dayton | 37 |

Taking Cleveland as an example we will see how the new, or Eastern (instead of Central) time will fit the conditions of light and suit all the people. Attention is called to Fig. 2. The distance between the horizontal lines, except those drawn to show 7 o'clock a.m. and 6 o'clock p.m., Eastern and Central Standard time, represents a period of one hour. The perpendicular lines represent the first and fifteenth of each month from September 1 to January 1. The lower shaded portion shows the period before sunrise and the upper shaded portion after sunset.

The groups of three figures at A and B above and below the line of dates give the different times at which the sun rises and sets at the dates given. The central figures in each group show the time by local time, the upper, Central Standard, and the lower, Eastern Standard time. Lines are drawn and marked 7 a.m. and 6 p.m., local Eastern Standard and Central Standard, to show the relation between the time to commence work and sunrise, and the time to stop work and sunset by the times under discussion. By following the times denoting 7 a.m. and 6 p.m. Central time, will be readily seen that the large section of daylight before the time to commence work, together with the large period of darkness before it is time to quit work, making this time absolutely impracticable for most kinds of work.

Following the lines marked 7 a.m. and 6 p.m. local, it will be seen that by local time the proper division of daylight to suit the working day is much improved, as compared with Central Standard. Again, when we follow the lines marked 7 a.m. and 6 p.m. Eastern Standard, we find still further improvement, and although by using this time the period of light is not evenly divided to suit the start and finish of the working day, it is approximately so, being a great improvement over the other times.

It has been shown that the fall and winter is when the light should be most evenly divided between the time of starting work in the morning and stopping in the evening. Using the same dates as before—October 1st, by Eastern time, the sun would rise at 6.24 and set at 6.08; October 15th it would rise at 6.41 and set at 5.45; November 1st it would rise at 7 and set at 5.20; November 15th it would rise at 7.19 and set at 5.05. It will therefore be seen that by using Eastern time in the cities mentioned and others in the same territory, the time used would not be

quite fast enough to exactly divide the daylight between the morning and evening. It would not only make it possible to use Standard time wherever labor is employed, but it would also be a great improvement even upon the local times formerly used.

As all the time used is artificial and made for the convenience of the people, while we are making it why not make it as convenient as possible? In the letters mentioned before written to the mayors of a large number of cities and towns in the territory of which we write, the question was asked: "Would it not be better for all your people and especially those who do ordinary labor if Standard time was one hour faster?" The great majority answered: "Yes," and a few "I do not know; never thought of it." Only two said they thought as there had been so much trouble getting Standard time started, better leave it alone.

The following would be some of the advantages of the change. The railroads would have a much longer run without change of time. Some of the large lines, as the Michigan Central, Grand Trunk, Lake Shore and Michigan Southern, Nickel Plate, Big Four and many others, would operate their entire lines under one time, therefore causing less confusion to the railroads and traveling public. It would favor the people who work, scholars in schools, and all who need more light the latter part of the day during the short days. As the change would do no harm to the merchants and those whose work is connected with the professions there is no reason why they should not adopt the new time, then all the people would use the new time and the present confusion cease to exist.

The new time would also be a great advantage during very hot weather. The hottest part of the day is the middle of the afternoon, and by moving the time one hour faster a much larger part of the work would be performed before the time of the greatest heat, leaving a shorter time to work after the time of the greatest depression. The writer has talked with many and looked carefully for one reason why the plan should not be adopted and can find none.

E. C. HARGRAVE.

## The Cole Four-Cylinder Balanced Compound.

Dec. 3, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I am glad of the opportunity to read over Mr. Moore's criticism (see *Railroad Gazette*, Dec. 2, 1904,) of the counterbalance of our four-cylinder compound and to expose the fallacy of his reasoning, and his ignoring of certain elementary principles in mechanics. It may be interesting to call attention, before proceeding with the argument, to the fact that it is well within the mark to state that at least 90 per cent. of all the four-cylinder balanced compound engines which have been built in different parts of the world have the power sub-divided, the high-pressure cylinders driving one axle and the low-pressure cylinders the other. In France, where this type of engine has been successfully used for many years, this arrangement is used practically to the exclusion of all others; and Mr. De Glehn, who, more than any other man, deserves credit for the development and introduction of this type of engine, recommends and uses this arrangement to the exclusion of practically all others. The French roads have at the present time over 1,000 engines of this kind in service.

The statement for the New York Central balanced locomotive No. 3,000 that "four cylinders are so arranged in relation to each other that the horizontal moving or reciprocating parts balance each other without the use of the customary counterweights for these parts in the driving wheels," is practically correct, and the error into which Mr. Moore has fallen in his hasty criticism is, in regarding the reciprocating parts themselves as producing the vertical force or "hammer blow" upon the rails at every revolution, which is a popular misconception, believed in to a certain extent by some persons.

As far as the track alone is concerned, there would be no vertical action or hammer blow if the over-balance for the reciprocating parts in an ordinary engine were omitted, but it is customary to add a certain proportion of these weights in the wheels directly opposite the crank pin, in order to neutralize, as much as possible, the action of the reciprocating parts on the engine itself in order to make it run smoothly, and to save the engine frames and moving parts from unnecessary vibration and shocks. In a balanced engine, the reciprocating parts on the inside of the frames balances those on the outside which move in the opposite direction, so that the use of the customary amounts of counterweights for reciprocating parts in the wheels is rendered unnecessary. It is also well known that an engine of this description runs smoothly without the use of weights for balancing reciprocating parts. This can be shown conclusively by mathematical proof, and it is a matter of common knowledge that these engines run remarkably steady, both on the road and testing plant.

The action of the reciprocating parts is entirely horizontal and no vertical force can be exerted by these parts except the slight vertical component produced by the angularity of the main rods; hence there can be no pressure produced upon the rail by the action of the reciprocating parts. Mr. Moore is evidently confusing the "hammer blow" in simple engines produced by the overbalance in the wheels to take care of the reciprocating weights, with the action of the reciprocating parts themselves which have nothing to do directly with the hammer blow. So far as the principle of balancing is concerned, it makes no difference whether the main rods are connected to a single or separate axles. In either case, the reciprocating weights counteract each other and counterbalance for all the rotating weights is all that is necessary.

Had Mr. Moore witnessed the test of the New York Central No. 3,000 at the World's Fair when running at 75 miles per hour, he would no doubt have been satisfied that the counterbalance of this engine left little or nothing to be desired. The absence of vertical motion was demonstrated by means of wires run under the wheels. These wires were flattened along the entire length.

F. J. COLE.

KANSAS CITY, MO., Dec. 10, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In your issue of December 2 there appears a communication from L. E. Moore regarding the counterbalancing of the Cole four-cylinder balanced compound No. 3,000 built for the New York Central by the American Locomotive Company. He says the claim is made in print that "the four cylinders are so arranged in relation to each other that the horizontal moving or reciprocating parts balance each other without the use of the customary counterweights for these parts in the driving wheels." After describing the way in which the engine is coupled up he says: "The customary counterweights are omitted in the wheels except enough to balance the side rods and a part of the mass of the cranks in the cranked axle." He then proceeds to show that such an engine would be anything but a balanced engine.

The writer has met master mechanics who did not understand the rudiments of dynamics, but it seems almost incredible that the designer of this engine could be ignorant or unmindful of the vertical forces acting on the main pins, cranks and cross heads due to the motion of the main rods. In the common types of engines we can balance in one direction, either horizontally or vertically, but not in both directions. In practice we have, therefore, a compromise in which we have over-balance in one direction and under-balance in the other.

The magnitude of the hammer blow of modern heavy engines when running at high speeds due to this defective balance and its destructive action on track and bridges is what has led to the building of a limited number of so-called balanced engines. The object sought in designing the balanced engine has been to practically balance all of the moving parts in both directions in order to reduce the hammer blow and to increase the driving axle loads without increasing the destructive action of the locomotive on track and bridges.

Is it not possible that Mr. Moore has been misinformed regarding the counterbalancing of the Cole engine? There is no difficulty in counterbalancing such an engine just as closely as an engine in which all of the cranks are connected on one axle. The vertical forces generated in the main rods are transmitted to the main pins or crank and to the cross heads in the proportion of about 7 to 1, depending on the design of the rods. What goes to the pins and cranks can be balanced by weights in the wheel centers. The horizontal forces of the counterweights being in opposite directions will balance each other. Owing to the transverse horizontal distance between the wheel centers and the inside rods, it might be well to divide the counterweights between the two wheels in the inverse ratio of their distances from the rods attached to them. The forces going to the cross heads are practically equal and opposite in direction, but, owing to the horizontal distance between their points of application, they produce an alternating couple which tends to rock the whole body of the engine. Since, however, we neglect the much larger similar couple caused by the working thrust on the main rods it is hardly necessary to consider them.

Without a diagram of the engine to consult, it would appear that the largest unbalanced forces in the Cole engine are due to the perpendicular distance between the centers of the piston rods on each side. If the writer remembers correctly, the inside cylinders are higher than the outside cylinders; therefore, we will have two alternating couples acting on the oblique planes passing through the centers of the piston rods. These would, of course, tend to give the engine the same "duck motion" which is found in under-balanced engines of the common type. The magnitude of these couples is easily computed, but, no doubt, it is but a small fraction of the somewhat similar couples set up in most simple engines.

ELLIOT HOLBROOK.

## Rail-Carrying Joints.

Paris, Nov. 25, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In connection with my previous communications published in your issue of November [illegible] 1903, and January 29 of this year, I beg to call attention to Mr. Haarmann's latest publication containing his lecture before the

"Verein für Eisenbahnkunde" May 10, 1904.

In your issue of November 6, 1903, you illustrated Mr. Haarmann's superstructure, tested on the Berlin high-speed test track. The wheel-carrying angle bar used there was unfavorably reported on by the "Central Organ der Bauverwaltung" November 11, 1903, and by the "Organ für die Fortschritte des Eisenbahnwesens," April, 1904. I will here only speak of a few points which may be of interest to American engineers.

Mr. Haarmann reports that the Prussian Minister of Railroads has recently ordered a further test to be made with his superstructure. This is rather surprising, coming so soon after the official condemnation of *all wheel-carrying joints*, and leads one to believe that the Minister has grown somewhat suspicious as to the correctness of his referee's theory. The Prussian Government railroads have been testing the different kinds of "Blattstoss" (lapped rails) on a large scale, but up to date they do not seem to have been able to arrive at any satisfactory conclusion, as otherwise they would not continue to equip all their main lines with the ordinary rail and angle bar.

The main objection to the "Blattstoss" was the increased weakness of the rail ends. Mr. Haarmann tried to overcome this by supporting the ends with his joint carrier. The results obviously were no more satisfactory than those which have been attained by supporting the foot of rail ends with bridges. As a last resource Mr. Haarmann took recourse to the wheel-carrying angle bar, and discovered that his joints with bridges and carrying bars, after a severe winter, were behaving better than all the others. He refers in his lecture to the remarkably good results which have been achieved in Saxony and Bavaria by equipping ordinary rails with wheel-carrying angle bars. These results are not new; they have been well-known for many years, such a device now being used on about 2,000 miles of track.

The most interesting point in his statement is that his joint carrier relieves the strain on the bearing surface of the angle-bars; in other words, that the angle-bars intended to support the rail ends necessitate being themselves supported. It is scarcely possible to explain more clearly the mistake which has been made for so many years by supporting the angle-bar on the rail ends, instead of relieving the weak ends of at least a part of the pressure. This can only be done by supporting the carrying joint immediately on the joint ties. Experience with my rolled joint has shown that by these means even old tracks with battered ends can be kept in shape for a great number of years, at the same time securing smooth riding and considerable reduction in cost of maintenance of way. There is therefore no reason whatever why the existing system of rails should be replaced by a more expensive one.

Those who claim the increased expense for replacing outer angle-bars by the Barschall joint to be a disadvantage do not consider that the saving in cost of maintenance of way, and still more, the saving of interest for so many years on investment for new rails, gives an immense return. With the present prices of rails there is good reason to employ the means at hand in order to prolong the life of rails. By using say 1,000 tons of rolled joints, about 10,000 tons of rails can be saved until they are worn out in their entire length. A "retrenchment" of this kind has more sense than all others.

Mr. Haarmann also said that he is making tests for the purpose of improving the efficiency of the wheel-carrying principle by changing the shape of the tread of the main rails; in September last, this change was made public as consisting in a flattening of the outer head. From the description of the "double rail joint" printed elsewhere in this issue it will be seen that in this direction Mr. Haarmann's ideas have been anticipated!

MAX BARSCHALL.

## Pernicious Diversity in Signal Practice.

THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY COMPANY.
CLEVELAND, OHIO, Nov. 21, 1904.

To the Editor of the Railroad Gazette:

I note that there is being put on the market a form of semaphore signal operated directly from a switch stand and located at the point of facing point switches. This semaphore in its form as well as in the position and light displaying indications is identical with the semaphore used at interlocking plants. It is so arranged that when the switch is set for main track the arm is lowered and the white light shown; when switch is set for siding the arm assumes a horizontal position and a red light is shown.

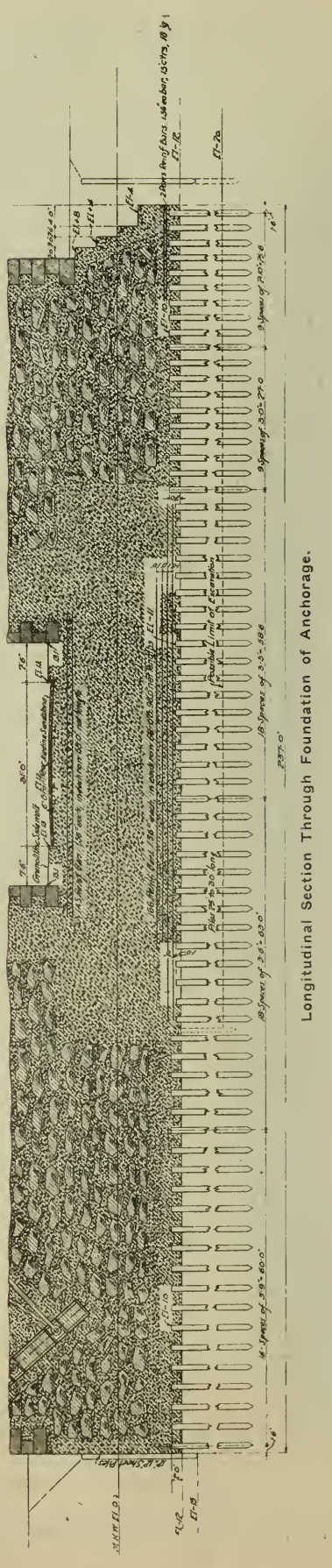
I think this device used in this way is wholly improper, in fact, pernicious, and that all who are interested in proper signaling should unite in protest against its being used in the manner in which it is intended to use it. In signaling by means of semaphores the rules in this country are well nigh universal. With arm in horizontal position, and (in addition) by night a red light indicates stop. The arm lowered, either 60, 75 or 90 deg., and, in addition, a proper light at night (on some roads green, on others white) indicates proceed.

Every semaphore signal should indicate one of three things, viz., stop, caution or proceed. Now in this device the semaphore is deliberately used to indicate, when in a horizontal position, that the switch is set one way, and when it is in an inclined position that the switch is set another way. I do not think there is anything that should be more vigorously objected to than the use of the stop indication of the semaphore signal as a means of conveying information regarding the position of a facing point switch. If such a switch-stand is to be used it should either be provided with two arms, so that a proceed signal can be given for either route, or there should be some additional indication to denote the position in which the switch is set.

AZEL AMES, JR.,
SIGNAL ENGINEER.

## Anchorages for the Manhattan Bridge.

The Department of Bridges, City of New York, has issued contract plans and specifications for the anchorages of the Manhattan Bridge, No. 3, over the East river about half a mile above the Brooklyn, and will shortly advertise for bids on the work. It will be remembered that under the former bridge commissioner plans for this bridge were prepared which contemplated the use of nickel-steel eye-bar chains with stiffening trusses and rocking steel towers. These plans were published in the *Railroad Gazette*, Dec. 4, 1903. The present commissioner, Mr. Best, on taking office last January discarded the proposed eye-bar chain cables and had the original plans for a steel wire cable bridge with fixed steel towers revised and completed. Last July these completed plans were submitted to the Municipal Art Commission for its approval, according to law, and were the subject of further controversy. Reproductions of the architect's sketches showing the completed bridge were published in the *Railroad Gazette*, July 1, of this year. The tower piers for this bridge are completed and the work on the anchorages now remains to be done before the superstructure can be started. When completed the

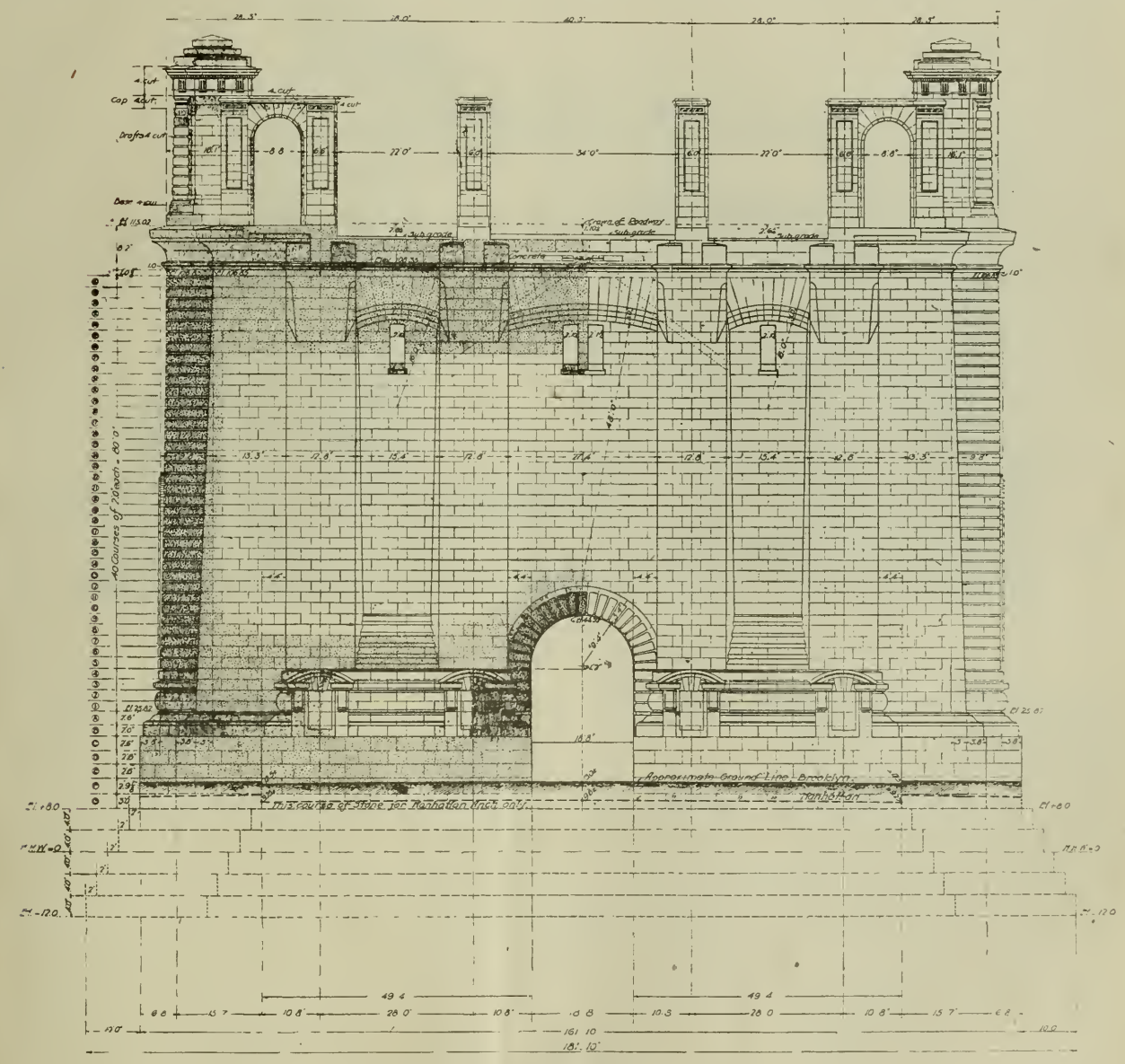


Longitudinal Section Through Foundation of Anchorage.

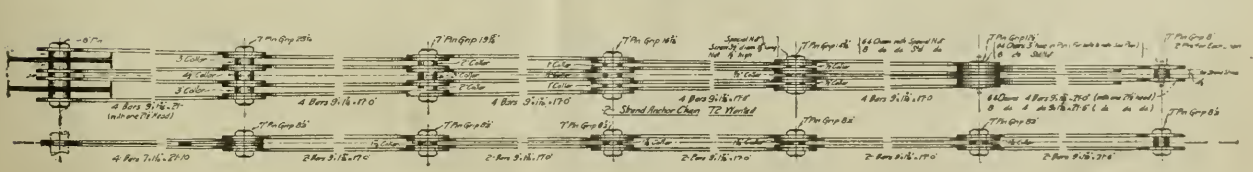
bridge will have a clear channel span of 1,470 ft., with two identical shore spans 725 ft. long.

The anchorages on both sides of the river will be identical and the foundations will cover an area 237 ft. x 181 ft. The Manhattan anchorage will stand at the intersection of Cherry street and Pike Slip, and the Brooklyn anchorage at the intersection of Adams and Water streets. On the New York side it is expected that piles will have to be driven on which to support the foundation, and the plans show the proposed depth and spacing to which they will be driven. They will be not less than 14 in. in diameter at the butt and from 25 ft. to 30 ft. long, spaced about 3 ft. center to center in each direction over the entire area of the foundation. The heads are to be cut off 2 ft. above the bottom of the excavation and bedded in the concrete. Provision is also made for reinforcing bars laid in rows longitudinally along the bottom of the foundation in the center and along the heel of the anchorage. The solid body of concrete will be about 6 ft. thick over the tops of the piles. On the Brooklyn side it is not expected that piles will be necessary. The excavation will be carried on inside of an open sheet piling coffer dam made of 12-in. x 12-in. timbers, tongued and grooved and driven 15 ft. below mean high water level.

Above the street level the exterior of the anchorages will be faced with cut granite masonry laid in courses 2 ft. thick. Aside from the ornamentation of the ring over the arched roadway under the middle of the anchorage and the flanking pilasters, there is no ornamentation of any kind below the level of the bridge roadway. The court or colonnade formed over the anchorages at the roadway has been treated with quite a little




Front Elevation of Anchorage, Manhattan Bridge.




Detail of Double and Single Eye-bar Chains, Manhattan Bridge.

elaborate cut stone work to relieve the massiveness of the whole structure. The roadway under the anchorages will be 46 ft. wide, including the two sidewalks, and the crown of the arch is 46 ft. above the pavement. The roadway on the bridge is 98 ft. above the surrounding street level.

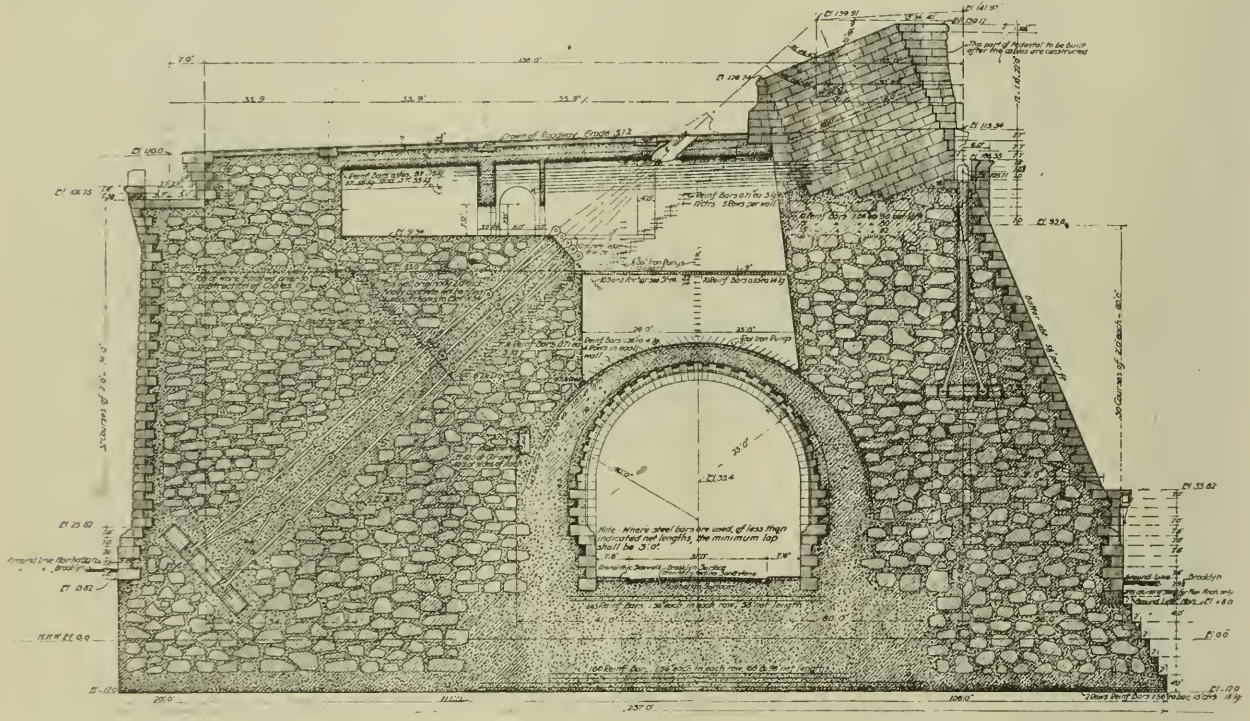
From the longitudinal section through the anchorage it will be seen that the masonry is carried up in two masses, a strut with a batter of 5⅛ in. per ft. on the outside face and a cubical mass over the heel in which

lower chains. The angle of inclination is 41 deg. 55 min. 14 sec.

The anchor girders are 4 ft. deep over flanges with $^{9}/_{16}$-in. web plates and 7-in. x $3^{1}/_{2}$-in. x $^{3}/_{4}$-in. angles for flanges. They are heavily reinforced around the pin holes with two plates on each side of the web, $^{9}/_{16}$ in. and ½ in. thick. The girders are 25 ft. long and are arranged in pairs for each bank of eye-bars. The connecting pins are 8 in. in diameter.

The bridge was designed in the office of

ment, with rails weighing 76.60 lbs. per yard (Belgian State Railway), the results were so unsatisfactory that they had to be taken out after they had been in use only a few years; they had been put in on certain lines over which more than 100 heavy trains (weight hauled, 300 to 600 tons) ran per day. The greatest objection to these sleepers was that the ballast, which consisted of broken porphyry, became crushed; they drew up the water from the subsoil into this crushed ballast and made it muddy; under



Longitudinal Section Through Anchorage Showing Anchor Chains and Roadway Arch.

the anchor bars are bedded. The space between these two masses over the arched roadway is divided into nine vaulted chambers separated by longitudinal walls, and stairways will lead down from the bridge roadway to the cable connections with the anchor chains and to the roadway below.

The main body of the backing in the anchorages will be Cyclopean masonry consisting of large stones roughly cubical in form with approximate level beds and vertical joints, bedded in, and filled around with concrete. Good quality granite, limestone or sand stone will be used, and at least 75 per cent. of the stones must have a volume of ½ cu. yd. or more. Concrete in the proportion of one cement to seven sand and from seven to 12 parts of 1½-in. broken stone will be used for filling in around the large blocks. Wherever steel work is to be bedded in concrete a mixture of one cement, six sand and from six to 12 parts of ¼-in. broken stone will be used.

The anchor chains and fastenings are divided into four groups, one for each cable. Each group consists of nine banks of three eye-bar chains each. At the upper end the eye-bars in each bank are spread out to give five points of attachment for the cables. They extend down 110 ft. in the concrete filling to the anchor girders in the heel of anchorage. Each chain consists of four 9-in. x $1^{7}/_{16}$-in. eye-bars. At the bottom end the middle chain is spread out and connected to the girders at the pins of the upper and

the Bridge Commissioner, Mr. George E. Best, under the direction of Mr. O. F. Nichols, Chief Engineer.

## Permanent Way for Fast Train Services.

The following extract is taken from the report on this subject for all countries except America, Germany, Holland, Rumania, Russia, Denmark, Sweden, Norway and Switzerland, prepared for the International Railway Congress by Mr. Van Bogaert, Chief Engineer and Director of the Belgian State Railway, and director of the company for laying out Chinese railroads. Thirty managements supplied information, from England, Australia, Austria, Hungary, Belgium, France, British India and Italy.

These managements use two kinds of rails: Bull-headed rails are used by the English companies, by three French companies and by two companies in British India. Symmetrical double-headed rails are used only by the French Midi Railway; the other railroads on the continent of Europe, the Australian railroads, two railroads in British India and one Irish railroad use Vignoles rails.

### *Rail Supports.*

The rails are supported on wooden transverse sleepers, and in the case of two Indian railroads on cast iron pot sleepers with iron tie bars. No railroad uses metal sleepers, and where they had been put in, as an experi-

the sleeper, a sort of macadam was formed which it was impossible to pack properly. These lines were abominable. Moreover cracks started from the holes provided for the fastenings. It might be possible to avoid the drawing up of the water by carefully draining the subsoil, and to prevent the cracks by drilling out the holes, but I do not see how the crushing of the ballast could be prevented. In Germany, there are heavy lines with fast traffic which have metal sleepers; they seem to give better results, but ballast of broken basalt is used, which is probably harder than ballast of broken porphyry.

In a recent paper Mr. Labordère, Engineer of Bridges and Roads, gives some interesting figures about the German lines with metal sleepers; he observes specially: "It is moreover very difficult, as far as the life of these sleepers is concerned, to take as basis any averages, as enormous differences present themselves. Thus, the metal sleepers replaced during the last few years in the Essen district, have had lives of 9, 11, 13, 15, 16, 25, 29 and 33 years respectively. The last figure but one applies to a line over which 32 trains run per day, and the first to one over which 75 heavy trains run every day; in the latter case, the life of the rails themselves did not exceed nine years. The sleepers which had a life of 13 years supported 102 trains per day."

The reporter a few days ago examined a piece of line between Mechlin (Malines) and

Antwerp, which was being taken up; it had been built, 12 years ago, of 29 ft. 6⅜ in. rails weighing 104.83 lbs. per yard supported on 12 sleepers of creosoted oak packed with a ballast of broken porphyry. The line was on the flat and 85 trains per day ran over it. 32 passenger trains (weight behind tender, 300 to 400 tons), three-quarters of which ran at a speed of 49.7 miles per hour, and 53 goods trains (weight behind tender, 500 to 700 tons), running at a speed of 24.9 miles per hour. A very few sleepers had become split and were no longer fit for use; the others had as a maximum a wear of six millimeters (¼ in.) just below the bedplate and no screwspike had worked loose in the wood. If it had not been for the wear of the bedplates, which we will refer to later on, those sleepers would have been fit for use for another ten years or so. As for the rails, they were again put in with new sleepers, and the wear of the heads, measured by the Zimmermann profilograph, varied from three to five millimeters (0.12 to 0.20 in.) as a maximum near the inner side (the web of these rails is vertical and the average wear at the middle of the crown is three millimeters [0.12 in.]). They are good for another 40 years or more as far as the wear of the head is concerned, although the steel is too soft (ultimate tensile strength 38.10 tons per sq. in.). I must say that I cannot understand that it should be necessary to take up rails after they have been in nine years on a line in the open, where only 75 trains pass per day, unless indeed this is due to one or more of the following causes: Too light a rail for the weight of the traffic, a rail rolled too hot, or too soft a steel. Probably metal sleepers, owing to their hardness, are conducive to a more rapid wear of the rails.

The figures given by Mr. Labordère show that on a busy line with heavy and fast traffic, a metal sleeper in Germany would have a shorter life, by one-half, than a creosoted and oak sleeper on the Belgian State Railway (with a rail weighing 104.83 lbs. per yard. It seems therefore that for the lines which we are at present considering, creosoted hard wood sleepers are not at all likely to be replaced by metal sleepers. It is probable that on lines with a medium amount of traffic or situated in hot or damp countries, the contrary would apply.

Metal longitudinal sleepers have disappeared from all lines with fast and heavy traffic; they are now only of historical interest.

*Weight of Rails.*

Everywhere on lines with fast trains, a tendency to increase the weight of rails is observed; it is, however, worth mentioning that some railroads still have rails weighing 60.48 lbs. per yard in use on such lines. Thus the French Northern Railway will only have removed the last in 1905. These rails, which are 26 ft. 3 in. long and are supported on 11 or 12 sleepers, may even have their heads worn to a certain extent and still be sufficiently safe. It is true that the heaviest wheel-load on that line only amounts to 8.1 metric tons, and that the fast and heavy trains are hauled by four-cylinder compounds, acting two and two on two driving axles.

These powerful and well-balanced engines are very stable, even at speeds of 74.6 miles per hour, and impart very little irregular movement to the vehicles hauled. The destructive action of the rolling loads on the track is thus reduced to a minimum, in spite of the great tonnage and great speed of the trains.

The reporter recalls to mind several runs he made in 1882 on locomotives hauling international trains between Ghent and Mechlin. When he stepped down from the locomotive at Mechlin, after a run of 35 miles in about 50 minutes without a stop, he remained absolutely deafened for some moments, so violent had been the noise, the oscillations and the vibrations of the locomotive, although it had inside cylinders.

Twenty-two years later, he went from Hal to Brussels on a four-cylinder compound with six wheels coupled, of the French Northern type, hauling a 210 ton train at a speed of 49.7 miles per hour; the smoothness of running was remarkable and to be compared with that of the carriages of 1882.

If we assume the weight and amount of traffic and its speed to be constant, then the better the construction of the rolling stock the lighter the rail that can be used and the less the rail will become worn.

For heavy and fast train traffic, however, heavy rails show many advantages as compared with light rails. It has been found on the Belgian State Railway that the wear of the 76.60 lbs. per yard rails amounted to about one millimeter per 70,000 trains (Vesdre line), whereas that of the 104.83 lb. per yard rails was one millimeter per 120,000 trains; this was determined by very careful measurements made on the flats and gradients of the Luxemburg line (ascents and descents of 1.6 per cent.), and on the lines from Brussels to Ghent and from Mechlin to Antwerp. Here practically the same rolling stock was used, and Bessemer rails made at the same steel works. The steel is a little too soft; it has an ultimate tensile srength of 38.10 tons per sq. in. and an elongation of 13 per cent.; its average chemical composition is 0.75 per cent. of manganese, 0.44 per cent. of carbon and 0.08 per cent. of silicon, sulphur and phosphorus. (The rails now rolled are of harder metal and have an ultimate tensile strength of 44.45 tons per sq. in.; specified minimum, 41.27 tons per sq. in.)

The heavier rails break less than the lighter rails (transverse fractures).

In 1903 there were taken out from the main lines of the Belgian State Railway, on account of transverse fractures, 401 of the light, 76.60 lb. per yard rails, and nine of the heavy 104.83 lb. per yard rails. Now, of these main lines 4,970 miles are laid with 76.60 lb. rails and 870 miles with 104.83 lb. rails. It is however true that the average age of the 76.60 lb. per yard rails broken is about 20 years or even more, whereas the average age of the 104.83 lb. per yard ones is only 13 years.

Sixty-three of the 104.83 lb. per yard rails were taken out during 1903 because they showed longitudinal fractures due to large blow-holes. In such cases the crown began to flatten gently, and then part of the head flaked off; we intend to return to the subject of such fractures in the chapter on the manufacture of steel.

Other things being equal, it has been determined on the Belgian State Railway system, that less maintenance was required for the track with heavy 104.83 lb. rails than for the track with 76.60 lb. per yard rails. On the busiest lines only one man is required for every two kilometers (1.2 mile) of single track.

Such rails are therefore to be recommended where a very busy traffic makes maintenance difficult and where labor is costly.

If plenty of capital is available at a cheap rate, and when steel is cheap and the concession of the company has a long time to run, it seems an advantage to use very heavy rails for busy lines with fast traffic. Moreover, when a heavy rail has lost about 10 per cent. of its weight by wear, it may be re-rolled; thus a rail is obtained the steel of which is improved because it could be rolled at the low temperature desired (850 deg. C. [1,562 deg. Fahr.]).

The weight of the rail varies on the different railroads between a minimum of 60.48 lbs. per yard (older types) and a maximum of 104.83 lbs. per yard. It may be said that the rails now supplied for first class railroads, over which heavy trains run at a speed of 74.6 miles per hour, weigh between 86.68 and 104.83 lbs. per yard.

*Rails With Inclined Web and Rails With Vertical Web.*

The web is as a rule inclined about 1 in 20, so that a new tire is in contact with the middle of the rolling surface of the crown. Only two Austrian railroads and the Belgian State Railway set the rails so that the webs are vertical; this is also the general practice in the United States of America. This is no serious disadvantage as far as the wear of the crown is concerned, but we think that this practice leads to abnormal wear of the tread of the tire, near the flange, during the years which elapse until the rolling surface becomes worn down to an inclined plane. Moreover, when a wheel runs over a rail, the rail is canted, and as a consequence the inside fishplate has to support the greater part of the stress due to the bending at the fishjoint, if the joints are suspended joints with weak fishplates, those on the inside become broken in a few years (outside fishplates very seldom break). In America, where the rails are also set with the web vertical, fishplates break equally frequently; such fractures do not occur so frequently with the rails inclined, and on such there is probably no difference between the numbers of fishplates broken inside and outside.

We only see disadvantage and no advantages in setting the rails with the web vertical.

*Width of Crown and Curvature of Its Surface.*

The width of the crown varies from 2⅜ to $2^{13}/_{32}$ in.; it would perhaps be an advantage to have it still wider, as at present tires are materially wider and wear hollow. If the width of the rail was a little less than that of the tread, say $3^{17}/_{32}$ in., the taper of the tire would be better maintained and the wear of the two articles in contact (tire and rail) would probably be reduced.

There are other advantages in widening the crown, as we shall see later on.

On two of the railroads, the French Northern and the French Eastern, the central part of the rolling surface is flat over a width of ⅞ in.; on the Lancashire & Yorkshire this flat has a width of $1^{9}/_{16}$ in. All the other railroads have this surface curved; average radius, $7^{3}/_{32}$ in. Soon after the rails have been put in this curve disappears, but not without damaging the tires by producing hollows in them. We think that the three railroads which form the exceptions are in the right and that the English railroad, the Lancashire & Yorkshire, has the best arrangement. The ideal would be to have a plane surface in contact with the tire over as great a width as possible; the mutual wear of the rail and of the tire would keep the tread of the latter conical over its whole width.

The corner between the rolling surface and the vertical sides of the head may be rounded off to a radius of $^{25}/_{64}$ in., as found on worn rails (the Paris, Lyons, Mediterranean has a radius of $^{5}/_{16}$ in. only).

*Thickness of Head.*

It is useless to give too much thickness to the head. With rails which have a strong cross-section, and are made of hard and tough steel, the wear does not amount to 0.04 in. per 100,000 or 120,000 trains. On busy lines with fast traffic where the weight of the trains and the wheel-loads are not

excessive (and this applies to all the railroads which we are considering) it is enough to have as minimum 1⅜ in. at the thinnest part. The rails on a line in the open will then not require to be taken out, on account of the wear of the head, till after 50 years.

*Inclination and Size of the Surfaces on Which the Fishplates Bear.*

The inclination varies between 1/2 (general practice) and 1/5 (Belgian State Railway); the greater the inclination the more work the bolts have to do. The inclination on the Belgian State is too small. What happens is, that by the mutual wear of the fishplates and the surfaces on which they bear, the vertical face of the fishplate soon comes in contact with the web of the rail; the inclination of 1/5, however, is enough for the flange, for the surfaces there are in contact over a width of $1^{27}/_{32}$ in., as compared with a width of $^{43}/_{64}$ in. under the head. It seems rational to have two different inclinations for the head and for the flange. The Vignoles rail of the Victorian Railways shows this peculiarity; the inclination is 1/3 under the head and 1/5 on the flange.

A small inclination of the bearing surfaces (*e. g.* 1/4) gives, other things being equal, a tighter fishjoint than a larger inclination (*e. g.* 1/2); the rails, if the fishbolts are drawn up tight, and if considerable changes of temperature occur, only move with difficulty relatively to the fishplates, or even not at all, and strains are thus produced which may result in fractures. From this point of view, small inclinations are suitable for very heavy rails and larger ones for too light rails. In countries where there are extreme temperatures, having too good fishjoints may produce the fracture of rails which are too light for the traffic.

When a Belgian State 104.83 lb. rail, which has been in use for a dozen years or so on a line with very heavy traffic, is examined, it is found that there is a considerable wear at the bearing surface under the head (up to one millimeter), but not at that on the flange. It is therefore advisable to increase the bearing surface under the head; this may be done by making the head considerably wider, *e. g.* $3^{15}/_{32}$ in. wide.

This wear at the surfaces on which the fishplates bear, can also be reduced by using rails made of a little harder steel (having an ultimate tensile strength of at least 44.45 tons per sq. in.) and stronger fishplates, made of harder steel. The fishplates at present used are of very mild steel and become worn very quickly near the joint; but as soon as this wear has been produced, the joint becomes unsatisfactory, owing to the play between the fishplate and the rail, and the blows produced by rolling loads then deform not only the fishplate but also the rail.

*Web of the Rails.*

The thickness of the web of the Vignoles rails varies from $^{15}/_{32}$ to $^{45}/_{64}$ in. The web of double-headed rails is as a rule thicker and goes up to $^{27}/_{32}$ in.; the web of these rails is subjected to more wear where it is in contact with the jaws of the chairs.

In order to increase the stiffness of the rail, it is advisable to increase as much as possible the height of the web. This varies from $3^{7}/_{32}$ to 4⅛ in. (Victorian Railways) (measured from bottom of head to bottom of flange). A considerable height of web makes it possible to use fishplates having a large moment of resistance.

*Flange: Thickness and Width.*

The Vignoles rails which have the part of the flange on which the fishplate bears at a considerable inclination, have the upper surface of the flange hollowed. This shape is a very advantageous one for rolling, because the volume of the flange approaches that of the head; there is less danger of splitting the flange when the rolling is done at a low temperature. On the other hand, the width of the surface on which the fishplate bears is reduced, and a small inclination seems to be better for resisting the action of the fishplates. Heavy Vignoles rails with the bearing surface at an inclination of 1/5 must have the flanges not less than $^{33}/_{64}$ in. thick at their thinnest point, particularly in the case of rails supported on steel bedplates, as the flanges of such rails become appreciably worn just over the bedplate (about 1/3 of the wear of the head). Moreover, heavy rails having a thick flange are easier to roll and are of better quality than those with thin flanges, as the former can be rolled at a lower temperature without risk of splitting the flanges. We do know that if we compare two rails made from the same ingot, one rolled at a low temperature not exceeding about 850 deg. C. (1,562 deg. Fahr.), the other rolled at an appreciably higher temperature, say 950 deg. C. (1,742 deg. Fahr.), the former will prove to be of better quality.

The flange may have less width if the rail is supported on steel bedplates. Of the railroads which do not use steel bedplates, the French Eastern has the narrowest flange relatively to the height of the rail (width of flange, 5⅛ in.; height of rail, $5^{9}/_{16}$ in.), and the Victorian Railways the widest (width of flange, $5^{19}/_{32}$ in.; height of rail, 5⅞ in.).

Of the railroads which use steel bedplates, the Austrian North Western has the narrowest flange (width $4^{3}/_{32}$ in.; height of rail, $5^{15}/_{32}$ in.).

*Bedplates.*

Most of the railroads using Vignoles rails support them on steel bedplates; the French Northern and French Eastern support them on slabs of felt or of creosoted poplar wood; the two Australian railroads place the rails direct on the sleepers.

We think that the use of steel bedplates gives a harder track and promotes the wear of the rails not only at the flange but also at the crown.

We notice, if we travel from Paris to Brussels, that the trains run more smoothly while on the track of the French Northern than while on that of the Belgian State, although they are going faster when on the former and although the track of the Belgian State is the more solidly built one. There is no appreciable difference in the hardness of the ballast used; the French Northern uses broken slag, the Belgian State broken porphyry; the difference in the smoothness of the running can only be due to the fact that the Belgian State uses steel bedplates.

The following is what is observed on a line of the Belgian State Railway, which had 104.83 lb. rails put in 12 years ago, and over which 85 trains run per day: minimum wear of one millimeter at the horizontal surface of the bedplate and of that part of the sole of the rail in contact with it. As the bedplate has a border on to which the head of the screwspike takes, a border which does not become worn as much as the bearing surface of the rail and bedplate the inner side of the head of the screwspike is no longer in contact with the upper surface of the flange of the rail, and the play between the two makes it possible for the track to spread from $^{9}/_{32}$ to $^{28}/_{64}$ in. The outside vertical edge of the flange works into the vertical part of the bedplate to the extent of $^{13}/_{64}$ to $^{15}/_{64}$ in.; the flange on the inner side is then no longer held by the screwspikes, and the passage of rolling loads produces a hammering effect of steel against steel. This quite explains the less smooth running on the track of the Belgian State Railway. It would seem that greater wear of the head should also result, but this is difficult to control experimentally, as the conditions of working and of hauling are so different on the French Northern and Belgian State Railways. Moreover other factors, such as the hardness of the rails and their moment of resistance, and the tonnage of the trains, come into play and it is impossible to eliminate them; it is, however, observed that the 86.68 lb. rails of the French Northern show for the same number of trains (but weighing less) a somewhat smaller amount of wear at the head than the 104.83 lb. rails of the Belgian State (the latter show one millimeter [0.04 in.] per 120,000 trains and 60 millions of tons hauled.

According to Haarmann, the rails of the Prussian State (between Cologne and Hamburg, near Osnabrück), the hardness of which may be compared to that of the rails of the French Northern (ultimate tensile strength 44.45 tons per sq. in.) and which weigh 82.65 lbs. per yard and are supported on strong bedplates, become worn at least one millimeter by 45,000 trains, representing about 24 millions of tons hauled; whereas the 86.68 lb. rails of the French Northern, between Paris and Creil, as supplied by steelworks A, only become worn one millimeter by 160,000 trains, representing about 48 millions of tons hauled. Rails supplied by another steelworks B, which were made of softer steel, became worn one millimeter by 120,000 trains, representing 36 millions of tons.

It is, however, observed on the Prussian State Railway, that the tracks with metal sleepers give practically as smooth running as the tracks with wooden sleepers and strong bedplates, and that the wear of the heads is about the same in both cases. Does this not rather show that steel bedplates will make tracks so hard that they will approximate to tracks on metal sleepers?

On the section of line referred to above, between Mechlin and Antwerp, it was found that the intermediate sleepers with bedplates show twice the amount of impression as the joint sleepers; the latter have no bedplates. The two joint sleepers are protected against having the flange of the rail driven into them by the horizontal flanges of the supporting fishplates; but at certain parts of the track, two pieces of fishplate were bolted to the web of the rail and secured to the two middle sleepers, in order to prevent creeping; the impression on even those middle sleepers was less deep, and the sleepers were in as good a state as those which had bedplates on them. This method of securing the rails to the sleepers by means of pieces of fishplate will probably replace bedplates, with considerable advantage.

Another disadvantage, but a slight one, of bedplates is that they facilitate creeping, for very soon the wear of the bedplate results in having some play between the edge of the screwspike and the flange, and the rail slides more easily on a worn surface of steel than of wood. As a rule, the railroads which use Vignoles rails with or without bedplates have succeeded in counteracting creeping; that disadvantage of bedplates is, therefore, among those which are of minimum importance.

Besides these disadvantages of the steel bedplates, there are also sundry advantages which have led to their adoption. We think that they are very useful, perhaps even indispensable, in the case of soft wood sleepers; but if the sleepers are of beech or of oak, the disadvantages of metal bedplates seem to outweigh their advantages.

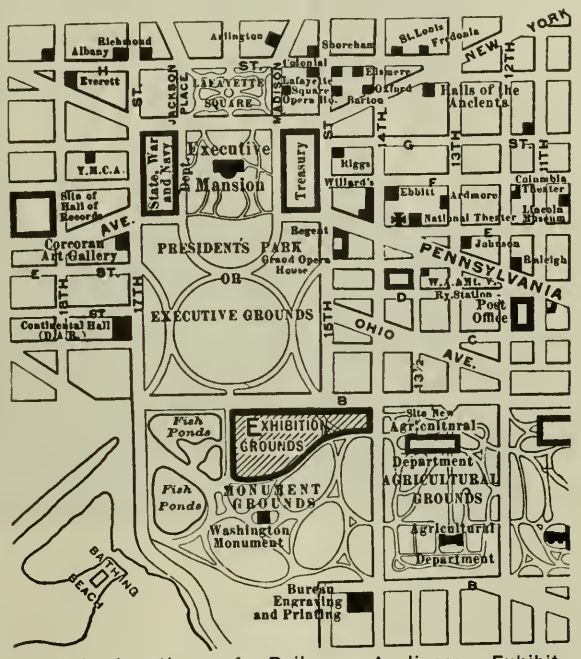
*(To be continued.)*

## Exhibits at the International Railway Congress.

Mr. George A. Post, Chairman of the general committee on arrangements for the American Railway Appliance Exhibition to be held in Washington, D. C., in May, 1905, in connection with the meeting of the International Railway Congress, has been in Washington since December 5, in company with Mr. J. Alexander Brown, Secretary and Director of Exhibits, presenting the matter before Congress. It was necessary to have passed by Congress a special act authorizing the Commissioners of the District of Columbia to permit the proposed exhibition to be held on the site selected, known as the White Lot. Mr. Post and the members of the committee on arrangements have been working since last summer in the interests of the exhibition and have made strong appeals to the members of Congress for the passage of such an act. On Monday, December 12, the Senate passed the necessary joint resolution after it had been unanimously approved by the members of the District of Columbia Committees of both the house and the Senate. In the house the vote in favor of the resolution was unanimous with the exception of Congressman J. R. Mann, of Chicago, who bitterly opposed the passage of the resolution and resorted to filibustering tactics to defeat it, finally raising the point of "no quorum" in the House, which temporarily retarded the passage of the bill. Mr. Post, however, has assurances from the leaders of the majority and minority sides of the House of Representatives that the resolution will come up again on Monday, December 19, which is known as "Suspension Day" when bills may be passed by a two-thirds vote. It is confidently expected that at that time the further opposition of Mr. Mann will prove futile.

The position of Mr. Mann is that he is unalterably opposed to the use of any public reservation for private purposes, which position he has a perfect right to maintain but his resort to filibustering tactics simply to maintain his personal views on the policy of the measure, which had previously passed the Senate unanimously, which was approved by the Secretary of War, by the Commissioners of the District of Columbia and by every other member of the House of Representatives, was an unexpected attitude, to say the least, particularly in view of the fact that in the city of Chicago, which he represents in part, nearly 100 manufacturers have signified in writing their earnest desire that the measure should be passed and many of them have appealed to Mr. Mann in person for his support of the resolution.

The resolution, which has already passed the Senate, authorizes the Commissioners of the District of Columbia and the Secretary of War to grant permits to the American Railway Appliance Exhibition for the occupation of the plot of ground near the Washington Monument which is known as the White Lot, and which is shown on the accompanying map of a part of the city of Washington, between March 20 and May 25, 1905. It gives the general committee on arrangements the right to construct temporary buildings on the ground, lay steam, gas and water pipes and string electric wires from the nearest source of supply into the reservation and to lay tracks and switches on the streets from the railroad to the grounds for the transportation of exhibits and material.

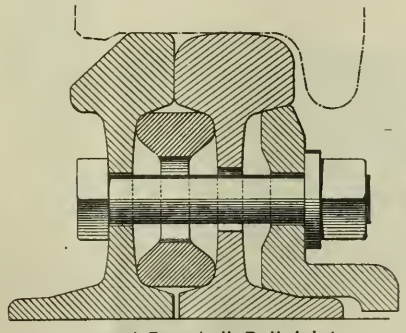



Proposed Location of Railway Appliance Exhibit, Washington.

The exhibition assumes all liability and must have all of its plans approved by the Secretary of War.

## Improved Barschall Rail Joint.

The Barschall wheel-carrying rail joint in its original form has been extensively tried in Europe and to a limited extent in this country and although it has some objections, on the whole, the results obtained from its use have been generally favorable, to judge from reports received from a number of



Improved Barschall Rail Joint.

roads in Germany and Austria which have the joints in track. One road which has an experimental stretch of track 12 miles long laid with these joints, put them in only after expensive trials of flat-plate joints and angle bars. The line was originally laid in 1885 with 78-lb. rails, 25 ft. long with flat-plate joints. The ends of the rails became battered and worn out while the body of the rail was in good condition. Angle bars were tried with no better results and in 1899 the Barschall type of supported joint was put in. The results have been very satisfactory and would seem to indicate that where the ends of the rails have been battered and worn out while the remainder is in good condition, a supported joint can be used to good advantage. The cost of maintenance of track fitted with these joints is about $16 less per mile per year than for adjoining sections of track laid with angle-bar joints.

Those roads which have used this type of joint are almost unanimous in saying that the riding qualities of track fitted with them are greatly improved, that there is less wear-and-tear on rolling stock and that the rails themselves last longer than with the ordinary angle bar joints. The one objection to the old form of joint which is in use so extensively in Saxony and Bavaria is the effect of false flanges worn on wheels, which batter down the outside or supporting rail. The efficiency of a joint of this kind depends on two conditions; false flanges clearing the joint, outward and downward; and the uneven tread of worn wheels being equalized by the independent deflection of the two bearers at the joint. These conditions are not entirely fulfilled by any previous forms of lapped rail-ends, joint bridges or wheel-carrying angle bars. In the improved form of the Barschall joint shown in the accompanying illustration these conditions have been met and the best features of the three types of joints referred to have been embodied in it without the inherent disadvantages of each.

In 1903, an official report on the performance of the original type of Barschall joints laid in a stretch of track on the Berlin-Halle line, commented unfavorably on them because of the destructive action of the false flanges. The width of the bearing surface at the joint on this stretch is 3⅞ in., and the head and foot of the filling piece between the main rail and the joint rail was made so wide as to partially prevent its free canting under the deflection of the rails. In this country the joints experimented with on the Pennsylvania Railroad were also too wide, being $3^{9}/_{16}$ in. across the bearing surface; yet notwithstanding this serious defect in detail the principles involved have been shown to be correct. Mr. L. F. Loree, who recently resigned from the presidency of the Rock Island, examined the experimental track near Berlin in 1898 and in his report said:

"I have found a double-track stretch on the line between Berlin and Halle on which one track is laid with Thomas steel rails weighing 41 kg. per meter (83 lbs. per yd.) with Barschall joints and the other track laid with Bessemer steel rails and angle-bar joints. Both tracks had been in use for the same length of time. The track with Barschall joints showed the joints to be in good condition but the rest of the rail in bad shape, while the other track showed the reverse, rails in good condition and joints in bad shape." Even with the faulty design of having the bearing surface too wide the wheel-carrying joint proved to be superior to the angle bar joint.

The improved joint illustrated here has been redesigned as a result of the experiments on the Pennsylvania and in Europe, and while it combines all of the principles of the original joint and some new ones it has none of the inherent defects of its predecessors. It is intended to be used with a rail section, also of new design, in which the head is not symmetrical but is ¼ in. narrower on the outside of the web than the Am. Soc. C. E. standard section for 85-lb. rail. This brings the web of the main rail and the outside supporting rail ¼ in. closer together and the outside or carrying rail is made symmetrical with the main rail. The

total width of the bearing surface of this improved joint is less than 3 in. so that it will clear any false flange, as shown in the drawing. Shorter and therefore stronger bolts can be used. The head and foot of the filling piece being narrow, this proportionately facilitates its canting and therefore the independent deflection of the two rails.

It has been found that in all cases the outer rail carries the greater part of the load at the joint and this has therefore been correspondingly strengthened by making the base symmetrical and cutting off part of it on the inside. The flanges on the main rails are cut away on the inside at the joint and the partial inside flange of the outer rail fits into the recess so formed. This gives the outer rail additional support on the ties and the weakening of the main rail ends is not objectionable because the outer rail carries the load. The proposed unsymmetrical rail can be made by re-rolling old and battered rail in a manner similar to the McKenna process and a better and more homogeneous metal obtained than in the original rail.

Patents on this improved joint were issued to Max Barschall on November 22, last. These joints are not sold outright, but, by arrangements with the patentee, railroads can have them made anywhere. The American office of Mr. Barschall is 31 Nassau street, New York.

## Three Historic Locomotives—and Some Others.

BY HERBERT T. WALKER.

It will be remembered that the Transportation Exhibit at the Columbian Exposition of 1893 included an extensive and highly interesting display of historical locomotives, illustrating the development of transportation by steam from Sir Isaac Newton's suggestion—made in the year 1680—for a vehicle to be propelled by a jet of steam working on the reaction principle, down to specimens of the locomotive engine of the present day.

Fig. 3—Seth Wilmarth's "Pioneer," First Engine in the Cumberland Valley, 1851.

Fig. 2—The "Mississippi," First Engine in the Lower Mississippi Country, 1834.

The principal part of this representation was formed by the collection made by the Baltimore & Ohio Railroad Company, under the direction of Major J. G. Pangborn, who visited Europe as well as the leading railroads and engine builders of this country, gathering a large amount of data of early locomotives which enabled him to construct full-size reproductions of nearly all the types of early engines. Specimens of real locomotives were also secured; and these invaluable acquisitions, with the models, supplied important links in the chain of locomotive history, which, however, at that time was far from complete.

Even in its then imperfect state the display was of the highest interest and importance, inasmuch as it was absolutely unique in the history of expositions, and opened a new field in the study of railroad history—a difficult and complex subject, and one, moreover, that has never been written in book form.

This collection was bought by the Field Columbian Museum, and at the close of the exposition it was duly installed in the Museum's handsome building; and from thence it was transferred to St. Louis. In the meantime Major Pangborn had been busy acquiring additional historical material both in this country and in Europe, thus supplying missing links and forming a chain of locomotive evolution and development that is now practically complete; and it formed perhaps the most attractive section of the Transportation Exhibit at the St. Louis Fair.

Most of the more important engines now on exhibition have been previously noticed in the columns of this journal from time to time, and it is proposed in the present article to examine only the more noteworthy recent additions; though in passing a word may be said about the exhibit as a whole. This unparalleled collection of historical engines includes about sixty specimens, many of them actual engines, and the rest full size reproductions, mostly of wood. Among the landmarks of locomotive history will be found Trevithick's tramway engine of 1803; Stephenson's "Rocket" of 1829; Jervis' "Experiment" of 1832, the first engine with a leading truck; Eastwick and Harrison's "Hercules" of 1837, the first engine with equalizers; several of the original "grasshoppers" built in 1832 and subsequently; some of Ross Winans' "camel" engines; the "Buffalo" of 1844, and the "Peppersauce" of 1862.

The subject of the evolution and develop-

ment of permanent way has now received more attention than it has hitherto, and every example of motive power stands upon the track of its period—in many instances upon original rails, stones, etc.; in others on a faithful reproduction. There is also an extensive showing of tie or sleeper history.

Another novel feature is the introduction of life-size figures of contemporary engine-drivers and firemen on the different examples of motive power. It is a matter of opinion whether such an adjunct is appropriate to an exhibition of a scientific character, but the attitudes of the figures are in most cases natural, and, to the general sightseer, they probably produce an atmosphere suggestive of life and motion.

The principal historical additions to the collection since 1893 are the engine "Pioneer," contributed by the Chicago & Northwestern Railway; the "Mississippi," from the Illinois Central, and Seth Wilmarth's "Pioneer," from the Cumberland Valley Railroad. All three are the actual locomotives—not reproductions—and are a great acquisition.

The Chicago & Northwestern "Pioneer" is illustrated in Fig. 1. It is a Baldwin engine and was built in the year 1836. In 1848 it was transported by lake from Buffalo to Chicago, where it was put to work on a road that is now a part of the Chicago & Northwestern. It was the first engine seen in Chicago, and did duty altogether for thirty-five years. Baldwin built many engines of this type and they did satisfactory work. The engine before us is inside connected, with half cranks. The driving boxes and valve motion are outside, and the eccentric rods have drop V hooks. The engine weighs about 10 tons and appears to be well preserved.

Fig. 2 shows the engine "Mississippi," said to have been built in England in the year 1834, and imported to the United States in 1836. It was the first locomotive in New Orleans, and ran on the Natchez & Hamburg Railroad, now a part of the Illinois Central. In 1868 the engine was removed from Natchez to Vicksburg, where it did switching work. Then it was laid aside and became gradually buried in sand, until 1878, when it was exhumed and put to work on the Natchez, Brookhaven & Meridian Railroad, where it ran until 1891.

An examination of this engine shows that it is now probably not as originally built; neither can it be ascertained who were the builders, nor does it possess any of the earmarks of an early English built engine. Furthermore, a search through the Government Report of 1838, giving a list of locomotives used on American railroads which were imported from England, fails to show any English locomotives at New Orleans or the railroad where the "Mississippi" orignally worked. It is possible that some of the parts were purchased in England, as it is known that at least one of the minor firms of engine builders bought parts of locomotives from there, making some of the smaller fittings in their own shops, and so turning out a complete engine as of their manufacture. But however this may be, the "Mississippi" is a curious engine, with its cab the whole length of the boiler, and will repay a careful examination. The cylinders are 9½ inches diameter by 16 inches stroke; driving wheels 43 inches diameter; weight about 7 tons.

The next engine claiming our attention is the "Pioneer" illustrated in Fig. 3. This locomotive is of more than ordinary interest, for it was built by Seth Wilmarth, who was an engine builder of some note in the early fifties. His shops were situated at South Boston, and he built many engines for the Boston & Worcester, the Hudson River, the Eastern of Massachusetts and the Old Colony Railroads. His designs were generally patterned after the Hinckley engine of those days; but they had some points of originality, as for instance, leading and trailing four wheel trucks, he being, probably, the first to design this wheel arrangement, which was repeated by later builders, and was discussed in the *Railroad Gazette* of June 17 last, page 29. Fig. 6 in that article probably shows a Wilmarth engine, but the writer was not aware of it at the time.

The "Pioneer" has cylinders 9 inches diameter by 14 inches stroke, driving wheels 54 inches diameter, weight 13 tons. It is a tank engine and has a single pair of driving wheels—types of the locomotive that are not, and never were, so common in the United States as in Great Britain. The boiler has a wagon top and the steam and exhaust pipes come outside the smokebox, where they enter the valve chest at the back side. The valve chest cover is on the front side of the chest instead of the top, and neither the pipes nor chests have any lagging. The sand boxes are on the driving wheel guards, but side elevations of the engine which have been published show a sand dome on the boiler barrel, which was probably its original position. The engine has link motion. The connecting rods and other working parts are very light, but the engine was probably never used for heavy work. It was built for the Cumberland Valley Railroad in 1851, and is said to have never been changed or remodeled. As the engine ran for 40 years, this is a remarkable record.

Fig. 1—The "Pioneer," First Engine in Chicago. Built in 1836.

In order to indicate locomotive practice at exposition periods, it has been decided to include as a permanent part of this collection the Baltimore & Ohio engine "600" shown at the Philadelphia Centennial Exposition, 1876, where it was awarded a prize. This engine is said to be the first passenger mogul, and was built for "fast" traffic over mountain grades. The exposition period of 1893 is represented by the "Royal Blue" express engine "Director General," shown at Chicago in that year. This engine will also be included as a permanent exhibit. It is a Baldwin compound and is a fine piece of work.

The strictly modern examples in the B. & O. exhibit are "the Governor Francis," a consolidation engine built by the Rogers Locomotive Works; the "Missouri," an engine of the Atlantic type; and the "St. Louis," built by the American Locomotive Co., all for use on the Baltimore & Ohio. This latter is the huge Mallet articulated compound engine, and is unquestionably the most notable of modern locomotives. As particulars of all these engines have been published, it is not necessary to repeat them here.

Of the vast assemblage of drawings, photographs and models covering the whole field of land transportation by steam, it is impossible even to make mention. Some of the more recent acquisitions are four models of trains, contributed by the Egyptian State Railroads, and illustrating freight practice in that country. There is, also, a model of the Rigi Railway and several other additional models of English and other locomotive practice of the sixties and seventies. These models are, generally speaking, made to a scale of one inch to the foot.

The total exhibits in this unparalleled representation occupy something over sixty-two thousand square feet of floor space, to say nothing of all available parts of walls, column pedestals and screens, which are occupied by pictorial representations and smaller objects—the evolution and development of brake mechanism being fully illustrated.

The amount of labor involved in the collection, classification and arrangement of such a large and diverse display can only be imagined. Much credit is due to Major Pangborn and his associates for the energy and zeal they have thrown into their labors. The value of the display, from an educational standpoint, can scarcely be overestimated, and foreign attention has been thereby attracted, so that special reports are being prepared upon it at the instance of European governments.

It is gratifying to know that good progress is being made toward making of this great collection the nucleus of a permanent museum devoted to the railroad and allied interests.

No extension of the Simplon Tunnel was effected at either end during October, the work being confined to walling out the hot-water spring and providing the cooling apparatus to make it possible to resume drilling in front of it. There remained 794 ft. between the north and south headings. The water discharges from the south end of the tunnel at the rate of 190 gallons per second. About the middle of November the work of isolating this hot spring was completed, a covered masonry channel having been pro-

vided to drain it away without heating the tunnel to an insufferable degree, and cold water being conducted inward by pipes to reduce its temperature. This covered channel is a mile and a half long. If no further unforeseen obstacles are met, the contractors hope to reach the excavation from the north by the middle of January.

### Western Union Loses Its Suit Against the Pennsylvania.

The Supreme Court of the United States in an opinion by Justice McKenna has decided the case of the Western Union Telegraph Company against the Pennsylvania Railroad, involving the right of the railroad to remove the telegraph company's poles from its right of way, in favor of the railroad company. The court holds that the act of Congress of July 24, 1866, which controlled the case, does not grant eminent domain to telegraph companies over the private property of railroad companies. The case originated in New Jersey. The telegraph company contends that the necessary implication from the provisions of the act of 1866 permitting telegraph companies to use post roads is that telegraph companies may appropriate for their poles and lines a part of the rights of way of railroads on paying just compensation, may exercise the right of eminent domain. But there is nothing in it which provides for condemnation or compensation. The power of eminent domain is against common right. It subverts the usual attributes of the ownership of property. It therefore must be given in express terms or by necessary implication.

Responding to contentions on the part of counsel for the telegraph company that railroads are not essentially different from other highways, Justice McKenna said:

"This argument would seem to make a railroad right of way public property. To that extreme we cannot go. The right of way of a railroad is property devoted to public use, and has often been called a highway, and as such is subject, to a certain extent, to State and Federal control, but it has always been recognized that a railroad right of way is so far private property as to be entitled to that provision of the Constitution which forbids its taking except under the power of eminent domain, and upon payment of compensation.

"It follows from these views that the act of 1866 does not grant the right to telegraph companies to enter upon and occupy the rights of way of railroad companies, except with the consent of the latter, or by grant of eminent domain. Nor does the statute of New Jersey make those rights of way public property so as to subject them to such occupation under the provisions of the act of 1866. It is admitted that the statutes of New Jersey do not confer the right of eminent domain upon telegraph companies. It happens to be the policy of New Jersey not to grant eminent domain to telegraph companies, and a railroad's right of way enjoys in that State the same immunity from compulsory proceedings as other private property enjoys. But this has no bearing on the act of 1866, nor does it make that act, as construed by us, a grant to railroads of greater power over commercial intercourse by telegraph than the States have. . . .

"Interstate commerce by the telegraph has marched to a splendid development, although in the acquisition of the means for its exercise it has, for the most part, relied on purchase, or eminent domain granted by the States. We cannot but feel, therefore, that there is something inadequate in the argument which is based on the apprehension that the act of July 24, 1866, construed as we construe it, gives a sinister power to railroad companies. It gives no power to those companies, but that which appertains to the ownership of their property."

In a dissenting opinion Justice Harlan expressed the opinion that "it was intended by the act of 1866, in the interest of the postal service and of interstate commerce, to throw open all the post roads of the country to the use of telegraph companies accepting its provisions, subject always to the condition that the use should not interfere with ordinary travel on the road occupied."

Summing up, Justice Harlan said: "Practically the railroad corporations operating post roads, looking to their own interests and caring little for the general welfare, may give exclusive privileges in the matter of interstate telegraph communications, while the States are prohibited from so doing. Thus a railroad corporation is recognized as having more power than a State. I cannot assent to an interpretation of the act of 1866 that will cause such a result. No such result is, in my opinion, consistent either with the words of the act or with the object which Congress intended to accomplish by its passage. That act, reasonably interpreted, was, I think, intended to give a telegraph company accepting its provisions the absolute right to put its wires and poles upon any post road—a public highway established primarily for the public convenience—if the ordinary travel on such road was not thereby interfered with."

The court also decided against the Western Union in the case involving the right to condemn a part of the Pennsylvania Railroad's right of way in Western Pennsylvania and appropriate it for its lines. The contention of the telegraph company in this case, as in that involving the right of the railroad to remove the poles, was that it had the right to maintain its wires over and along the lines of the railroad company, on making compensation, so long as the maintenance of its telegraph lines did not materially interfere with ordinary travel on the roads, and that the right could be asserted by proceedings in eminent domain. This contention was denied. There was also an additional element caused by the claim of the telegraph company, as the lessee of the Atlantic & Ohio Telegraph Company, incorporated by the State in 1849, and authorized "to erect and construct works, edifices, fixtures and structures along and across any of the roads, highways, streets and waters within this State, the said works to be so placed as not to interfere with the common use of such roads, highways, streets and waters." This point was decided adversely to the Western Union, on the ground that "eminent domain cannot be delegated," and that "lessees cannot exercise it."

### Railroad Shop Tools.

(*Continued.*)

SHAPING MACHINES.

The 16-in. crank shaper shown in Fig. 1 is made by the Stockbridge Machine Company, Worcester, Mass. The ram is of box pattern and it has a bearing in the column of 26 in. when at full stroke. The stroke can be adjusted while the machine is in motion and an index and pointer facilitate setting the ram to any desired length of stroke. The tool head is graduated and the tool slide has an automatic feed of 6 in. The table is 10 in. x 11½ in. and has automatic power cross feed of 22 in. either direction. It has a vertical adjustment of 14 in. by

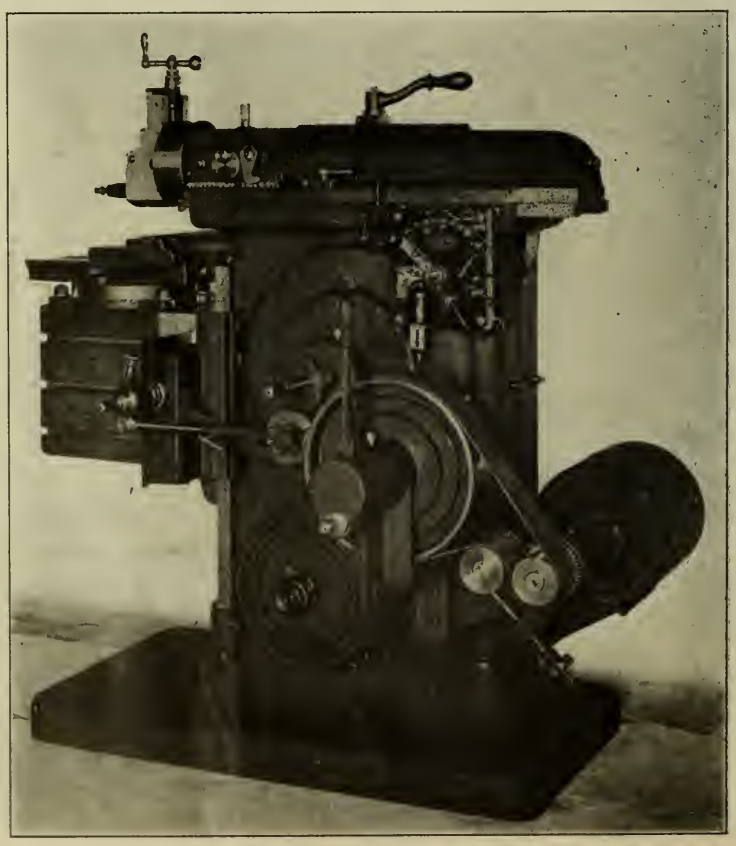


Fig. 1—The Stockbridge Shaper.

means of bevel gears and a telescopic screw. The screw is fitted with ball bearings. The vise can be set to any angle and has a graduated base. It is secured to the table by four bolts which fit into the T-slots. The rocker arm is designed so that a 3-in. shaft can be passed through under the ram for key-seating. In connection with this machine an interchange of gears being obtained by a clutch operated by a lever within easy reach of the operator. The table has an adjustable roller bearing support, as shown in the illustration. Ball bearings are placed under the elevating screw used for raising the rail, thus reducing the friction to the minimum. An opening through the column under the ram will admit shafting or similar work up to 4 in. in diameter. The position of the stroke is changed by the hand wheel shown on top of the ram and the length of the stroke is adjusted by means of a crank. These changes can be made while the machine is in motion. The screws for adjusting the gibs in the down slide of the head and the ram slide are held in position by locknuts which are countersunk flush with the casting. The machine as shown in the illustration is equipped with an automatic circular feeding head and a special chuck. This device was designed primarily for machining locomotive driving boxes preparatory to forcing in the brasses. It is especially recommended for shops where the installation of a slotter is not warranted. This automatic circular feeding head can be easily detached and replaced by the regular head, when desired. The weight of the machine complete with countershaft is 3,750 lbs., and the following table gives its principal dimensions:

| | |
|---|---|
| Extreme length of stroke | 24½ in. |
| Vertical travel of table | 15½ " |
| Horizontal travel of table | 27 " |
| Greatest distance ram to table | 18¼ " |
| Diameter of head | 9 " |
| Feed to head | 7¼ " |
| Length of top of table | 24 " |
| Width of top of table | 14 " |
| Depth of table | 17 " |
| Length of Ram bearing in column | 36 " |
| Width of ram bearing in column | 12 " |
| Size of vise jaws | 14x2½ " |
| Vise opens | 10½ " |
| Grades to cone on machine | 4 " |
| No. of speeds to ram | 8 " |
| Countershaft pulleys T. and L. | 14x4 " |
| Revs. per min. of countershaft | 200 |

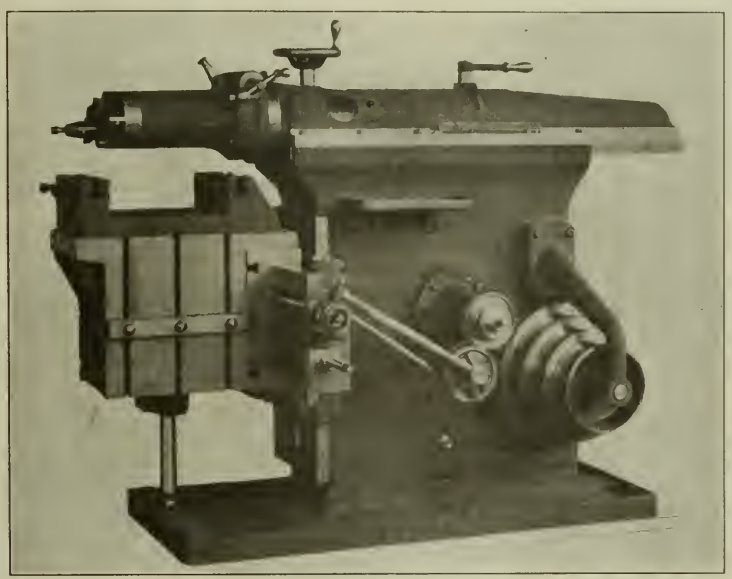


Fig. 2—The Cincinnati Shaper.

genious and novel method of belt connected motor drive is shown. The driver and idler pulleys are geared together so that both drive the belt positively, and by adjusting the idler pulley by means of the adjusting screw, tension can be put upon the belt. The idler is hung on a bell crank lever which can be swung around until the belt has an arc of contact on the driving pulley almost equal to the full circumference of the pulley. It is claimed that practical tests have shown this drive to be as positive as a chain drive and more flexible. This machine is especially adapted for tool work. It is built rigidly and has a quick return stroke of 4 to 1. It is equipped with a two-piece crank motion, which gives a powerful and even cutting speed. The motor used on the tool is a 1½-h.p. variable speed Storey motor having 26 changes of speed, obtained by means of field control. There are two runs of gearing which with the 26 speed changes make a total of 52 speed changes for the ram. This type of shaper is also made in the 20-in. and 24-in. size. The 24-in. shaper is a powerful machine and is especially adapted for the heavier work in railroad shops.

The 24-in. back-geared crank shaper shown in Fig. 2 is made by The Cincinnati Shaper Company, Cincinnati, Ohio. Both the column and ram of the machine are ribbed and braced internally and the ram slides project in front and in back of the column. The rail is ribbed horizontally and is gibbed to the column and the cross traverse screw has a graduated collar reading to .001 in. and it is also provided with a variable automatic feed which admits of changing the feed from zero to the maximum without stopping the machine. The head swivels to any angle; it is graduated and has a simple locking device. The down feed screw has a graduated collar which reads to .001 in. The vise has annealed tool steel jaw plates; it swivels and has a graduated base. This machine can be operated either as a single-geared or back-geared tool; the

The No. 2 Fitchburg shaper shown in Fig. 3 is made by the Fitchburg Machine Works, Fitchburg, Mass. This shaper has an 18-in. stroke and the movement of the cutter bar is obtained by the "Whitworth" quick return motion; the forward movement takes about two-thirds of a revolution and the return stroke takes about one-third of a revolution. The cutter bar is 40 in. long and it has a bearing 29½ in. x 8½ in. The connecting rod is of steel and the bearings at each end of the rod are fitted with hardened steel bushings which are adjustable for wear. The top of the bed is 75 in. long by 20 in. wide. The head has a vertical movement of 5¼ in. and is provided with power, vertical and angular feeds. It is also graduated and can be set to any angle desired, and the feed screw has a micrometer attachment which reads to thousandths of an inch. The saddle has a cross movement on the bed of 28 in., and the tables have a vertical adjustment of 14 in. The maximum distance from the bottom of the ram to the top of the table is 16 in., and the top of each table measures 16½ in. x 17 in. A hole through the bed admits a 3-in. shaft for key-seating. An independent automatic circular feed is provided for the cone mandrel. Each machine is furnished with chuck and centers. These are fitted to the table with a dovetail circular base, and will swivel to any desired position. The centers swing 12 in. and will take in a piece of work 14½ in. long. The driving cone has four steps with a 4⅛ in. face; the largest diameter is 20 in. and the smallest diameter is 10 in. The countershaft has two friction pulleys, each 20 in. in diameter by 4¼ in. face; these should run from 80 to 100 r.p.m. The weight of the machine is 5,700 lbs.

*(To be continued.)*

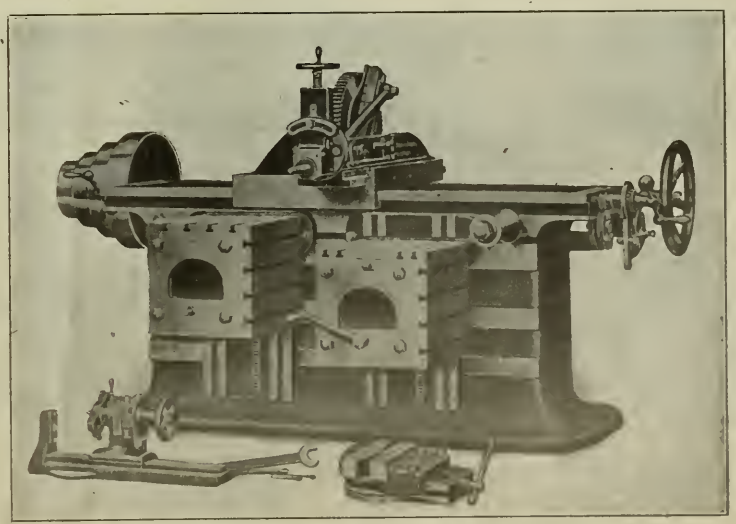


Fig. 3—The Fitchburg Shaper.

## Ferry Transportation in New York.

The following statistics are taken from a paper on "Ferry Transportation," presented to the New York Railroad Club Oct. 21, by Captain J. M. Cherry.

The ferries enumerated below constitute the services to and from Manhattan Island. The figure following the name of the company gives the number of passengers carried annually:

| | |
|---|---|
| Brooklyn Ferry Company | 33,910,000 |
| Hoboken Ferry Company | 31,990,000 |
| Union Ferry Company | 30,500,000 |
| Pennsylvania R. R. Ferry Company | 30,300,000 |
| Erie R. R. Ferry Company | 16,667,252 |
| Central R. R. of N. J. Ferry Co. | 10,650,000 |
| S. I. Rapid Transit Ferry Company | 7,900,000 |
| Long Island R. R. Ferry Company | 15,625,000 |
| West Shore Ferry Company | 5,865,000 |
| Nassau Ferry Company | 2,678,000 |
| N. Y. & South Brooklyn Ferry Co. | 1,715,000 |
| Fort Lee Ferry Company | 1,700,000 |
| N. Y. & East River Ferry Company | 4,309,000 |
| P. R. & Bergen Point Ferry Company | 550,400 |
| Babylon & Oak Island Ferry Co. | 10,000 |
| | 194,369,652 |

The average number of passengers entering and leaving the city daily by ferry is 532,520.

The following comparison shows the respective fuel consumption of four different types of ferry boats, selected as characteristic. The figures were taken in the month of June.

| | Cent. R. R. of N. J. | Erie Railroad. | | |
|---|---|---|---|---|
| Ferryboat | "Plainfield." | "Susquehanna." | "Tuxedo." | "McCullough." |
| Type of engine | 4 cylinder triple. 19-in., 30-in., 2 35-in. 30-in. stroke. | Beam engine. 50-in. cylinder. 10-in. stroke. | Fore-and-aft comp. 2 18-in. x 38-in. 30-in. stroke. | Fore-and-aft comp. 36-in. x 50-in. 28-in. stroke. |
| Coal per trip | 445 lbs. | 348 lbs. | 458 lbs. | 517 lbs. |
| Seating capacity | 427 | 225 | 799 | 400 |
| Team capacity | 18 | 18 | 18 | 18 |

This shows a difference of 31 lbs. per trip in favor of the triple as against the fore-and-aft compound. This does not work out so in every case, as, by comparing a number of the four-cylinder triples with fore-and-aft compounds, we find the difference but very slight in favor of the four-cylinder triple.

The most economical ferryboat in operation to-day is the beam engine. It does not, however, give as good results as the propeller boat, nor does it furnish the seating capacity for passengers. We find that the most expensive boat to operate is the single engine as shown in above statement. It is also an unsatisfactory type of engine for ferry service for the reason that in stopping and backing it is slow to respond.

## Scherzer Bridge for the Newburgh & South Shore.

The Newburgh & South Shore Railway forms the connecting link for the heavy traffic between the furnaces of the American Steel & Wire Company, on the east bank of the Cuyahoga River, Cleveland, Ohio, and its wire mills at Newburgh. The road crosses the Cuyahoga River, which is a navigable stream; a movable bridge was, therefore, required.

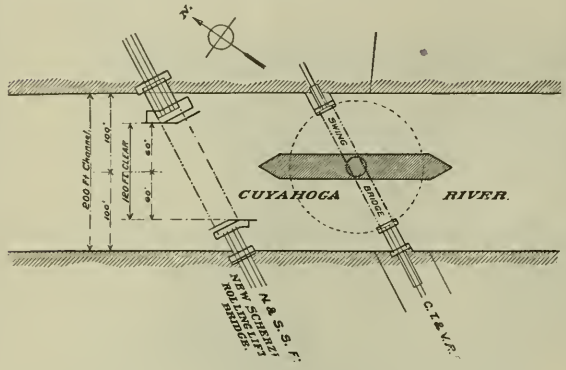



Fig. 1—Location Plan of Scherzer Bridge at Cleveland.

The Scherzer type was finally selected, and a double-track bridge was ordered. A plan of the bridge site is shown in Fig. 1, from which it will be seen that the crossing is quite close to the center-pier swing bridge of the Cleveland Terminal & Valley R. R.

The requirements of the City of Cleveland and the War Department called for a clear channel 120 ft. wide, measured between protection fenders, at right angles to the center line of the river. This necessitated a movable span of 160 ft. from center to center of bearings, as the new bridge crosses the river at an angle of 60 deg. 30½ mins. It is the longest span Scherzer bridge yet built. The general design of the bridge is shown in Fig. 2 and a photograph of the completed bridge in Fig. 3. In Fig. 4 the bridge is opened an amount sufficient to permit the passage of a moderate sized vessel. It is only necessary to open the bridge fully for the passage of large masted vessels.

There are a number of new features in the design of this bridge. The movable superstructure is composed of a single-leaf simple truss span, having a length of 160 ft. from center to center of bearings. It differs from some of the former Scherzer railroad bridges in that the operating machinery and electric motors are placed upon the movable span. The pinion at the center of the rolling segment engages with a rack, which is fixed and supported alongside of the track girder. This improvement tends to shorten the total length of bridge required and simplifies the machinery and operation. The bridge is designed in accordance with Cooper's E 50 specifications, to carry two 177½-ton locomotives, followed by a uniform load of 5,000 lbs. per lineal foot on each track. The operating power consists of two 177½-ton locomotives, followed by a uniform load of 5,000 lbs. per lineal foot on each track. The operating power consists of two 50-h.p. continuous current motors, but the bridge, although a large one, operates so easily that less than 20 h.p. is actually used in ordinary weather. The tracks are interlocked with the mechanism for locking the bridge so that the operator cannot open the bridge until the proper signals and derailing switches are set to prevent the passage of trains. The bridge is counterbalanced so as to be at rest in all positions, and when closed forms a simple rigid truss span resting firmly on two supports. The rails weigh 100 lbs. per yard, and are firmly fastened at all points.

The piers are Portland cement concrete resting on piles. The piles for the two main piers are cut off at the bottom of the channel, and those for the rear pier and abutments at a considerably higher level. The entire work was in charge of Mr. H. L. Schuler, Chief Engineer of the Newburgh & South Shore. The Scherzer Rolling Lift

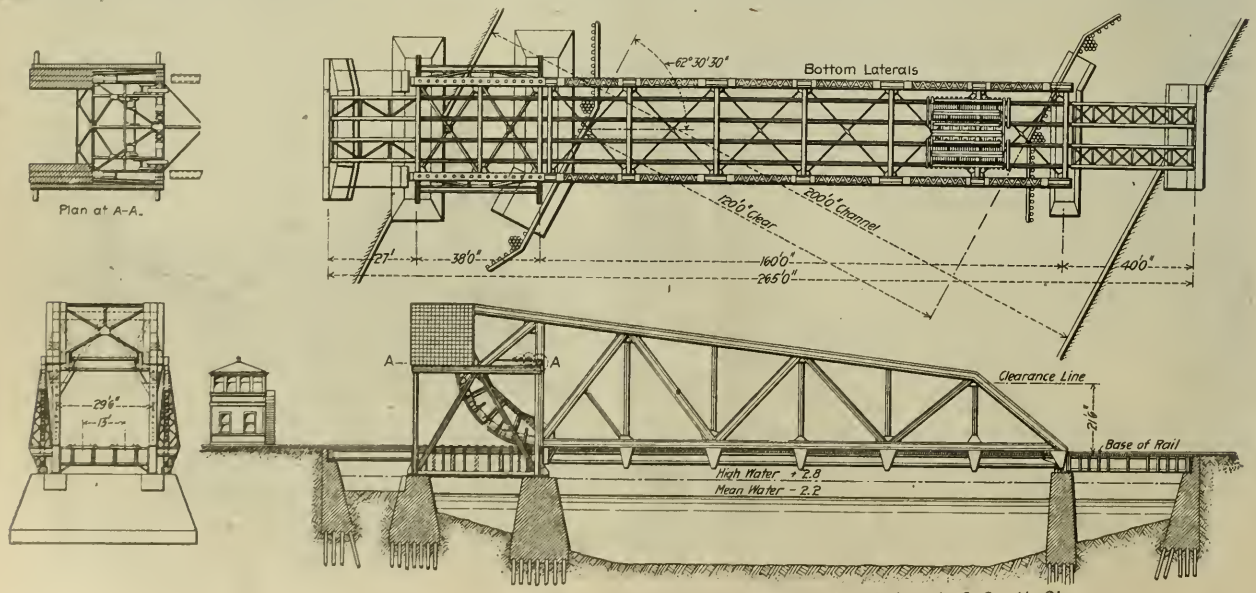



Fig. 2—Plan and Elevations of 160-ft. Span Scherzer Rolling Lift Bridge, Newburgh & South Shore.

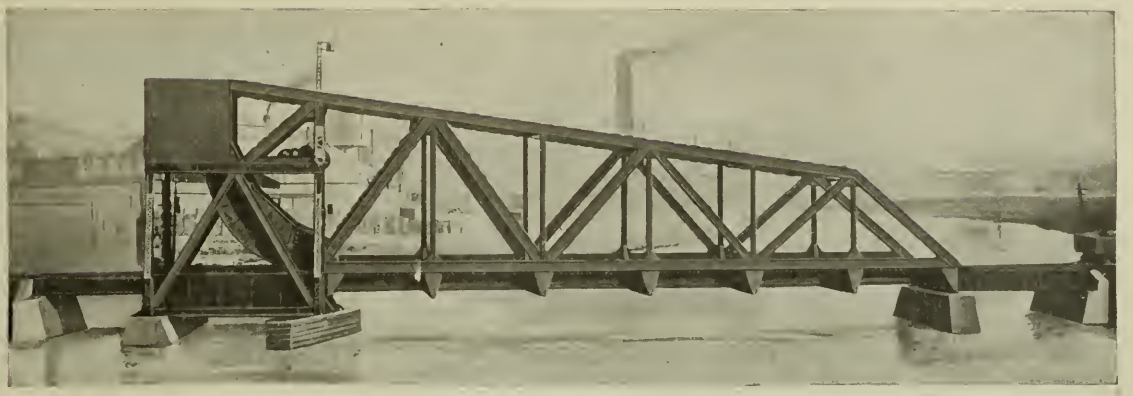


Fig. 3—Scherzer Rolling Lift Bridge Closed, Newburgh & South Shore.

Bridge Company, Chicago, furnished the detail plans for the substructure, superstructure, operating machinery and operating equipment. This company also maintained a general consulting engineering supervision over the construction of the bridge. The American Bridge Company built the superstructure. The L. P. & J. A. Smith Company, Cleveland, was the contractor for the substructure, and the Union Switch & Signal Company installed the interlocking.

Fig. 4—Scherzer Rolling Lift Bridge Open, Newburgh & South Shore.

## Impact Tests on Wrought Steels.

Messrs. A. E. Seaton and A. Jude on November 18 read before the Institution of Mechanical Engineers (London) a paper on "Impact tests on the wrought steels of commerce," in which they detailed some of the characteristics and peculiarities of the wrought steel supplied by steel makers for commercial purposes. One of the objects which the authors had in view in the preparation of their paper was to assist in the development of a more rational method of testing the suitability of such steels for each particular purpose of the engineer. They also pointed out a few of the peculiarities that are observed in the fracture of test specimens and actual pieces of machinery. Although there has of late been a considerable movement made towards the establishment of a shock test for steel, conducted on a smaller scale than is the custom with axles where the full-sized article is tested, this movement is progressing too slowly, and the aggregate part of Messrs. Seaton and Jude's paper was to help towards a further appreciation of this valuable test. Ten different tests that can be made on most pieces of metal (steel in particular) were given, and the general uses to which steel may be put were divided into three main groups, the authors proceeding thereupon to decide which of the specified tests was really a true universal gage of the suitability of a piece of steel for any purpose to which it may be put. As a help to answering the question, attention was drawn to an analysis of stresses in the steel parts of an up-to-date steam engine of moderate size, which showed that 87.6 per cent. of the whole engine was subject to more or less shock, while pure tension formed an insignificant percentage of the total stress. The authors showed that vibratory or alternating stress where the transition from one kind to another was gradual (say following a sine law), and unaccompanied by shock, did not occur at all under normal conditions, although it might occur under ideal conditions, in the crankshaft. Though this related to only one machine, it was stated that if others were examined, it would be found that nine out of ten are working under similar conditions.

Though it is true that opinions differ as to the best means of making the impact test, on the whole the consensus of opinion appears to be that it should be made with a machine that breaks at one blow, and at the same time measures the energy expended in breaking the specimen. From the very many bars that the authors had tested they found that the number of blows to produce fracture was a fair gage of the toughness or anti-brittleness; but there is no relation whatever between this result and the tensile results except that if the impact result is good, the elongation is sure to be good too, but, on the other hand, a steel showing high tensile strength and good elongation may be useless to resist shock. The authors made their tensile tests in a Buckton testing machine, while the shock tests were carried out in an apparatus designed by them which required, as a rule, more than one blow to produce fracture, for they contended that the apparatus to test the endurance of a material under shock should not be one in which the sample was fractured at the first blow, especially for steels that are soft and are really very tough. Such a test may, however, be instructive and actually necessary for very high carbon steels.

The maximum shock strength for the particular grade of steel containing 0.25 per cent. of carbon is 30 blows as gaged by the author's machine, but, while this may be a fair figure, such steel cannot be relied upon to give this always. With the usual factors of safety considered by authorities to be sufficient, Messrs. Seaton and Jude find that for those parts subjected to more or less shock, there is a grave risk of breaking under the modern conditions of high speeds. They urged engineers to demand of the steel-maker a greater attention on his part to produce and supply the ordinary grades of steel with a more uniform "shock" quality. The nature and peculiarities of the fracture of mild steel by shock formed the subject of a large part of the paper, the matter being gone into in some detail and accompanied with many photographic illustrations showing effects of impact tests on cast steel, mild cast steel (Pearlitic), forged steel, fractures in service, and fractures at right angles to surface due to alternating stress.

The prize of 6,000 marks offered by the German Society of Mechanical Engineers for the best scientific treatise on locomotives has been awarded to Professor von Borries, who has been assisted in the work by Professor Sommerfeld, of Aix-la-Chapelle, and Herr Berner, of Berlin.

### The Burlington's "Seed Special."

On Wednesday, the 14th inst., the Burlington started a "Seed Special" train through eastern Nebraska from Lincoln. The purpose of the movement, of which this is the first stage, is to give the farmers of Nebraska, and later of Illinois, Iowa and Missouri, an opportunity of placing themselves more closely in touch with the agricultural and experimental departments of their state universities, and getting the benefit of the systematic and practical study of corn raising, and the tests that are being made constantly at these institutions.

The tour now in progress will occupy seven days, and will be continuous except for the stops at the different points where the lectures are delivered. The special includes two private cars, occupied by Professor T. L. Lyon, of the University of Nebraska; Professor Holden, of the University of Iowa; Professor Hopkins, of the University of Illinois; a representative of the University of Missouri, and by officers of the Burlington. A large coach has been equipped as a lecture room, with charts and maps about the walls, with other corn data, and with equipment for making practical tests determining the germinating power of seeds.

At the stops, of which 66 are scheduled for the tour, the train is halted conveniently near the depot. All communities are advised in advance of the arriving time of the train, so that there will be no delay in getting an audience. After the lecture is delivered, the auditors are supplied with printed copies of it, and with other literature, provided principally by the university of the state in which the special is then traveling.

In January, probably about the 10th, the special will move into Illinois, and spend some time there. In February it will tour Iowa; in the early part of March go to Missouri; and in the latter part of March it will go back to the semi-arid district of Western Nebraska, and possibly on to Wyoming. On this latter trip the special will work in conjunction with not only the Agricultural Department of the University of Nebraska, but with the Plant Pathology Division of the United States Department of Agriculture, the purpose being to give additional impetus to the present rapid reclamation and development of the semi-arid parts of Nebraska, and, perhaps, Wyoming. On this trip, in addition to the lectures, and the circulation of literature on seed corn and soil inoculation, there will be, for the first time, a general and generous distribution of Professor Moore's nitrogen bacilli, together with packages of Russian wheat, from the semi-arid districts of Russia and Algeria, and of Kersten oats, which latter, experiments have proved, are adapted quite admirably to such soil and latitude as those of Western Nebraska. In the sections referred to the farmers have raised 25 to 30 bushels per acre of macaroni wheat, and an even larger percentage per acre of Kersten oats. It is the claim of the agricultural departments of the state universities that these districts can be made as productive as the famous macaroni wheat district of Russia, where climatic conditions and the nature of the soil are exactly similar.

Last fall the Burlington operated, in Iowa only, a seed special in which the farmers took such active interest, and from which they seemed to receive so much of a helpful nature that this year the road and the agricultural departments of the state universities referred to decided to widen the field and, with it, the scope of the work, the single aim of all effort being to have the farmers co-operate more closely with the institutions where farming has been made, in reality as well as in theory, a practical science. The special is under the general supervision of W. K. Manss, Industrial Commissioner of the Burlington.

### To Expedite Per Diem Cars.

The following outline of instructions for carding foreign cars, when received, has been sent to us by Mr. F. L. Hutchins, of the Boston & Maine. From his statement we gather that in its main features it has lately been adopted on the B. & M. The proposition to avoid unnecessary expenditure of time by putting cards on cars without stopping to write in the number and initials of the car seems to be a sensible labor-saving expedient. Concerning the proposal to have penalty dates shown on all lists we are not so sure.

Every per diem car should have attached to each side, under or near the number, a home route card (Fig. 1), which would indicate by color, or by name, the railroad from which received, the junction symbol, or name (preferably the former), and a date, not less than 20, nor more than 25, days ahead of the day of receipt.

Should any car thus carded be upon our road at the expiration of this time, namely, upon the date shown by card, a red penalty diamond (Fig. 2), having the word PENALTY in conspicuous letters, is to be tacked above the home route card upon both sides of the car. After receiving this penalty card the car is to be hurried to the home route without diversion or unnecessary delay.

When the car goes on to another road to reach its destination, the cards are not removed when delivering to the connection; and if it returns with the cards attached, they are to be stamped with the junction symbol, and the date then in use, i.e., 20 days (or more) ahead of the current date, thus informing all parties handling the car that it belongs at such a junction for home, that it was there received from connection, and that it should not be detained or diverted, but that it must be delivered to the indicated road before date last shown.

In case cards have been removed while on the connection, the station records should show the junction symbol and date, so that the car could be carded with a blank home route card (Fig. 3), properly filled out and handled without the delay incident to asking car accountant for the information.

When cars are delivered to home route particular care must be taken to remove all home route and penalty cards.

To insure the effective working of this method, and to prevent all liability to nonperformance, all yard men should be required to note the junction symbol and the penalty date on all car lists taken by them.

Should any per diem car lack the proper home route card, the car accountant should be informed by wire. He would then give the proper junction and date and the blank home route card (Fig. 3) would be filled out and attached, and the defect taken up with the proper party to cure such omissions.

Should the home route cards upon any car show a passed date and yet lack the red penalty diamond, the first yard man discovering same would supply the defect and notify the car accountant. The matter can then be taken up with the party who had charge of the car at the date of expiration.

To facilitate the work of attaching these home route cards at junction points the writing of initials and numbers on cards should be omitted. Carders should have a stamp showing junction symbol, with removable dates. With these they can stamp up cards ahead for quick use. The stamp conduces to correctness in dates, as it is only necessary to move the type ahead one date each day.

The recording of junction symbol and date upon car lists would prevent any wholesale transferring of cards. Even if a few such cases should occur the consequent loss and annoyance would be less expensive and troublesome than the writing in of thousands of initials and numbers daily. Again, the more simply and easily the work can be done the fewer failures under adverse conditions.

Making all agents and yard masters strictly accountable for the proper carding of cars, and responsible for all cars remaining upon the road more than 30 days, unless the detention was beyond their control and they had so notified the proper official, will get the cars home, or in position to receive proper attention, before penalties can accrue.

This plan is not designed to take the place of, or interfere with, the efforts to dispose of cars upon which the car accountant has penalty notices; nor does it affect the practice of card-billing of per diem cars, either before or after they have become penalized.

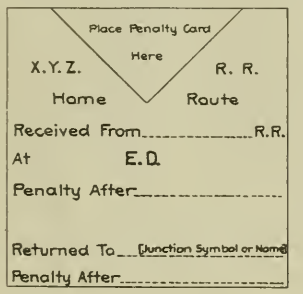


Fig. 1.

Fig. 2.

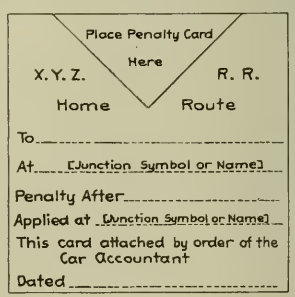


Fig. 3.

## CAR AND LOCOMOTIVE OUTPUT IN 1904.

Returns received from practically every car building plant in the country show that approximately 62,950 cars have been built, including cars for use on elevated railroads, but exclusive of street and other electric cars. These figures, of course, do not include cars built by the railroads at their own shops. Of the above total, approximately 60,806 are for freight service and 2,144 for passenger service; 60,955 are for domestic use, and 1,995 are for export. All the figures this year are official, except in the case of one of the smaller equipment firms where it was necessary to make an estimate from our own current records, so that the sum total as given here may be accepted as very nearly correct. This is the smallest car output since 1897, when 43,588 cars were built. Business conditions looked very uncertain, at this time a year ago, with gross earnings falling off rapidly, while operating costs continued to grow higher; and in view of the recent large equipment purchases, beginning in 1898 with more than double the 1897 output, and continuing to increase until the high-water mark of 164,547 cars was reached, in 1902, it was wholly to have been expected that retrenchment would show first of all in equipment orders. A large amount of old rolling stock was overhauled and put into service at the railroad shops, supplying current needs in more or less temporary fashion, and it is only since the early part of the fall that new orders have been coming in rapidly. During the past three months, over 70,000 cars have been ordered; some ten per cent. more than the total output for the year. The majority of these are for delivery in the early part of 1905. During the year, 1,942 cars were built by three firms in Canada. The following table shows our estimates for cars built during the past six years:

| | Freight cars. | Passenger coaches. | Total. |
|---|---|---|---|
| 1899..... | 119,886 | 1,305 | 121,191 |
| 1900..... | 115,631 | 1,636 | 117,267 |
| 1901..... | 136,950 | 2,055 | 139,005 |
| 1902..... | 162,599 | 1,948 | 164,547 |
| 1903..... | 153,195 | 2,007 | 154,808 |
| 1904..... | 60,806 | 2,144 | 62,950 |

During the year, 3,441 locomotives were built at the various locomotive plants in the country, as against 5,152 last year. This figure is officially correct and required no estimating. The number for the current year includes 95 electric locomotives. These figures do not include locomotives built by the railroads at their own shops nor orders given for repairs. It is interesting to note in this latter connection that during the past year an order was given by one of the leading railroads in the country to one of the largest locomotive builders for the repair of 600 locomotives. The following table shows our figures for locomotive building for the past thirteen years:

| | | | |
|---|---|---|---|
| 1892..... | 2,012 | 1899..... | 2,473 |
| 1893..... | 2,011 | 1900..... | 3,153 |
| 1894..... | 695 | 1901..... | 3,384 |
| 1895..... | 1,101 | 1902..... | 4,070 |
| 1896..... | 1,175 | 1903..... | 5,152 |
| 1897..... | 1,251 | 1904..... | 3,441 |
| 1898..... | 1,875 | | |

## COMPULSORY BLOCK SIGNALING.

In the contributors' column, Colonel Prout makes a strong statement of the arguments against Federal requirement of block signals. He believes that it would be an invasion of states' rights if Congress should compel the use of the signals, and hence that such a measure would be unconstitutional; that until the state government breaks down the Federal government has no right to interfere. With regard to the proposal that the enactment should be made by the states individually, he asks where the thing is to stop if the state begins the protection of people on the railroads; whether this protection should not logically include the control of interlocking and of permanent way and structures, and why it should stop short of protecting railroads against trespassers and trespassers against themselves. The *Railroad Gazette* in the past has always maintained, and now continues to maintain, that extension of the central government authority is a highly dangerous thing. It opposes flatly the efforts of the Interstate Commerce Commission to place the rate making power in the hands of the government, and it fully believes that the solution of the many important problems in the harmonizing and efficient conduct of the American railroad system will come through intelligent corporate initiative, and not through government control. But while the harmonizing of the elements which go to make up perfection is in progress, too many lives are being lost. As a preventive of collisions—the most tangible and the most curable of all fatal railroad accidents at the present time—the block system stands above all other safety measures, both in efficiency, and in the relative ease and quickness with which it can be made effective. But no reader of the *Railroad Gazette* needs a sermon on the merits of the block system.

If it is granted that the establishment of a system by which trains are protected by a definite space interval is likely to reduce the loss of life by tending to do away with a particularly common and particularly fatal kind of accident, then it is highly important that this system should be found at least on all passenger lines that are of any consequence, as soon as possible. But the manager or the superintendent who believes in all sincerity that such improvements as this are sure to work for genuine economy cannot always get his appropriation when he wants it, if indeed he can get it at all. From the standpoint of railroading then, legislation of the kind indicated would in the first place save lives, and in the second place would strengthen the hands of the operating man in placing blocking at the head of the appropriation list instead of at or near the bottom of it.

But the objections raised by Colonel Prout are based rather on constitutional than on operating grounds. He points out that the salient difference in requiring a standard type of brake or coupler, as was done by the Safety Appliance Act of 1893, and in requiring the use of the block system, is that the brake or coupler used in interstate commerce cannot be changed at the state line, while a signal post is a "fixture" on the soil of the state. But the proposed law says nothing about signal posts. It asks that a space interval be required between all trains engaged in interstate commerce. The constitutionality of the coupler law surely did not rest on the fact that a Federal enactment was the quickest way to secure uniformity of design. The government either had the right to make such a law or it had not, and if the Safety Appliance Act of 1893 were to come before the bar, it would have to be upheld on other grounds than those of mere expediency. This particular question turns on the ability or inability of the several states to make the necessary regulations. It was conceded in the Safety Appliance case that the state governments could never obtain the uniformity of specification necessary to make automatic brakes and couplers constitute a safety appliance, and those who are familiar with state legislatures, the ends served thereby and the process of manufacturing laws therein, will probably concur in this opinion. The same question now arises with regard to the block system. If the state governments be waited for, nothing will be accomplished.

Whether or not the courts would hold that interstate traffic and, specifically, the carrying of the mails, is jeopardized in trains which are not run by the space interval system, and that, being jeopardized, the government has the right to interfere, we cannot say. We incline to the belief, however, that the proposed law would be held constitutional, but we are disposed to doubt that its constitutionality would ever be tested. With regard to the question as to where state protection of people on the railroad shall stop, it seems hardly necessary to carry this out to the extreme limits suggested. As Colonel Prout himself says, the British Board of Trade has been showing for a great many years that this protection can be afforded with an arbitrary limit far short of complete government control. The British Board of Trade has been a great life-saver. That it is concerned with a great many appliances and devices which add very largely to fixed charges and scarcely appreciably to public safety, seems to be a consequence rather of the British temperament than of the general system on which the Board of Trade regulation is based.

Entirely apart from accidents to trespassers and from what may be called the unavoidable, or almost unavoidable, death rate from extraordinary accidents where there is no negligence, too many people are being killed in train wrecks. Inasmuch as a safety appliance act already exists, and has existed for 10 years without any apparent damage to states' rights, it may conceivably be extended to cover the question of the fixed space interval, likewise without any damage to states' rights; and if this can be accomplished, there is no doubt that the annual death rate from railroad wrecks in this country, which has for years made a scandalous showing in the eyes of the world, will be greatly reduced.

The coupler law was passed after the principal roads had decided on their course and it was clear that the automatic coupler of the Janney type was destined to prevail throughout the country; and the law served to bring the laggards into line. A parallel case exists now; the most enterprising roads have adopted the block system, but others have not done so, and some of the large ones are slow in extending it. As all efforts have failed to awaken these laggards it is

not strange that President, Congress and people conclude that a Federal law is the only practicable remedy for the great losses of life from collisions. What can we say to them?

## REACTION IN ELECTRIC RAILWAYS.

The Massachusetts Electric Companies is a "holding" corporation owning or controlling various electric properties, chiefly street railways in eastern Massachusetts with extensions into Rhode Island and New Hampshire. It manages them through two operating corporations representing, through consolidation, some 40 original and independent properties. It operates, according to a recent return, in 22 cities and 66 towns; has 854 miles of street railway track; $6,333,911 gross earnings; and preferred stock (cumulative) of $20,557,400; common stock $14,293,100, and so-called "coupon notes" of $3,500,000, saying nothing of the underlying debts of subsidiary corporations. This great street railroad corporation—for such it may as well be called—after paying for some time an annual dividend of 4 per cent. on its preferred stock, has just passed the semi-annual dividend of 2 per cent. normally due next month.

Such an incident has some importance in itself in the case of the corporation of such magnitude, the owner of so large a system of street railways and in a State where capitalization of those lines—as distinguished from the holding company itself—has been rigidly limited by the rule and policy of "replacement value" adopted and enforced by the Massachusetts Railroad Commission. It would even have its importance if due to local or specialized or transitory causes such as a new plan of financing the parent company or its subsidiary bodies. But, in fact, the causes assigned are more general and, therefore, more significant. They are connected with heavy operating expenses during the year and these, as well as traffic returns, connected in turn with a severe winter followed by a cold summer, the latter bearing heavily upon excursion business. In fact, it is predicted that, in Massachusetts, the summary of street railway business, when compiled by the State Commission, will show generally for the year past—except for business in the larger cities, notably Boston—a considerable falling off. Related to the same subject and on a more extended scale are returns for the last ten years which show a reduction in street railway gross earnings from $11.972 to $10.124 per mile operated, and of net per mile from $3.651 to $3.180, while net earnings per car mile fall from 9.23 cents to 7.46 cents though the average per passenger car mile rate from 1.54 cents to 1.59 cents. As an isolated but suggestive fact it may be added that at a single session of the United States Circuit Court at Boston last summer there were three applications for street railway receiverships.

The Massachusetts example, of course, has some qualifying facts such as a reduction during the last ten years of operating expenses from $8.321 to $6.944 a mile, and other economies due to system, experience and consolidation of properties. But the facts in that State collectively carry out the idea that a period of reaction in street railways is at hand even if it has not positively begun. The street railway—as demarcated somewhat sharply from the long distance electric line—is probably following out the natural destiny attending the discovery of a new and highly useful motive force. At first came, 15 years or more ago, the early tentative efforts to adapt electricity to the old horse car line; next the demonstration of its popularity and, what was more to the point, its profits, especially on old urban routes; then the loud popular demand for it, echoing into the rural regions, the frenzy of new construction with overcapitalization as a pervasive factor; and, at the last, exhaustion of profitable territory, the proof that even the popularity of the electric street line is dependent on such accidents as the state of the weather and the inevitable force and reaction not merely affecting new projects but the prosperity of the completed road. And attention may also be called to the fact that the great majority of the street railways of the country have yet to stand the final and searching test of a period of serious industrial depression.

A single feature in the up-to-date status of the electric railway, as exemplified by the Massachusetts experience, deserves its brief and final reference—namely, "novelty" traffic. In the early stages of the successful trolley perhaps nothing was more forceful in stimulating fresh enterprise than the volume of business on the newly opened line derived from passengers who had never traveled in a trolley car before; and, under the spur of the novel passion, they took their recreative rides over and over again. But "novelty traffic" on the electric street railway has passed now to a secondary and reduced stage. With the trolley car a familiar fact novelty traffic on a new line rests not on the fresh experience of a strange and agreeable motion but either on a desire to "see the country"—which quiets itself in one or two trips—or on the momentary delight of a new and nearby convenience which very quickly becomes old. For a novelty that was general, extensive and somewhat prolonged has been substituted a novelty that is local and, by comparison, transitory. It is not, perhaps, a very striking change, but, in the history and evolution of the street railway, it is symbolical of other changes of more importance.

The decision of the Supreme Court of the United States in the Johnson case, reported elsewhere in this issue, substitutes common sense for technicalities, and judicial clearness for verbal imperfections in the automatic coupler law of 1893; and it reverses the lower court, where the railroad company won its case on the ground that a tender is not a car and that, even if it were, the law is complied with when one car has a Janney coupler and another has a Miller, a radically different type. The details of the Johnson case were given in the *Railroad Gazette* of Jan. 2, 1903, page 10. Under the original law this absurd use of diverse types was, apparently, lawful. Practically, no railroad tried to couple Janneys to Millers, but legally they might do so, as the statute was so crudely drawn as to seem to permit it. The act of March, 1903, was passed to correct this defect; but Chief Justice Fuller holds that the amendment was unnecessary; by a rational interpretation the original law forbids all attempts to use couplers not adapted to each other. In the Johnson case it was plain, of course, that the Janney on the tender and the Miller on the car could not be fastened to each other without a link, and Johnson lost his case, not only for the reason just mentioned, but also because it was clearly a situation where he could see that special danger existed and special care was required. But the Supreme Court does not countenance hair-splitting, and declares unequivocally that, for the purposes of this law, (1) a tender (and, of course, an engine, a snowplow, etc.) is a car; (2) that automatic coupling is required every time two cars are brought together; and (3) that in deciding whether or not a car is used in interstate service, the courts should not limit the effect of the law by the employment of petty technical distinctions. In this last point the Supreme Court confirms the view of District Judge Shiras as expressed in the Voelker case. The second point seems to bear very severely on a road which has to move broken cars by coupling them with chains, or by the employment of other makeshifts; but if this proves a hardship, Congress could probably be induced to pass an amendment.

Attention is called to a typographical error in the paper on Heavy Electric Traction, by O. S. Lyford and W. N. Smith, read before the American Institute of Electrical Engineers on November 25, and abstracted in our issue of Dec. 9. The second term of the traction formula proposed by Mr. Smith at the top of page 615 was incorrectly stated as 1.67 V. in the advance sheets sent out. It should have been .167 V.

### November Accidents.

The condensed record of the principal train accidents which occurred in the United States in the month of November, printed in another column, contains accounts of 25 collisions, 28 derailments, and one other accident. Those which were most serious, or which are of special interest by reason of their causes or attending circumstances, occurred as follows:

| | | Killed. | Injured. |
|---|---|---|---|
| 11th. | South Mound, Kan. | 1 | 9 |
| 12th. | Boyds, Md. | 0 | 12 |
| 12th. | Azusa, Wyo. | 13 | 20 |
| 13th. | St. Louis, Mo. | 1 | 6 |
| 14th. | Chadd's Ford Junction, Del. | 1 | 3 |
| 16th. | Elmdale, Mich. | 3 | 8 |
| 20th. | Wyland, Pa. | 2 | 0 |

Of the 13 persons killed at Azusa eight, at least, were employed on the trains. The cause of this collision as we have given it is one of two causes reported in the newspapers, but it is the one said to be "semi-official." A death-list in a single collision which includes eight persons not passengers, calls to mind the fact that with the increasing volume of mail and express traffic, both carried on the fastest trains, and the large number of double-head trains now run, a record of passenger casualties alone does not afford a fair index of the dangers attending our fast trains. The principal advantage to be had from separating the passenger list from that of trainmen is due to the fact that more care is taken to safeguard the lives and limbs of passengers; the passenger death list affords a measure of the success attained when the railroads have supposedly done the utmost possible to prevent accidents. But the only legitimate ground on which we can justify less effective measures for

the protection of trainmen than are taken for the protection of passengers is that of necessity; we have no right to impose greater risks on the employees unless it is impossible to avoid doing so. In view of this principle we must look upon the Azusa collision in the same light as though it had killed 13 passengers, for if the right kind of protective measures had been in force, the engines and baggage cars would have been safeguarded as well as the passenger cars.

A large proportion of the collisions in this record occurred at or near stations, and some of these on roads where the block system is in use. It is important to note, in connection with these cases, that the block system is used in a modified form; it is only a partial protection, like permissive blocking. For example, a single track road blocks trains from station to station, yet has no distant signals at the stations and often no home signals; or has a single signal by which a part only of the switches at the station can be protected. In such circumstances a train receiving a signal at A to proceed to B really receives this authority subject to the condition that the switches at B must be approached cautiously. Complications will constantly arise, of course, necessitating departure from this fundamental principle that all movements shall be completely controlled by fixed signals and the substitution of rules instead of signals. A case of this kind in the present record is that of the collision at Boyds, Md., which is described by the reporter as follows:

The Duquesne Limited was coming eastward and had orders to meet express No. 3, westbound, at Boyds. It was made up of eight cars and was in charge of Engineman Hall and Conductor Hendrix. The express, in charge of Engineman Zepp and Conductor Hammond, had arrived at the switch, 200 yards east of Boyds, and was pulling into the siding to allow the limited to pass. When the limited approached, the engineer blew his whistle for the block target, and Operator Emerson, thinking No. 3 had cleared and passed onto the side track, gave him a clear target. Hall gradually gave his engine more steam, and soon the train was making 30 miles an hour. Then, to the horror of the engineer, he saw two coaches ahead which proved to be the rear end of train No. 3, which was pulling into the side track. The heavy locomotive struck the cars, "sideswiped" them, and drove the second sleeper clear over and down an embankment.

Another accident in November which deserves notice is the derailment at South Mound, Kan., on the eleventh, killing one employee and injuring eight passengers. The tender of the locomotive "jumped the track at full speed." From circumstantial evidence it appears quite clear that tenders are often loaded so unevenly as to make them very unstable, and liable, with the aid of irregularities in the track, to lift a wheel. It would seem that the question of securing positive and conclusive evidence on this matter should receive careful attention.

The number of electric car accidents reported in the United States in November was 20, in which 18 persons were killed and 190 were injured.

We find only one important train accident in Canada in November, but that one was quite serious. On the Intercolonial, at New Glasgow, Nova Scotia, on the 7th, a freight train of seven cars broke through a bridge and fell into East river, the engine and tender having passed over in safety. The bridge was a lattice girder 80 ft. long, of English make, erected about 37 years ago. There was a street car accident in Toronto on the 17th in which four occupants of the car were killed. The car became uncontrollable on a descending grade, broke through the gates at a crossing of the Grand Trunk, and was run into by a freight train.

The description, in another column, of the road motor omnibus services which the Great Western Railway of England has recently established, deals with practice almost unknown in this country. These road services, which are designed primarily to connect otherwise inaccessible places with the railroad, have very little in common with trolley lines in the work which they perform. Their running speed is low and the fares are high, yet the experiment seems to have met with considerable success in England and on the continent as well. In fact, certain continental services have been in successful operation for some years, replacing former carriages and horse omnibus lines. It seems improbable that this means of conveyance is at present likely to find extended use in the United States, for it requires pretty thickly populated country to make such a service profitable—and the thickly populated portions of the United States are rapidly being served by trolley lines, which can offer much higher speed and can consequently cover a larger territory than can be done by any omnibus service. But the advantage of motor omnibuses as compared with trolley lines is that they can be temporarily tried in a locality and then withdrawn without loss of capital if they are not profitable, and it is quite conceivable that use might be found for them as an adjunct to suburban railroad services, or, indeed, to main line services where traffic originates at some little distance from the railroad station. In spite of the American commuter's well-known objection to changing conveyances on the way to and from his work, there are numerous suburban districts in the vicinity of all our great cities where a good motor omnibus service could undoubtedly increase the field tributary to the station, and save enough time, morning and night, so that new residents would be attracted to the district.

The annual report of the Superintendent of Railway Mail Service for the fiscal year ended June 30, 1904, again strongly urges publishers to classify their mail before sending it to the post office, thereby saving a great amount of labor both in the offices and in the mail cars. The enormous bulk of this second class mail which is being handled is well shown by the comparative totals throughout the country for the last six years. The increase has been steady, from 352,051,608 pounds in 1899 to 569,719,819 pounds in 1904. By way of reducing this to a more familiar figure it may be mentioned that the weight of the second class matter for the current year ending June 30 was well over 284,859 short tons. That is to say, this pile of newspapers, magazines, etc., would be equivalent to the gross tonnage of some 20 battleships of the largest size commonly found in the great navies of the world; or it would fill over 7,000 forty-ton freight cars; say 150 long trains. A hasty calculation, more picturesque than useful, shows that if this second-class-publication mail were distributed equally throughout the country, every man, woman and child would have between seven and eight pounds of it to read. It is to be feared that a good deal of this literature is designed to be read by the pound. New York easily leads in the output of second class mail, with 937 publications and 10,135,103 pounds of literature. Chicago is second with 602 publications and 5,363,367 pounds of second class mail matter, including a small amount which is free in the county. The number of sacks of mail sent out from New York in the past year was 184,980, an average, therefore, of over 500 a day.

The proposed underground moving platform for handling the heavy cross-town traffic on 34th street, New York City, has many features which commend it. The conditions which have to be met are ideal for the use of such transportation methods, as the distance is short and the number of stations is large. It is undoubtedly true that the cost of operation, including interest and depreciation, of a moving platform between First and Ninth avenues will be much less than the cost of a double-track railroad similar to the New York subway. The reasons for this are well set forth in the article which appears in another column. Moving platforms are by no means new, but heretofore they have not been used extensively except for amusement or spectacular purposes. The designs which are now proposed, however, seem highly practical. The only serious objection seems to be the fear that people will not learn to get on and off the platform without falling down, but such dangers are largely imaginary, as the relative speed of each section of the platform to the one next faster is less than the pace at which a man walks.

## NEW PUBLICATIONS.

*Practical Coal Mining*, by T. H. Cockin. 428 pages, 4½ in. x 7 in. The Norman W. Henley Publishing Co., New York, and Crosby, Lockwood & Son, London. Price $2.50.

The author of this work, who has a thorough practical knowledge of his subject, is a member of the Institution of Mining Engineers of England and a lecturer on coal-mining at Sheffield University College. This book is intended for students and for those preparing to qualify for first or second class colliery managers. It is clearly written and contains over 200 illustrations. The author assumes that the reader has no previous knowledge of mining and he has therefore discussed each subject in detail.

*Fowler's Mechanical Engineer's Pocket Book.* By William H. Fowler. London: Scientific Publishing Company, 1905. Leatherette, 498 pages, pocket size. Price, 1s. 6d. net.

In this new edition many substantial additions have been made. A new section on entropy has been added and this subject is treated in a thoroughly practical manner, so that its application to problems in steam engine design is easily understood. In all about 50 pages of new matter have been added to the book, which include notes on steam turbines, high speed tool steel, emery grinding, milling, reaming, etc.

## TRADE CATALOGUES.

*Condensers, Vacuum Pumps, Etc.*—The Deane Steam Pump Company, of Holyoke, Mass., is distributing its new catalogue No. D-23. This publication reviews the principles and advantages of the several types of condensers as applied to steam engines, including surface and jet condensers, vacuum pumps, exhausters, air and circulating pumps, and other auxiliaries are also briefly discussed. A recent development, which is treated of quite fully, is the provision of proper condensing arrangements for steam turbines. Unlike the reciprocating engine, the turbine can expand its steam to the extreme limit of the exhaust pressure and every inch of vacuum above 26 in. increases the economy by from 3 to 5 per cent. It is therefore advantageous to use the most per-

fect type of condensing equipment for this service, which has led to the production of improved types of independent air and hot-well pumps, separate circulating pumps, air coolers, etc.

*New York Central & Hudson River Railroad.*—The Passenger Department of the New York Central has just issued No. 36 of its "Four-Track Series." It is entitled "The Winter Boarder," and gives a list of more than one thousand hotels and boarding houses in all parts of the country, giving the name and address of the proprietor, the number of people the house can accommodate, its rates per day and per week.

This booklet covers the country quite generally from New York to the Pacific Coast, including the Adirondack Mountains, Canada, Colorado, Utah, Arizona, New Mexico, Texas, California, Washington and Oregon, and also includes the Hawaiian Islands.

*Direct Current Motors.*—The Westinghouse Mfg. Co., Pittsburg, Pa., sends a pamphlet descriptive of its type S motors for direct current circuits. A brief discussion of the advantages of electric drive is given as well as illustrations of the motor as applied to various classes of work.

*Rope.*—C. W. Hunt Company, West New Brighton, Staten Island, N. Y., sends a folder descriptive of its "Stevedore" rope. The sizes of this rope kept in stock and the approximate price per 100 ft. are given, as well as names and illustrations of 29 different kinds of knots.

*Rock and Ore Breakers.*—Allis-Chalmers Company, Milwaukee, Wis., sends a catalogue descriptive of its style "K" Gates rock and ore breaker. It is handsomely illustrated throughout with half-tones and a full detailed description of the machine is given.

## CONTRIBUTIONS

### Compulsory Block Signaling.

New York, Dec. 19, 1904.

To the Editor of the Railroad Gazette:

The Interstate Commerce Commission has repeatedly asked for the enactment of a Federal law, which would compel the railroads to protect their lines by block signals, and the President has recommended such an act. The Railroad Commissioners of some of the states, and various state officials, have also urged compulsory block signaling. The distressing list of accidents for the last year or two has given new force to this movement. Some expert observers at Washington think that no Federal legislation for block signaling will be had this winter; but they may be mistaken, and it will be wonderful if there is no such legislation in some of the states.

In times past I have expressed the opinion that a Federal Act to compel the railroads to signal their tracks, would be unconstitutional, and I have always expressed the opinion that either Federal or State legislation would be inexpedient and unfortunate. I still hold those opinions, and for certain special reasons, a few of your readers may be interested to know why. At least I may provoke discussion that will lead towards the formation of correct opinion.

We must assume that the President and the Commissioners have taken legal opinion; and it may seem impertinent to raise the constitutional question. Yet, an act to control signals by Federal power seems a plain invasion of the rights of the states. The constitutional right of Congress to regulate commerce between the states has been made to cover power brakes and automatic couplers, and it is assumed that by analogy it should cover block signals; but there is no real analogy. A brake or a coupler cannot be changed at the state line, but continues to operate throughout the entire journey of the car engaged in inter-state commerce. Congress, by its constitutional right to regulate commerce between the states, may say that a car starting in Pennsylvania must be made safe for its journey through New Jersey and into New York. At least, Congress has said so, and most of our fellow citizens acquiesce. But the safety of a car moving across New Jersey is not a bit affected by the presence or absence of signals in Pennsylvania. It is said that the car in Pennsylvania carries passengers or things destined for New Jersey, and is doing inter-state commerce; hence its safety in Pennsylvania may properly come under the care of the general government. This doctrine is inadmissible if we are to keep the scheme of federated society, under which we started, and which we have been taught from childhood is the most perfect form of government that the mind of man ever devised or carried into action. If Congress, in the exercise of its power to regulate commerce between the states, may enter a state to prescribe one fixture on the soil of that state, it may invade the state to prescribe another. It may require that switches be interlocked and signaled. It may scrutinize tracks and bridges and fix standards of construction and maintenance. These are elements of safety no less important than block signals. But what shall we do if the opinion of the people of Massachusetts or of the people of Indiana, as expressed through their legislature, differs from the opinion of the nation, as expressed through Congress?

It must be the duty of the state to protect the people traveling within its borders, and to deliver them safely at the state line, and until the state government breaks down the Federal government has no right to interfere. This seems to me to sum up the Federal situation in the matter of block signals, but I cannot pretend to be a constitutional lawyer, or any other kind of a lawyer, and I have probably missed the point.

If the Federal Congress has no right to invade the states, and order block signals to be placed on their soil, at least the states themselves may require block signals within their respective borders. But the expediency of this is at least questionable.

Block signals are only one element of safety. Many people are killed and injured for lack of interlocking; many others are killed and injured in derailments due to bad track; and still other casualties are due to inadequate bridges. Much of the greatest mortality on railroads is among trespassers on the right-of-way, and among careless passers at highway crossings. If the state begins the protection of people on the railroads, where shall it stop? Surely it should not stop short of the control of interlocking and of permanent way and structures; and it should not stop short of protecting railroads against trespassers, and trespassers against themselves. But this is only the beginning of state control. It is a commonplace that signals will not be displayed or obeyed without discipline and that track and structures will not be maintained without discipline, but there is great reason to believe that to a gradual let-down of discipline, more than to all other causes, is due that increase of accidents which has alarmed the public; and there are many railroad officers who hold, whether correctly or not, that this let-down of discipline is principally due to the influence of the unions. If then, the state is going to step in and prescribe means of safety, it cannot with propriety overlook discipline and the agencies which are acting to undermine it. Back of all is the General Manager with his superintendents. If these gentlemen are incompetent, no expenditure for safety appliances, no precautions designed to improve discipline, will be of much use. The state must extend its control to the superior officers of the railroads, and insure their fitness for the great responsibilities of their posts.

In short, there is no logical stopping place this side of that complete control of railroads which has been so thoroughly and admirably put in practice in Germany, and five minutes of reflection will satisfy any one but a confirmed socialist, that for such a degree of state control, we are entirely unfitted by habit, by temperament, and by social and political organization and methods. We, like the English, are accustomed to meet our emergencies as they arise. Perhaps we might profitably do as the English have done, and attempt some control with an arbitrary line far short of complete state control of the railroads. But it is my fixed belief that the more liberty we leave to the railroads, the more efficient and economical service we shall get. That is the great lesson of the history of railroad development in our land. On the other hand, the present disposition of the people indicates that if the railroads would retain that liberty, they must deserve it.

H. G. Prout.

The following statement about the existing status of the desired legislation in connection with the proposed American Railway Appliance Exhibition in connection with the International Railway Congress, is made by Mr. Geo. A. Post, Chairman:

There was no quorum in the House of Representatives on Monday last, owing to the near approach of the holiday recess and the absence of a large majority of its members. Congressman J. R. Mann, of Chicago, continued his vehement opposition to our resolution and compelled the postponement of consideration until Jan. 9, 1905, when a quorum is assured. There is no doubt that the resolution will be adopted when it is considered by the full house, but Mr. Mann has been able to defeat our efforts to obtain the quick action so greatly desired, in the absence of a quorum, because of the power given under the rules of the House to a single representative to block legislation until a quorum is present. Monday, Jan. 9, is District of Columbia Day in the House, and on that day the Committee on the District of Columbia having charge of our resolution will call it up for action in regular order. I believe that there is no occasion for uneasiness on the part of those interested in our proposed exhibition regarding the ultimate result in Congress.

### Single-Track Blocking Discussed at N. Y. Railroad Club.

The subject for discussion before the New York Railroad Club at its meeting of December 16 was the "Theory and Practice of Single-track Blocking," a paper on the subject being read by Mr. H. D. Emerson, a civil engineer and newspaper writer. The first part of Mr. Emerson's paper was a dissertation on the difficulties of running trains on single-track lines without the block system, showing the dangers of the American train-despatching method. Coming to his principal subject, he first took up Tyer's tablet, and next the electric train staff. In speaking of the staff he presented a letter from Mr. Sperry describing briefly the operation of the Union staff instrument, and one from

Mr. Short, of the Cincinnati, New Orleans & Texas Pacific, telling of the experience of that road with automatic signals and with the staff. Mr. Short makes the statement, which has been published before, that the automatic block signals on his road have increased the capacity of the line 75 per cent. at night and 50 per cent. in the daytime. He says that the cost of installing Hall electro-gas signals on single-track, at intervals of 1½ miles, is $850. This, we suppose, includes the cost of two signals, and means the cost per block, not the cost per mile. The maintenance per year is $131.20. For the Union electro-gas signal he gives for the same equipment $720 cost, and $124.90 maintenance. With the automatic signals on this road, the time-table and train despatcher are still supreme, and the fixed signals are an auxiliary; but on the short sections where the electric train staff is used, the time-table and the train despatcher's authority are suspended, the staff being supreme. On these sections the capacity of the line has been increased from 35 per cent. to 40 per cent. The C., N. O. & T. P. is operated as follows:

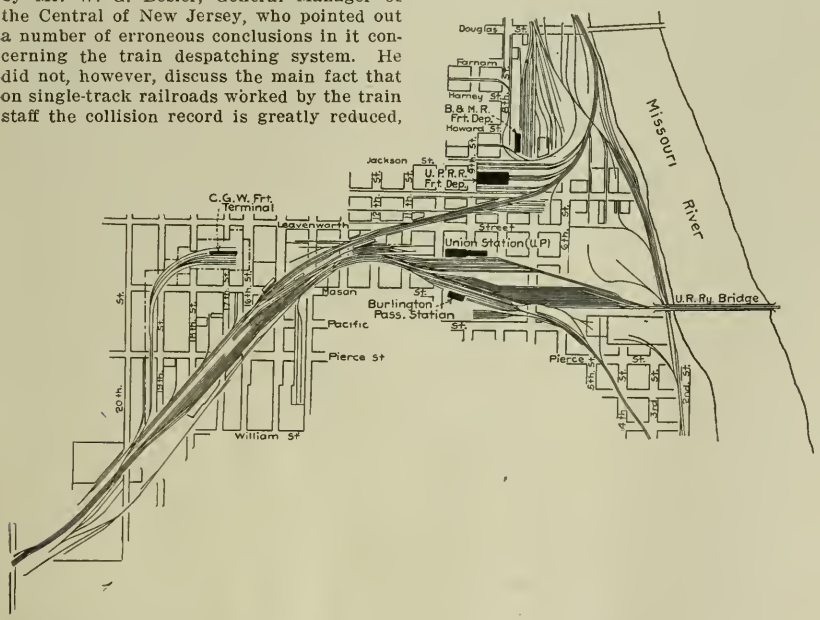
| | |
|---|---|
| By automatic signals | 298.2 miles. |
| Telegraph block system | 18.1 " |
| Electrical train staff | 13.1 " |
| Yards, not signaled | 5.6 " |
| Total | 335.0 miles. |

That part of the paper which deals with the train staff contains a brief account of the method of operation of the Union Switch & Signal Company's latest design, which is described in another column of this issue of the *Railroad Gazette*.

The discussion on this paper was opened by Mr. W. G. Besler, General Manager of the Central of New Jersey, who pointed out a number of erroneous conclusions in it concerning the train despatching system. He did not, however, discuss the main fact that on single-track railroads worked by the train staff the collision record is greatly reduced, and the capacity of the road increased. Mr. Besler read from a prepared paper, and beyond this there was little discussion. The common train staff, as used in England for nearly half a century, is in use on an electric road in Canada, and has been used at one place on the surface street railroads of Brooklyn, N. Y. Reference to these incidents brought out commendatory remarks concerning the efficacy of a "stick"; and Mr. Sperry, being called upon after the other speakers had finished, summarized the situation by saying that, as Mr. Emerson had shown that the staff system was the safest method of operating single-track, and as the use of the "stick" had been advocated partly on the ground of the recent approval of a "big stick" policy by the President of the United States, the railroads would do well to heed the fact that the said President is now "after the railroads with a big stick."

## Omaha Freight Terminal of the Chicago Great Western.

The Chicago Great Western has had its Omaha line in service for about a year and a half, although up to the present it has been without terminal facilities of its own in that city. It enters Omaha over the Union Pacific's Missouri river bridge and has been using the Union Pacific terminals, both freight and passenger. It also has in addition, the use of the Union Pacific tracks as far as the Omaha stockyards in the southwestern part of the city. Its use of the passenger station will continue indefinitely, but since its entrance to the city the Great Western has been engaged in the acquirement of land for, and the construction of freight terminals, which have just been completed and put in service.



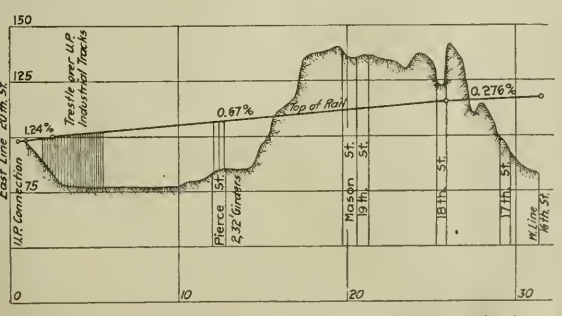

Map of Business Section of Omaha, Showing Chicago Great Western Freight Terminals.

The accompanying map shows that part of Omaha adjacent to the Great Western terminal property. The business district of the city lies directly north of, and only a few squares distant from, the freight house, its location being therefore an excellent one from this standpoint. The site was an expensive one, however, as nearly all of the land was improved property and its cost constituted a large part of the outlay for the terminal. The connecting tracks to the yard leave the Union Pacific near Twentieth street, crossing the low-lying industry tracks of the latter on a pile bridge 400 ft. long. This bridge is indicated on the condensed profile shown, which gives a good idea of the conformation of the land along the route of the connecting tracks, and on the terminal site. It will be seen that the principal part of the yard lies in a heavy cut. The grading at this point amounted to more than 150,000 yds., the material being used to fill in from Sixteenth street to beyond Seventeenth street.

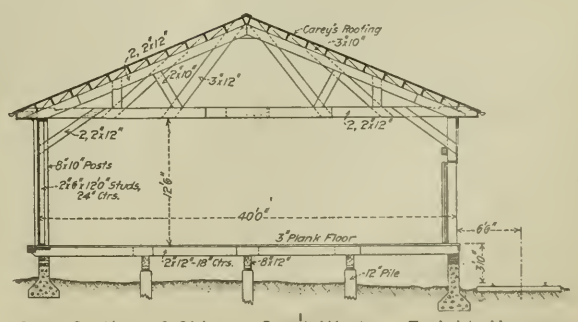
Pierce street is crossed on a double-track steel-girder bridge with concrete abutments. At Mason street, two blocks north, the excavation for the yard approaches reaches a depth of 30 ft. and street traffic is carried across on a wooden bridge. With the exception of these two crossings, all other streets leading across the yards and tracks have been vacated by the city. On Seventeenth, Eighteenth and Nineteenth streets, the city sewers and the pipes belonging to the gas and water companies had to be lowered at considerable expense, in order to carry them under the tracks.

It will be noticed that the Great Western property extends up to, and fronts on Sixteenth street. This street crosses the bottoms and the Union Pacific tracks on a steel viaduct which is 50 ft. high at its highest point. It was the desire of the Great Western, at the outset, to have the principal entrance to the terminal from this viaduct, with which it is on a level, but this privilege was denied the road by the city. Instead, therefore, that part of Sixteenth street lying between the viaduct and the property lines on the west side was raised to the level of the former by grading; level-grade entrances from Leavenworth street are therefore provided on both Sixteenth and Seventeenth streets. Teams have access to the team tracks from both sides of the yards on Eighteenth street and from the north side on Sixteenth and Seventeenth streets.

The general construction of the freight house is shown in the illustrations. As the filling under a part of the house was about 30 ft. deep, it was thought advisable, in order to avoid the costly foundations necessary for a permanent structure, to build a frame house for the present, without carry-




Condensed Profile of Approach to Freight Terminal.




Cross-Section of Chicago Great Western Freight House.

ing the foundations down to solid ground. The filling was done by team work, was thoroughly wetted during the progress of the work by numerous rain storms in the early part of the season, and is believed to be well compacted, so that there should be comparatively little settlement hereafter. However, to provide for any possible unequal settlement, the building proper, above the foundations, is resting on oak wedges so that it can be kept level as the fill settles.

The freight house is 46 ft. x 320 ft. and rests on a piling and concrete foundation. It is a brick-veneered building roofed with Carey's roofing. Thirty feet of one end is occupied by the office, and an additional 16 ft., for a part of the width, by a perishable freight room. Additional facilities include two 6-ft. x 8-ft. scales of three tons capacity.

We are indebted to Mr. A. Munster, Acting Chief Engineer, for the data for the foregoing.

## Annual Report of the Interstate Commerce Commission.

The Interstate Commerce Commission has sent out a synopsis of its eighteenth annual report to Congress, from which we take the following:

*Regulation of Rates.*—The act to regulate commerce, as amended by the Elkins law of 1903, appears to be operating successfully as applied to carriers subject to its provisions; but these provisions should be extended to apply to other agencies connected with transportation which may now be used as a means of affording concessions to shippers. In the present state of the law, the Commission may find a rate complained against to be unreasonable and order the carrier to desist from charging that rate for the future; but it cannot, though the evidence may and usually does indicate it, find and order the reasonable rate to be substituted for that which has been found to be unlawful. Any reduction of the wrongful charge amounts to technical compliance and frees the carrier from any legal obligation under the order. The Commission can condemn the wrong, but it cannot prescribe the remedy. Two cases of unreasonable rates decided during the year are cited as showing some reductions from the rates found unreasonable, but which were not so great as those recommended by the Commission.

Carriers are entitled to ignore the order of the Commission and await the judgment of the circuit court upon a petition by the Commission and another trial of the issues in that court. The more important the case may be, the greater the benefit conferred upon shippers or communities, the less likely is the order of the Commission to be obeyed. . . . The amendments to the statute recommended by the Commission involve no fixing of whole tariffs of rates in the first instance or at any time, but simply the redressing of transportation wrongs shown to exist after full investigation, during which all affected interests have been heard; and when an order is issued against a carrier under such procedure, it should by operation of law become effective upon the date therein specified.

The amendments desired would not confer upon the Commission the power to arbitrarily initiate or make rates for the railroads. No "vast authority" has been asked by or is seriously sought to be conferred upon the Commission. Though the popular demand may eventually take that form, under the stress of continued delay in remedying ascertained defects in the present plan of regulation, the amendment recommended by the Commission, as to authority to prescribe the reasonable rate upon complaint and after hearing, would confer in substance the same power that was actually exercised by the Commission from the date of its organization, in 1887, up to May, 1897, when the United States Supreme Court held that such power was not expressed in the statute. The situation is increasingly grave, in view of the rapid disappearance of railroad competition and the maintenance of rates established by combination, attended as they are by substantial advances in the charges on many articles of household necessity. . . . Authority to require the establishment of joint through rates over connecting and continuous lines is also believed to be necessary, if authority to correct an unreasonable or unjust rate should be granted.

*Private Cars.*—In the use of private freight cars no concessions are made to shippers in refrigeration charges which amount to the payment of a rebate; a practical monopoly has been created in the movement of certain commodities, especially fruit, which has enormously increased to the public the cost of transportation; when the owner of the car becomes a dealer in the commodity transported, the fact of ownership gives him an important advantage over his competitor; when the owner of the car is also the owner of the commodity transported, an excessive rental for the car may amount to a preference in the freight rate, as against the shipper who does not own his car. By consolidation of various companies, the "Armour car lines" now has a practical monopoly of fruit in large quantities in most sections of this country. That company only permits its cars to move fruits in large quantities under an exclusive contract. It provides the necessary number of cars for a fixed mileage, the railroads agreeing that no other cars shall be used for the purpose. The Armour Company furnishes the refrigeration for which it makes a specified charge. The result is good service and adequate car supply, but an enormous and unreasonable increase in refrigeration charges. These exclusive contracts, when they result in unreasonable icing charges, are unlawful, and the failure of the carriers to publish such charges is also a violation of the statute. The private car lines and the railroad companies earnestly insist, however, that the icing is a private service over which this Commission has no jurisdiction under the present law; and if it should turn out after three or four years of litigation that our opinion is wrong, the shipper will be entirely without remedy. Great good would be accomplished by such legislation as would leave no room for such contentions, and provide more adequate and certain remedies for the suppression of these abuses. Common carriers should be made responsible in the matter of this special equipment and refrigeration service (if they are not now responsible), or the car line companies which provide this refrigeration for interstate shipments should be brought under the jurisdiction of the act to regulate commerce.

*Terminal Railroads.*—The terminal railroad owned or controlled by shippers is a most dangerous means of giving preference to favored persons. The case of the Illinois Northern Railroad Company used principally to move traffic to and from the works of the McCormick Harvester Company, a corporation subsidiary to the International Harvester Company, is cited as an example. [See *Railroad Gazette*, Dec. 9, p. 631.] Also the Chicago, Lake Shore & Eastern Railway. Until recently these practices were confined to a few instances, but to-day they are extending in all directions and, unless checked, must soon become general. All available means will be resorted to by the Commission to suppress the wrongdoing, but further legislation may be needed to furnish an adequate remedy.

*Voluntary Submission of Controversies.*—In two instances during the past year the Commission has been asked by both shippers and carriers to adjudicate controversies between them concerning the adjustment of rates. In each case the questions involved are of manifest importance as affecting the business of competitive communities and the traffic of the railroad lines by which they are served. While the Commission is not in express terms authorized to act as a board of arbitration in matters referred to it by consent of the parties concerned, the subject of controversy and the issues involved in both these requests presented such a state of facts as would have justified a proceeding upon formal complaint or of inquiry by the Commission upon its own motion, and they were thus clearly within the spirit of the statute which defines the functions of the Commission. Believing this view to be correct, the Commission accepted the responsibilities it was thus asked to assume. The proceedings in form were strictly in accordance with the provisions of the act, although the voluntary submission by the adverse parties gave them in fact the nature of an arbitration.

One of these proceedings is the differential rate case which involves the relative adjustment of rates in both directions between interior points in the United States and Atlantic seaports from Halifax on the north to Norfolk and Newport News on the south, including Portland, Boston, New York, Philadelphia, and Baltimore. A short history of the differentials prevailing as between these different ports upon freight traffic to and from the west is given in the report. The other case is what is known as the Memphis case, which involves, among other things, the relation of rates to and from Little Rock and Pine Bluff, Ark., as compared with those to and from Memphis. The point is suggested by these voluntary submissions that the usefulness of the Commision in this direction would be greatly increased if its determinations in such cases were sanctioned by authority not now possessed.

*Pending Cases.*—The cases now pending before the commission affect almost every locality in the United States. They involve unreasonableness of rates, discriminations in rates between persons or commodities, discrimination in furnishing cars, preference of particular persons or localities, overcharges, demurrage charges, pooling, and failure to publish tariffs.

*Decisions.*—Besides disposing of a large number of complaints through informal investigation the Commission has rendered during the year 27 decisions involving the following subjects: Divisions or allowances to terminal or industrial lines; (Hutchinson salt investigation, Michigan salt investigation, and the "tap line" case, relating to the divisions of lumber rates on short-haul roads in the southwest); allowances to elevators (Union Pacific elevator case); private car lines and refrigeration of fruit in transit; publication and filling of tariffs on import and export traffic; unreasonable rates (nine cases); long and short haul clause (three cases); unjust discrimination and undue preference (delivery of live stock in Louisville, furnishing cars for coal, early closing of depots at Cincinnati, charges for parlor car seats between New York and Boston, etc.), and pooling (immigrants from New York).

*Tariffs.*—Under this heading the Commission discusses defects in the construction, arrangement, and printing of tariffs. The most important defect is complicated con-

struction and arrangement, it being often impossible to determine the intended application. A common fault in joint tariffs is the failure to specify the routes over which the rates are intended to apply. A plan is suggested by which this defect may be remedied without adding very materially to the cost of the tariffs. Some roads file a general or blanket concurrence in all joint tariffs to which the filing carrier may be named as a party, with the privilege of filing nonconcurrence in any issue which is not satisfactory.

*Routine Work.*—There has been much increase of work on account of the greater number of complaints and the labor involved in securing enforcement of the safety-appliance and accident laws.

*Court Decisions.*—The United States Supreme Court, in the Baird case, recognizes sweeping authority in the Commission to obtain information from witnesses before it upon any subject tending to bear upon issues in cases and investigations under the interstate-commerce law. The circuit court for the western district of Virginia, in the Chesapeake & Ohio coal case, declares unlawful a contract to furnish coal under terms which gave the carrier less than its published rates, but fails to restrain the carrier from further departing from its published rates. The case was appealed to the United States Supreme Court. The orange routing case, applying to the routing of oranges and lemons from southern California, was decided in the United States circuit court in California in favor of the Commission. The court found the defendant carriers were unlawfully engaged in pooling.

*Safety Appliances.*—The good effect of the amending act, especially in securing more effective control of trains through the increased use of air-brakes, is marked. Since the law became fully operative the number of brakemen employed on trains has been reduced on some eastern roads upon the stated ground that the control of trains by air-brakes renders the employment of the former number unnecessary. The number of cars inspected during the year was 208,177, of which 65,183, or 31.31 per cent. of the whole number, were found defective. A smaller number were inspected this year than last, because the provision in the new law relating to air-brakes has entailed much additional work in inspection and securing evidence in air-brake violations. The law is generally well observed, so far as the proportion of air-brake cars in service is concerned, but many of these cars are run in such defective condition as to be really inoperative in respect to use of the air-brake. Instances of defects are given, and the failure of carriers to properly educate employees in the use of air-brakes is noted.

On account of the greatly increased size of trains locomotives should be equipped with two air pumps, or with pumps of the largest capacity. Air-brake cars are frequently found cut out without anything to indicate the reason for such action. This is generally due to the negligence of trainmen, who fail to apply defect cards. Trainmen are often careless in the observance of those conditions which lead to proper compliance with the law.

Many of the defects in cars found not in compliance with the statute were of such a nature as to require men to go between the cars to couple and uncouple them, thus violating the spirit and letter of the statute. While 31 per cent. of the freight cars inspected were found defective, only 42 out of 2,319 inspected passenger cars were found improperly equipped. The number of defective passenger cars was less than 2 per cent. of the whole, and these defects were generally of a minor character and were immediately repaired.

The number of trainmen killed in coupling accidents during the year was 278, and the number injured was 3,441. A large proportion of these deaths and injuries were due to defective equipment, compelling the men to go between the cars to couple and uncouple, and might have been avoided had proper attention been given to the maintenance of safety appliances.

It has been suggested that our inspectors should designate defective cars by making or carding them, but owing to the limited force of inspectors at the disposal of the Commission the carding of defective cars could only amount to scratching the surface, and would tend to shift the burden of responsibility for defective cars from the railroads to the Government. If the Government is to assume such responsibility for the carding of cars, it should have a considerable increase in its force of inspectors, a number of whom should be stationed permanently at prominent interchange points.

Two prominent roads entering St. Louis have issued notice that they will refuse to receive cars from other roads unless the coupling appliances are in good condition. This action has produced most excellent results.

The number of prosecutions for violation of various provisions of the safety-appliance law is noted. None of the suits has come to trial, and in most cases the suits have been settled without trial by the roads confessing judgment and compromising the amount of the penalties. These prosecutions spur the roads to activity in maintaining their safety appliances in better condition.

The extension of time granted to the Colorado & Southern and Denver & Rio Grande, to enable them to apply to Congress for a change in the amended law permitting them to dispense with the driving-wheel brake on their narrow-gage locomotives engaged in road service and substitute the water brake therefor, was further extended by the Commission upon application of the roads. These carriers presented a bill for this purpose, and it was favorably reported by the committees of both Houses at the last session, but did not come to a vote. In view of such action in Congress, the further extension until March 1, 1905, was granted.

Through concurrent action with the Civil Service Commission, improved rules have been adopted for the appointment of safety-appliance inspectors. The greatest care is taken to ascertain the technical knowledge of applicants for these positions and to enable the Commission to secure the services of the very best men. Inspectors are relied upon to secure evidence of violations of the statute, and no reliance is placed upon the furnishing of such evidence by railroad employees. There must be a sufficient number of inspectors to follow all violations closely and secure evidence for their prosecution in the courts, as well as to keep the Commission advised of the condition in which they find the equipment. Several court decisions relating to the safety-appliance law are mentioned.

*Railroad Accidents.*—The article in the report on railroad accidents opens with a table giving the principal totals for the years ending June 30, 1902, 1903, 1904. There were 43,266 employees injured and 3,367 killed in 1904, as compared with 33,711 injured and 2,516 killed in 1902. The figures for 1903 are intermediate between those for 1902 and 1904. The increase in the number of deaths of passengers in train accidents in 1904 compared with 1903 is 64½ per cent. There were ten "unusually disastrous accidents" during the year. The number of deaths resulting from these ten accidents, eight of which were collisions, is about 23 per cent. of the total number killed in all the train accidents of the year, which comprise over 6,000 collisions and 4,800 derailments. Although there has been earnest discussion of the subject in the public press, it is noticeable that the very magnitude of the questions involved appears to have produced some confusion, and in the multitude of causes assigned the real question in many cases has been lost sight of. The paramount requirement, as pointed out in the last annual report, is an effective measure for the prevention of collisions. The Commission urges with added emphasis the same means recommended in its last annual report—the adoption of the block system. The cost of introducing the manual block system can scarcely be called a burden when we see it introduced on single-track lines of not very heavy traffic and find no prominent mention of the expense in the annual reports of the companies. The same reasons that existed for the introduction of the automatic coupler and air-brake by the provisions of the safety appliance act of 1893 apply to the prevention of collisions by compulsory use of the block system.

The Commission recommends that the report of accidents in the annual reports to the Commission should be abolished and that the law be made to require the monthly reports of accidents to cover all classes of accidents. The difficulty in obtaining reports from all companies within the time prescribed by law is mentioned. The extent of these omissions may be inferred from the fact that 64 roads admitted having omitted to report accidents after their attention had been called to them by the Commission. These omissions amounted to a total of 109 deaths and 226 injuries during the year ended June 30, 1904. Suits have been brought against a number of railroad companies for failure to comply with the law. To supply the public with full and accurate information concerning the causes of accidents the facts ought to be made the subject of impartial investigation on behalf of the Government.

*Statistics.*—For the year ending June 30, 1904, the preliminary report embraces returns for roads representing 209,002 miles of line, or about 99 per cent. of the mileage that will be covered by the final report. On the mileage stated gross earnings were $1,966,633,821. The gross earnings for the previous year, on 205,313 miles, were $1,900,846,907, as shown in the final report for that year. For 1904 passenger earnings amounted to $539,428,374, freight $1,377,684,976, miscellaneous $49,520,471. The average of gross earnings per mile of line was $9,410 ($2,581 passenger and $6,592 freight). Operating expenses for the year ending June 30, 1904, amounted to $1,332,382,948, being equivalent to $6,375 per mile of line. The ratio of operating expenses to earnings was 67.75 per cent. The net earnings of practically the same roads, as included in the present statement, were, for the year 1904, $634,250,873, and for the year 1903, $640,644,138. The total income of the roads covered by the preliminary report was $735,037,557.

The aggregate of all deductions from total income was $682,958,610. These deductions chiefly were interest on funded debt, rents of leased lines, permanent improvements charged to income, taxes (which were $56,474,106), and dividends; leaving surplus of $52,078,947. According to the preliminary report, the operating companies included in it declared dividends during the year amounting to $184,450,446. The dividends declared by the same roads during the year 1903 were $160,856,307, thus showing an increase of $23,594,139 in dividends for 1904. As the report under consideration is confined to the returns of operating companies, it does not include any statement of the dividends declared by subsidiary companies, the prop-

erty of which is leased to others for operation. The income which these companies receive is substantially the rent paid to them by the lessee companies from which their own corporate expenditures, including dividends, are made.

### The Union Electric Train Staff.

The Union Switch & Signal Company has brought out a new design of electric train staff instrument, called model No. 2. This design is like the last one made by this company in having a small staff, but in its mechanism it is more like the earlier Webb & Thompson design. As the reader is aware, the train staff is a billet of wood or metal which is given to the engineman of a train to signify that he has the right to the road between two stations, the names of which are inscribed on the staff. Without a staff, no engine can start from either station. A train running from A to B, with the staff for that section, gives up the staff at B and receives another one as authority to run from B to C, and so on. By the original plan a single staff was provided for each section, and thus could be used only by regularly alternating trains; thus, A to B; B to A; A to B, etc. By the use of tickets, a staff was made to serve for two or more trains following one another in the same direction. This, however, was cumbersome, and the electric apparatus was devised to make the staff always as readily available at one end of the section as at the other. Tyer's tablet apparatus was the first electrical device of this kind; next came Webb & Thompson's electric train staff (1889); then the American modification of this, brought out by the Union Switch & Signal Company a few years ago, and now we have the latest

Fig. 1—Front View, Normal Position.

Fig. 2—Indicator 16 Showing White.

Fig. 3 — Indicator Showing "Staff Out."

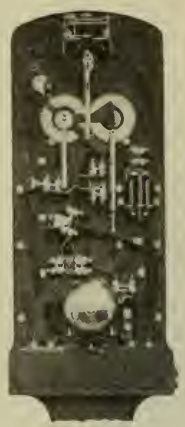


Fig. 6—Staff Out; Same as Fig. 3.

improvement.* The most noticeable outward change that has been made is in the arrangement of the magazine, Fig. 1, by which the staffs must always be taken out at one point and be put in at another, so that all of the staffs are used in rotation. In the earlier designs a few of the staffs did all of the work.

Of the illustrations, Fig. 4 shows the apparatus in the same position as it is in Fig. 1; Fig. 5 the same as Fig. 2; and Fig. 6 the same as Fig. 3.

The principal parts are shown in Figs. 4

*The Webb & Thompson staff machine was described in the *Railroad Gazette*, August 1, 1890. The operation of the staff on the Philadelphia & Reading was described Dec. 6, 1901, and on the Atchison, Topeka & Santa Fe Dec. 19, 1902.

Fig. 4—Back View of Interior; Corresponds to Fig. 1.

Fig. 5—Back View of Interior; Corresponds to Fig. 2.

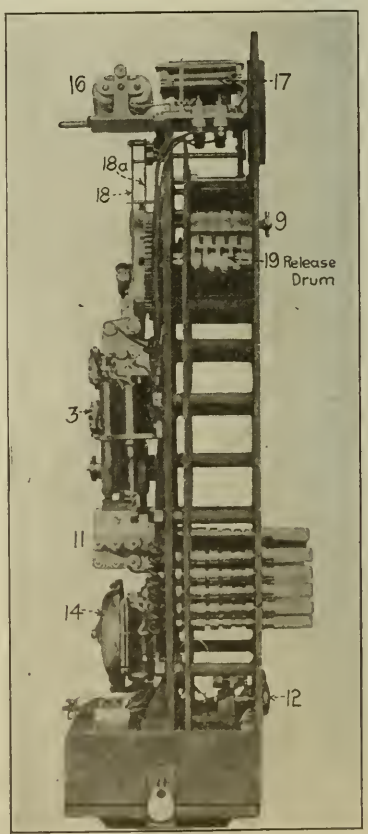



Fig. 7—Side View.

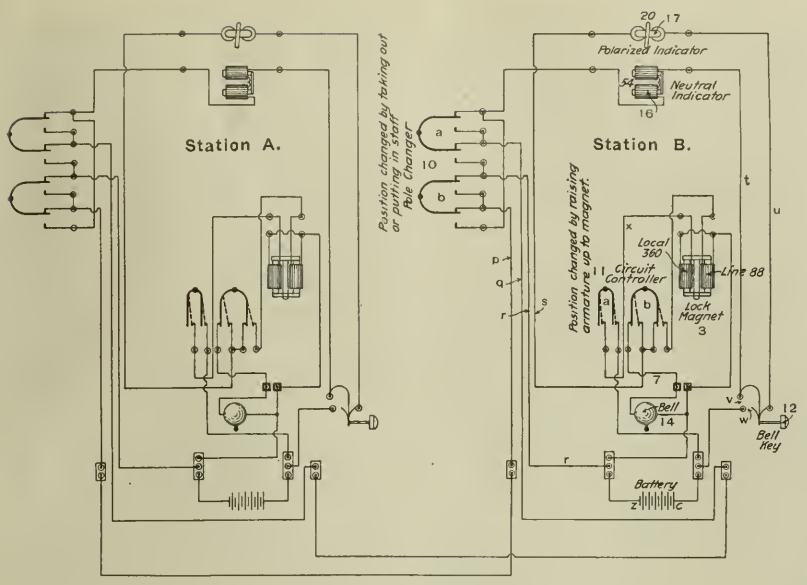



Fig. 8—Electric Circuits.

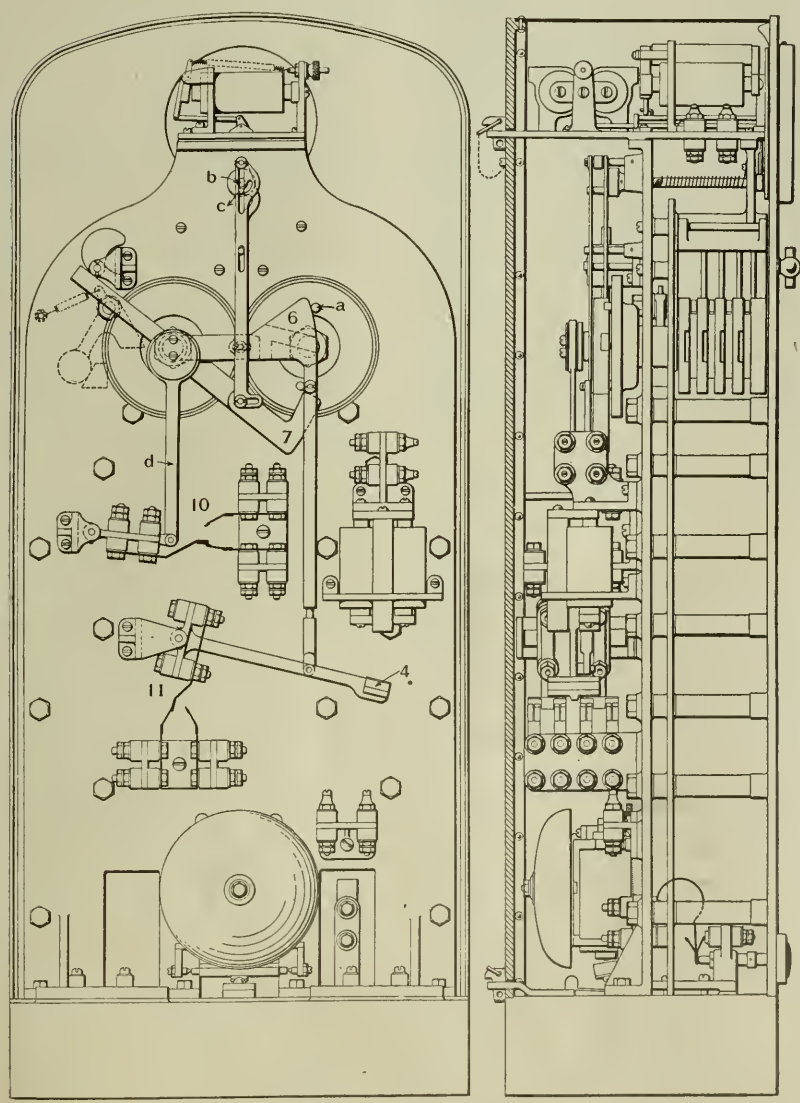


Fig. 9—Union Electric Train Staff, Model No. 2.

and 7, as follows: 1, releasing wheel, and, 2, locking wheel, these being geared together, and always moving in unison; 3, special compound magnet; 4, armature of magnet; 5, rod to lift armature; 6, lock; 7, arm for lifting 5, 6 and 18; 8, cam (turned by knob 9, Fig. 1) for moving arm 7; 10, pole changer; 11, circuit controller; 12, bell key (key 13 shown in Fig. 1 is not used); 14, bell; 15 (Fig. 1), base; 16 (Figs. 1 and 7), neutral indicator; 17, polarized indicator; 18 (Fig. 1), red disk; 19 (Fig. 7), releasing drum. Disks D 1 and D 2, Fig. 1, can be revolved only when wheels 1 and 2, Fig. 4, are free to revolve with them.

Compound magnet 3 consists of one coil of high resistance and one of low; the two, when energized by currents of opposite polarity, both exert an influence in the same direction to hold an armature placed between them, at right angles to a line passing through the axes of the two coils. The electrical connections are shown in Fig. 8. The arrangement is the same at both stations, and there is one metallic circuit (two wires) from station to station. The normal position of the apparatus is as shown in Fig 4; and the electric circuit from station to station is normally dead. The operator at A, desiring to send a train to B, calls *B* by pushing the bell key 12 (Figs. 1 and 7), which closes the points at *w* (Fig. 8), closing circuit through indicator 16 at station B (as well as in his own machine). At B, points *w* being open, the current passes through the polarized indicator 17 also; and thence through wire *s* and points *b* in the circuit controller, 11, to bell 14; thence through wire *r* and points *b* in pole changer, 10, and wire *p*, to line, and back to station A.

If all the staffs are in, at both station *A* and station *B*—that is, if no train is in the block section—*B*, responding, presses key 12 and holds it in until *A* turns knob 9. The turning of knob 9 at A, depressing the left hand end of lever 7 (Fig. 4), by means of cam 8, lifts 5, bringing armature 4 up to the magnet; and also lifts lock 6, thereby unlocking wheel 2 by removing the obstruction from the pin *a* in this wheel (Fig. 9). At the same time the other pin in wheel 2 is obstructed by the lower end of lever 7, and the wheel cannot be moved until lever 7 has dropped to its normal position, as shown in Fig. 5.

The operator at A therefore does not hold knob 9, but at once releases it, and arm 7 falls back; but armature 4 is held by the magnets. When *A* lifts 4 he moves controller 11, closing the circuit through wire *x* (Fig. 8), and local coil 360 of magnet 3, at the same time opening the circuit through wire 7 and the bell. The current from station B is by this transferred from the bell to line coil 88 of lock magnet 3. By this means this current (points *w* at B still being closed) energizes both coils of 3 so that they act together to hold up armature 4. The apparatus is now in the position shown in Figs. 2 and 5. The red disk has become invisible, indicating that a staff may be taken out.

*A* now lifts a staff *s* (Fig. 2) to the disk D 2, and, revolving the disk one-half revolution, removes the staff from the machine and delivers it to the train.

The relation of lever 6 to wheel 2 is shown in Fig. 9. Locking pin *a* is released as soon as lever 6 is raised sufficiently to bring the slot shown by the dotted line opposite the pin, this slot being cut in the back side of the lever. The control of disk 18, Fig. 1, by lever 7 and lock 6, is best shown in Fig. 9. Rod 18 (Fig. 7), is lifted by lever 7 (Figs. 4 and 9), and rod 18 *a* is lifted by lock 6; and the disk, carried on the shaft *b* (Fig. 9), is moved when the slots in the two rods have both been brought into the right posi-

tions to release pin c. This position of rods 18 and 18 *a* is shown in Fig. 5.

The withdrawal of a second staff at either station is impossible because the process above described cannot be repeated until a staff (the one just taken out) has been inserted in either the A machine or the B machine. If a second staff, at A, or a staff at B, be lifted to drum D *2*, which is on the same axis with wheel 2, this wheel, locked by its lower pin having made a half revolution and been stopped by lock 6, will prevent the drum from turning, and will thus keep the staffs in the machine; and the only way to unlock the wheel is by repeating the electrical operations before described. If these be attempted the effort will be futile, because the next current sent by either station will be of such polarity that magnets 360 and 88 will neutralize each other, and so will not hold up armature 4. The change of polarity was effected when the staff was taken out. When this was done (revolving wheel 2 one-half turn), wheel 1 was also revolved the same distance; and thus, by means of eccentric

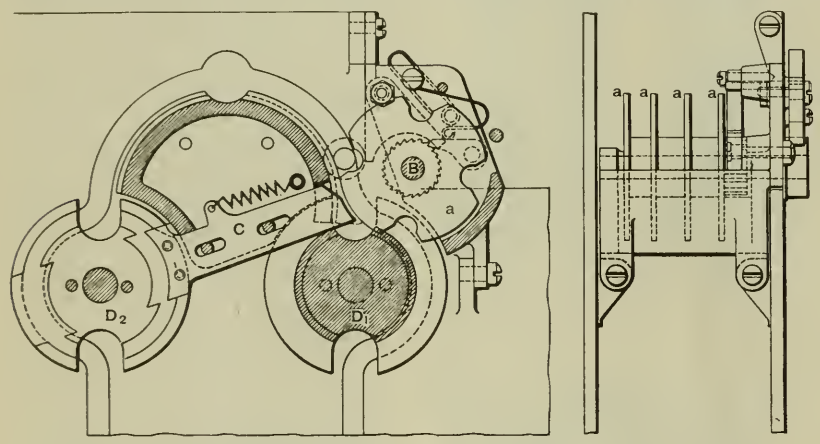



Fig. 10—Sectional View of Drums.

and rod *d* (Fig. 9), changed the path of the current by moving pole-changer 10 (Figs. 4 and 8) so that if the battery should be again connected to the line, the current would flow through magnet 88 in a direction opposite to that which it flowed before, and thus it would neutralize instead of reinforce the current through 360.

Replacing the staff in the machine (by passing it through slot D 1, Fig. 1) again changes the points 10 *a* and 10 *b* (Fig. 8), and a staff may be taken out as before. Staffs always come out through D *2*, revolving wheel 2; and always go in through D 1, revolving wheel 1; but either of these two wheels always revolves the other with itself.

If the staff is restored to the same machine from which it was taken, it restores the pole-changing points to the positions from which it had withdrawn them; if it is taken to B and put into the machine there, it moves the pole-changing points there so as to make them correspond with the changed position of the corresponding parts at A.

The operations that we have described may be summarized as follows: *A*, having a train that he wishes to send forward to *B*, presses the bell key 12 the prescribed number of times (called for by the bell code), which rings the bell 14 (Fig. 4) at *B*; *B* answers and holds in his bell key 12, which moves over the current, indicating needle 16 to the right (see Fig. 1). *A*, seeing this indicator standing over, at once turns the preliminary spindle handle 9 over to the right as far as it will go. He immediately releases it, and it returns automatically to its normal position. As soon as this occurs, the red disk 18 (Fig. 1) will show white as in Fig. 2. This indicates to *A* that the instrument is unlocked. He then moves a staff S through the vertical part of the slot into engagement with and revolving the drum D 2 and withdraws the staff at the circular opening at the uppermost point. When the drum D 2 is revolved the circuits are changed, throwing the instruments out of synchronism. At the same time, the staff-indicating needle 17 (Fig. 1) will move from "Staff in" to "Staff out." As soon as *A* has withdrawn the staff he presses in his bell key 12, which will move the indicating needle at B to "Staff out" (16 Fig. 1).

The staff is 6 in. long and ¾ in. in diameter. Staffs for different sections of the road have rings or wards of different shapes or sizes, so as to prevent the use of any staff in any machine except the two to which it belongs. The four steel disks a, a, a, a, Fig. 10, fixed to shaft B, constitute a lock to prevent the improper manipulation of the dogs C.

Machines of this design will probably soon be put in use on the Chicago, Burlington & Quincy's line across the Missouri River between Pacific Junction, Ia., and Plattsmouth, Neb.

## Supreme Court Decision in Johnson Coupler Suit.

In a decision handed down last Monday by Chief Justice Fuller, in the case of Johnson against the Southern Pacific, the Supreme Court of the United States holds that all cars, including locomotives, should be equipped with uniform automatic couplers. The dining car, which was involved in this case, is declared not exempt from the requirements of the safety appliance law, even though it was empty and standing on a side track.

The accident out of which the suit grew occurred at Promontory, Utah, in 1900, when Johnson, a brakeman, was directed to couple the locomotive to a dining car which was standing on a sidetrack. (Johnson and the engine belonged on a freight and were called in merely to take the car to the turn-table and turn it around.) The engine was equipped with the Janney coupler and the car with the Miller, so, of course, Johnson had to go between the cars to couple with a link, and his hand was so badly mangled that amputation became necessary. He brought suit for damages, but both the Circuit Court for the District of Utah and the Circuit Court of Appeals for the Eighth Circuit decided against him. To-day's opinion reverses both these judgments and orders a new trial.

Chief Justice Fuller said that the purport of the law was to require that cars should be "equipped with couplers coupling automatically by impact, and which can be uncoupled without the necessity of men going between the ends of the cars." He held that the act requires that locomotives should be equipped with such couplers; "it was as necessary for the safety of employees in coupling and uncoupling that locomotives should be equipped with automatic couplers as it was that freight and passenger and dining cars should be, perhaps more so, as Judge Thayer suggests, since engines have occasion to make couplings more frequently. Manifestly, the word 'car' was used in its generic sense."

The locomotive in this case was equipped with an automatic coupler, as was the dining car, but the couplers on the two cars were of different types, and would not couple automatically, so as to render it unnecessary for men to go between the cars to couple them. This, it was held, did not comply with the requirements of the law, "whose object was to protect the lives and limbs of railroad employees by rendering it unnecessary for a man operating the couplers to go between the ends of the cars. That object would be defeated if these different kinds would not automatically couple with each other.

Of the contention that the dining car was not actually engaged in interstate commerce at the time of the accident, the Chief Justice said: "Confessedly the dining car was under the control of Congress while in the act of making its interstate journey, and, in our judgment, it was equally so when waiting for the train to be made up for the next trip." He held that the car could not be considered "empty" when in use, but said that "whether cars are empty or loaded, the danger to employees is the same."

## Permanent Way for Fast Train Services.*

(*Continued from page 642.*)

On the continent, there is a tendency to change the process of manufacture of steel for rails; formerly scarcely anything but acid Bessemer was used, but to make this, cast iron manufactured out of ore from phosphorus was required. Such ore being scarce, most of the steel works have been led to adopt the Thomas or basic Bessemer process. Exceptionally there are also steel works where rails are made out of Martin basic or Martin acid steel.

The managements that used Thomas steel ten years ago have had plenty to complain about; metallurgists till then did not understand the process properly. It was thought that any cast iron, of any composition, was suitable for making Thomas steel, and the results obtained were poor. But subsequently, we think that the Thomas steel manufactured for rails was just as good as the Bessemer, and most engineers seem no longer to have any objection to Thomas steel. If, however, we are to believe in certain statistics, the general (?) use in Germany of Thomas steel is the cause of the more numerous rail fractures which occur there as compared with England. Now in the first place, is it true that in Germany there are more Thomas rails than Bessemer rails in actual use? Moreover, there is nothing conclusive about these comparative statistics applying to two countries where the climate, the working, the traction, the cross-section and the dimensions of the rails, their method of manufacture and the railroad system are so entirely different. Any comparison of fractures can only be made between rails of the same cross-section on lines of the same age and carrying the same amount of traffic. The North Eastern in England uses both Bes-

*Extract from a report prepared for the International Railway Congress, by Mr. Van Bogaert.

semer and Thomas rails, and the latter do not break more frequently than the former.

The Belgian State Railway system has 6,978 miles of rails on main lines; of which 870 miles are 104.83 lb. rails laid between 1888 and 1894; and 1,118 miles are 81.84 lb. rails laid between 1900 and 1903. During 1903, there were recorded 401 transverse fractures of 76.60 lb. rails or of rails of old sections, nine of 104.83 lb. rails, and five of 81.84 lb. rails. The annual traffic amounts to 37,293,000 train-miles. The 76.60 and 104.83 lb. rails are of Bessemer steel. Of the former, there are some more than 30 years old (1872), and the oldest break the most; of the 81.84 lb. rails, two-thirds are made of Thomas steel and one-third of Bessemer.

According to these statistics, in Belgium, on a system of about 2,485 miles, about one rail is broken per year per 6.2 miles of railroad, whereas in England only one rail is broken per year per 62.1 miles of railroad (in Germany one rail per 2.5 miles); Bessemer rails, however, are used in both cases and the cause is not Thomas steel. The favorable influence of heavy rails is also clearly shown, for it must be noted that there is most traffic on the lines with 104.83 lb. rails. In order to reduce the number of fractures of rails, it would perhaps be advisable, taking the lightness of the 76.60 lb. rails as compared with the heaviness of the rolling loads into consideration, to limit the time the 76.60 lb. rails are left in on main lines to a greater extent than is at present the case.

According to Haarmann, 82.65 lb. Thomas rails, put in on the Cologne-Hamburg line, near Osnabrück, in 1901, at the same time as the Bessemer rails, show about twice as much wear as the Bessemer rails; we have already seen that the Bessemer rails of that line show twice to three times as much wear as those of the French Northern. The Thomas rails show a wear of one millimeter per 25,000 trains; but although the chemical composition and the physical qualities of the Bessemer steel are given, we do not find those of the Thomas rails; they are probably made of soft steel or else rolled at too high a temperature.

The Bessemer rails at Osnabrück, to which we shall refer later on, have an ultimate tensile strength of from 44.83 to 46.67 tons per sq. in. at the crown and flange respectively, an elongation of from 17.1 to 10 per cent. and a contraction of area of from 41.4 to 24.4 per cent. The chemical composition per cent., is: silicon, 0.41; manganese, 1.04; phosphorus, 0.09; carbon, 0.44.

The descents from Ans to Liége have an average gradient of 2.8 per cent. over a length of two miles 855 yards, and a maximum gradient of 3.1 per cent. over a length of 1,312 yards, every day 30 passenger trains weighing 350 tons each, 65 goods trains weighing 650 tons each, 13 passenger locomotives weighing 103 tons each and 58 goods locomotives weighing 121 tons each run down these inclines. To the goods trains, ballasted wagons with slipper brakes are added; the rails on this downhill track become worn more than the rails on any other part of the system. It is of interest to compare the wear of the 76.60 lb. Bessemer and Thomas rails on this section; the Thomas rails were taken out in 1902 and replaced by Bessemer rails.

*Observed Wear, in Inches.*

| Location. | After 18 mos. 76.60-lb. Bessemer rails. | After 19 mos. 76.60-lb. Thomas rails. |
|---|---|---|
| Above Aumônier ..... | 0.18 | 0.16 |
| " Saint-Laurent .. | 0.35 | 0.35 |
| Below Saint-Gilles .... | 0.43 | 0.45 |
| " rue Nysten .... | 0.43 | 0.47 |
| " rue du Sauveur. | 0.47 | 0.47 |

The agreement between the amounts of wear is remarkable and does not at all justify the opinion still held in some quarters that Thomas steel rails are inferior for wear to Bessemer steel rails. At the time when these rails were supplied, the specifications laid down a minimum ultimate tensile strength of 41.27 tons per sq. in. and a minimum elongation of 10 per cent. If any other railroads have made similar observations confirming or contradicting these conclusions, it would be of interest to inform the Congress of them.

*Rolling the Rails.*

We extract the following paragrapph from a note on the rolling of rails published by Mr. P. Pasquier, Engineer, in the *Revue Universelle des Mines et de la Métallurgie*, May, 1901, Liége.

"The physical work put in during the rolling process has no influence on the quality of the steel of the finished rail, as was formerly thought to be the case. Large ingots which have more work put on to them do not give better steel than small ingots; even hammering does not add anything to the quality of the steel. Coarse crystallization gives a metal of bad quality, and fine crystallization is a sign of good quality."

Mr. Sauveur (translated and annotated by Mr. Osmond) lays down the following propositions:

I.—Slow and undisturbed cooling, from a temperature equal to or above $x$ (point $b$ of Tchernoff), produces crystallization.

II.—Slow and undisturbed cooling, from a temperature below $x$, does not produce crystallization.

*Corollary.*—Steel sections finished at a temperature below $x$ do not become crystalline in their structure.

III.—The temperature $x$ varies with the chemical composition of the steel. The different impurities, carbon and phosphorus at least, lower $x$, although to a very different extent.

*Corollary* 1.—Carbon and phosphorus and probably all impurities, at least if present in certain proportions, increase the size of the grain.

*Corollary* 2.—The harder the steel, the higher the temperature at which the rolling can be completed without coarse crystallization.

IV.—The higher the temperature from which the steel is allowed to cool slowly and without further work being put on it, the coarser the grain for given chemical composition.

V.—The slower the cooling, the coarser the grain for a given composition.

*Corollaries* 4 *and* 5.—The grain of a finished section is coarsed at those points which were hotter when the rolling was completed and which were cooled more slowly.

VI.—The size of the grain is independent of the amount of work put on to the steel.

A Vignoles rail finished hot from the same heat as one finished cold is characterized by elongations of 15, 19 and 22.5 per cent. at the center of the head, the side of the head and the edge of the flange respectively, whereas the corresponding figures for a rail finished cold are 20.5, 20 and 21 per cent.

Mr. Pasquier has made experiments on the influence of the temperature of rolling on rails made out of the same bloom cut in half, the test pieces being taken from near the cut. He concludes that: "Any steel the rolling of which is finishesd either at a temperature above $x$ or below $y$, will on testing give results which are the worse the further the temperature from those limits ($y$ is a temperature which varies with the composition of the steel and gives the defect called cold-shortness)."

The defects due to these two causes (too hot or too cold rolling) are removed by reheating. Experiments have also shown that with well-made steel, physical work does not in any way improve the quality. In the case of double-headed rails, all that is necessary not to exceed the disastrous temperature $x$, is to reheat the blooms to the temperature just required to do the rolling properly; there are no thinner parts which cool too quickly and the rolling is easy. But Vignoles rails have the flange with less metal and thinner than the head. As one starts with a bloom of square section, the steel must be worked across from the flange to the head, and the flange must be prevented from cooling too much during the operation of rolling. It is therefore necessary as much as possible to avoid overheating the blooms, to roll very quickly and not to have too long bars; it is thus possible to roll at a low temperature without the flange becoming cracked. It is also advisable to increase the thickness of the flange of Vignoles rails.

The Kennedy and Morrison process consists in cooling the rail to a suitable temperature before putting it through the last pair of rolls. The temperature at which a rail should leave the rolls is the lower the greater the area of the cross-section of its head. It hence results that it is easier to roll a 72.57 lbs. rail without obtaining a coarse grain than a 100.79 lb. rail.

A 72.57 lb. rail must be finished at a temperature of about 860 deg. C. (1,580 deg. Fahr.) in order to obtain steel without coarse grain. To satisfy proposition V, the author proposes to cool the rails as quickly as possible by a current of air. The reporter would draw attention to the fact that, in order to make it unnecessary to work steel across from the flange to the head, it would be possible to cast ingots of trapezoidal section to roll Vignoles rails or even bull-head rails out of, and to make the blooms of that section. It would also be desirable, as Mr. Pasquier states, to roll sections having thicker flanges, particularly in the case of heavy rails and of rails which have a small inclination of the surfaces on which the fishplates bear, in order to avoid any cold-shortness in the flange during rolling at the suitable temperature (between $x$ and $y$) and at the same time avoid any coarse grain in the head. It is also advisable to use hard steel containing 0.5 per cent. of carbon which has only one temperature $x$, whereas steel containing less carbon has two or three lower than $x$.

Now although the 104.83 lb. rails of the Belgian State break much less frequently than the 76.60 lb. rails, on the other hand they have the disadvantage that the head more often becomes flattened out than with the lighter rails. But although this defect then makes it necessary to take out such a rail from the main lines, yet it presents no danger so far as the circulation of the trains is concerned. In America some railroads specify a maximum contraction of the rolled bars after they have been cut to length immediately after leaving the last rolls, in order to check the temperature the rolling is finished at. But this does not always prevent a coarse grain.

*Liquation and Cropping of Ingots, Blooms and Bars.*

We think that any specifications as to the cropping of ingots, blooms and rolled bars should vary with the purity of the steel, and consequently with any liquation effects. A special process (Sauveur) makes it possible to avoid these very injurious liquation effects almost entirely by casting into ingot moulds arranged in series; the steel flows down from the fifth to the last and continually reheats the heads of the ingots. It should therefore not be specified that at least 4 ft. 11 in. must be cut off from the end of the rolled bar corresponding to the head of the ingot; for this may be too little for impure steel in which considerable liquation has occurred and far too much for pure steel with little liquation or cast on the Sauveur system. Such clauses may have the effect of preventing the steel makers from improving as much as possible their manufacturing processes. In order to ascertain, with a given quality of steel, whether sufficient has been cut off the ends of the ingots, blooms or bars, it is advisable to make etching tests on the surface of rails. In case of any doubt, the microscopic examination of etched cross-sections may give more definite information;

but this is a laboratory method not yet used in ordinary inspection practice.

*Chemical Composition.*

In order to obtain tough and hard rails most suitable for resisting wear and tear, the chemical composition, in percentages, should be somewhere about as follows: Silicon, 0.1 or less; manganese, 1 to 1.2; carbon, 0.5; phosphorus and sulphur, less than 0.1. Haarmann proposes the same proportion of carbon as of silicon, from 0.2 to 0.5. (The English specifications place silicon on the same footing as phosphorus: not to exceed 0.1.) We have seen before that the rails with 0.2 to 0.5 of silicon on the line from Cologne to Hamburg become worn more quickly than rails of the same hardness on the French Northern. It is probably the bedplate which is one of the causes of the greater wear of the German rails; but in any case it is by no means proved that the great proportion of silicon beyond 0.1 reduces the wear. In order to arrive at any definite conclusion on the point, it would be necessary to make comparative trials on the same line, with rails hardened by carbon and with other rails hardened by carbon and silicon. We are inclined to think that rails hardened by means of silicon are more brittle than those hardened by carbon, and that it is for this reason that the English railroads seem to object to more than 0.1 per cent. of silicon.

*Special Methods for Avoiding Blow-holes.*

Ferro-silicon is added in a small proportion to steel in order to prevent blow-holes. Aluminum in the state of metal is also used successfully, but it is still rather expensive. Similar results are obtained with ferro-aluminum. It is also recommended to stir up fused metal before casting it; these are details for steel manufacturers to consider.

*Mechanical Tests.*

Many of the railroads are satisfied with drop tests and examining the fractures: they must show a fine grain. Others specify the steel by its ultimate tensile strength and elongation. There is a general consensus of opinion that the ultimate tensile strength of steel for rails should average 44.45 tons per sq. in. and should not be less than 41.27 tons per sq. in.; the elongation should be at least 10 per cent. When this is specified, the steel works (Bessemer as well as Thomas) generally supply rails having an ultimate tensile strength of between 43.18 and 45.72 tons per sq. in. and an elongation of from not less than 12 up to 17 per cent. In England, as a rule, an elongation of 15 per cent. is specified.

*Summary and Conclusions.*

Experience seems to prove that neither metal sleepers nor longitudinal sleepers are suitable for busy lines with fast traffic. The weight of rails tends to increase with the speed. Heavy rails have certain advantages over light rails; the track requires less maintenance and fewer renewals, the rails get worn less and break less.

With excellent rolling stock and well balanced locomotives, the necessity of using heavy rails is not so paramount.

Putting in the rails so that the web is vertical has more disadvantages than advantages.

It would be desirable to have a wider head and to have a flat rolling surface like the tire, so as to prevent the hollowing out of the latter by the mutual action of the two bodies in contact.

The minimum thickness of the head can be reduced to 1⅜ in.

By widening the head, the surfaces on which the fishplates can bear are increased; this reduces the excessive wear of the rail and fishplate surfaces in contact with each other, and consequently the deformation of the joint; for this same reason, the steel used for fishplates should be as hard as that used for the rails, contrary to the usual but erroneous practice.

The rails must be rolled at a low temperature (850 deg. C. [1,562 deg. Fahr.[).

Rails rolled at too high temperature, with a coarse crystallization, can be improved by re-heating to a suitable temperature.

In order to have steel of good quality, it is desirable, in the case of Vignoles rails, to roll sections with flanges thick at the edges, at least $^{33}/_{64}$ in.

Specifications laying down that part of the ingot, bloom or rolled bar that is to be cut off should not specify the exact amount to be cut off: the better the manufacture, the less liquation and piping is there and the less need to be cut off.

The chemical composition, in percentages, of rails should be about: Silicon, 0.1; manganese, 1 to 1.2; carbon, 0.5; sulphur and phosphorus, less than 0.1. Is it true that the resistance to wear is increased by increasing the proportion of silicon to 0.5 per cent.?

Steel having an ultimate tensile strength of at least 41.27 and even of 44.45 tons per sq. in. and an elongation of 10 per cent., is to be preferred for rails; for special track appliances, it is advisable to use even harder steel. Steel for the tires of locomotives and express rolling stock must be hard and tough; it should have an ultimate tensile strength of at least 44.45 tons per sq. in. and an elongation of 15 to 20 per cent.

Nickel steel is not used for rails and it is unnecessary to try it for European traffic; heavy rails of hard steel, rolled at a sufficiently low temperature, seem to be more economical even at places where there is an abnormal amount of wear and tear. Nickel steel might be tried for tires. Several systems of supported and suspended rail-joints are being tried; but sufficient time has not yet elapsed to make it possible to draw any conclusions.

Reducing the width of the expansion gap in the case of heavy long rails should be tried.

Welded joints are not to be recommended.

It is desirable to have long rails; 59 ft. is now a usual length; perhaps it would be possible to go to 78 ft. 9 in. if there were no difficulties of transport.

## Proposed Moving Platforms Under Thirty-fourth Street, New York.

The accompanying illustrations show the location of, and plans for a proposed subway under 34th street, New York City, as submitted to the Board of Rapid Transit Railroad Commissioners by Messrs. Schmidt & Gallatin at a hearing on Nov. 29, 1904. It is proposed that a subway be built from First to Ninth avenues, as shown in Fig. 1, and used as a feeder for connecting all of the north and south elevated and surface lines with the new Pennsylvania Railroad terminal, to and from which it is expected the traffic will be exceedingly heavy. It is estimated that over 70,000,000 people per year will have to be cared for at this point.

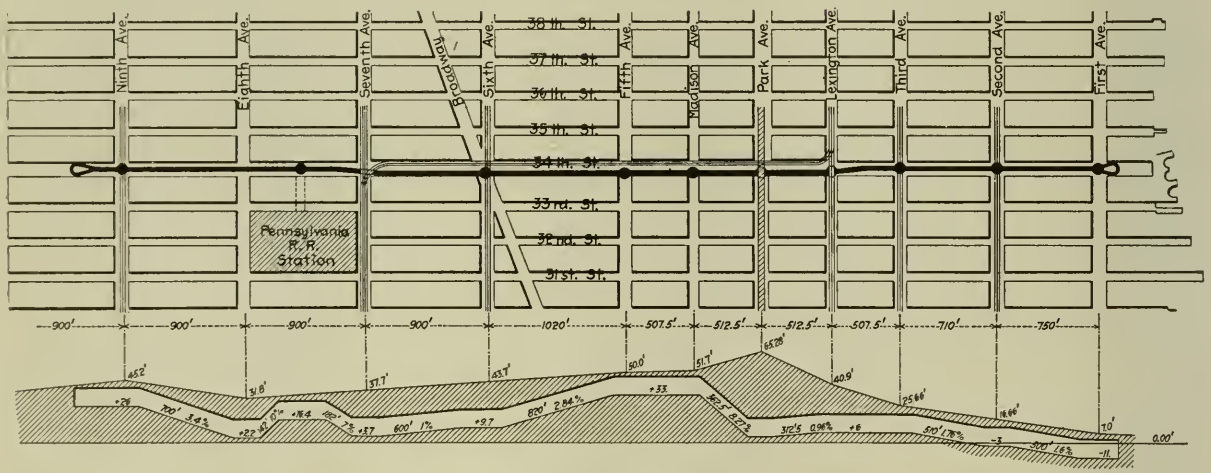



Fig. 1—Proposed Subway Under 34th Street.

The continuous train or moving platform as proposed, will have a capacity for delivering at a given point upwards of 50,000 seated passengers per hour. It is proposed to divide the subway by a partition, as shown in Fig. 2; one part of the platform moving eastward on one side, and one moving westward on the other side. This method is claimed to provide for more continuous circulation of the air than could be procured if the platforms moved in opposite directions in one large tube.

The system as proposed consists of an auxiliary platform, two "stepping" platforms and one platform fitted with seats, the whole really amounting to a continuous train. The driving mechanism consists of a number of 10 h.p. motors placed 75 ft. apart connected to shafts by means of chain drives; these shafts are mounted in boxes on

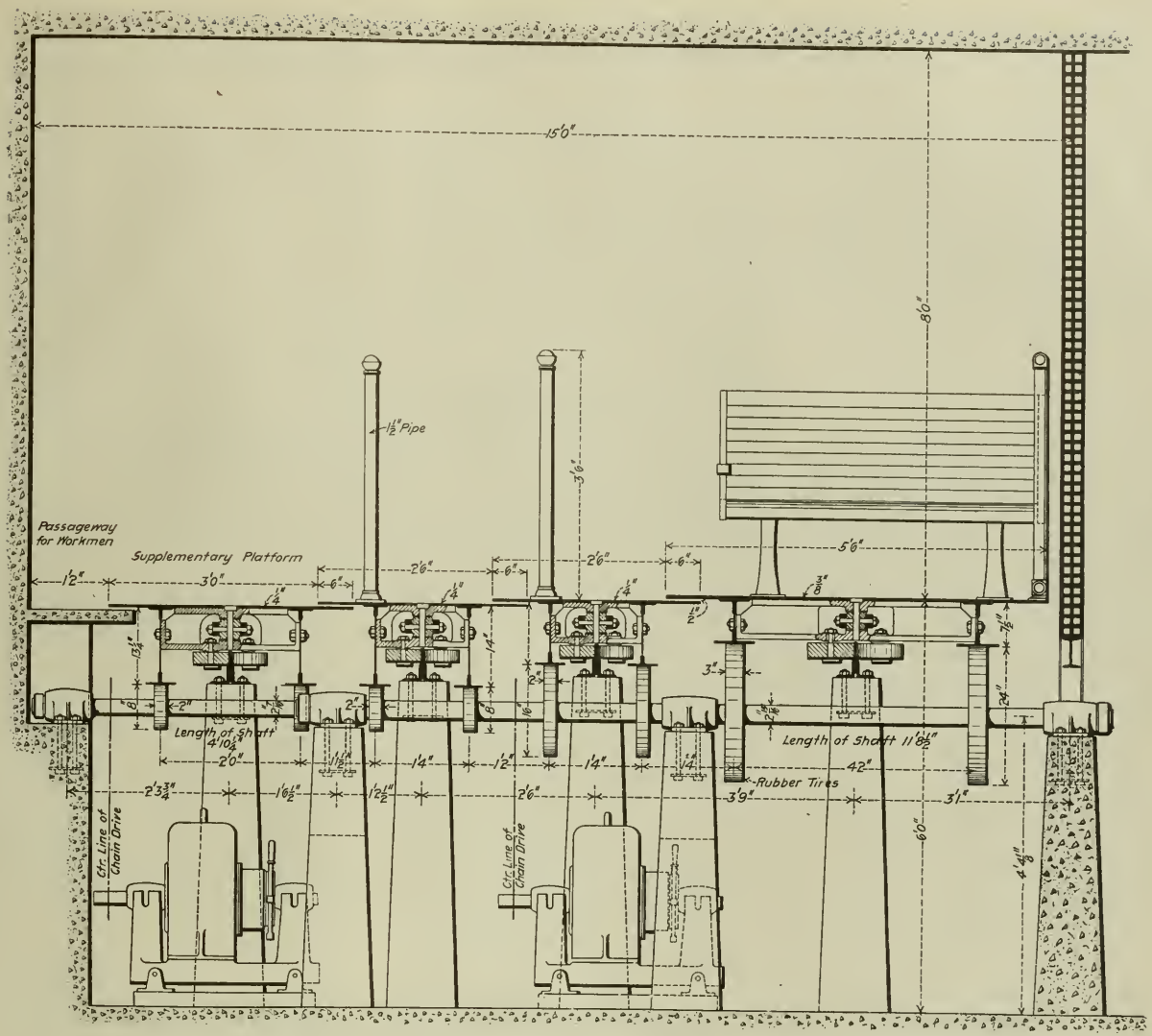



Fig. 2—Half Section of Proposed Subway Showing Arrangement of Moving Platforms.

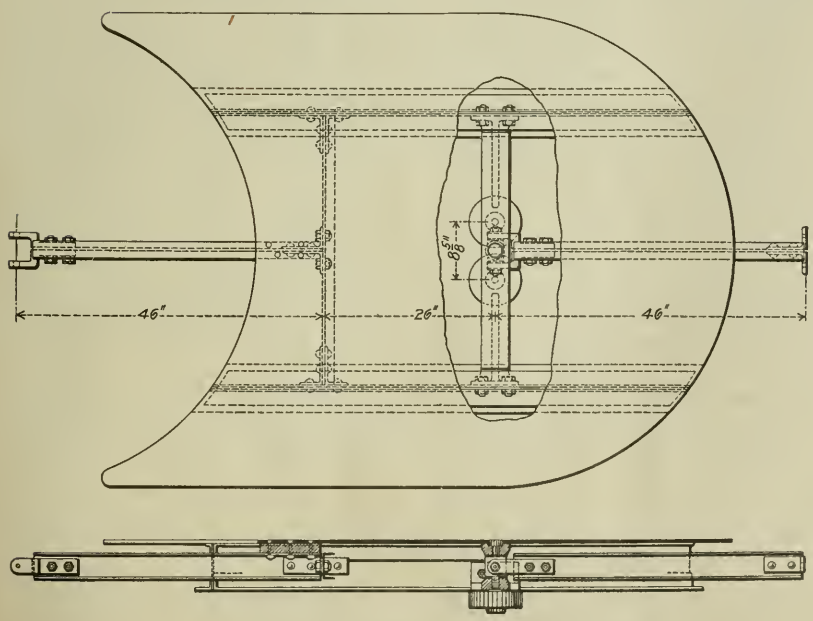



Fig. 3—A Section of the Moving Platform.

fixed foundations placed at about 2 ft. 9 in. centers. Each shaft carries three pairs of rubber tired wheels as shown.

The sections of the platforms are supported on these wheels and the wheels are of such a diameter that the platforms are actuated at speeds of three, six and nine miles per hour respectively. The auxiliary platform shown in the illustration is for use at night, or at times when for any reason it may be desirable to stop the main platforms, as for inspection. It is proposed to move this platform at a speed of three miles an hour. On the "nine-mile" platform, in addition to the seats, a walk is to be provided and a passenger who is in a hurry can board this platform and continue to walk. It is claimed that the power required to operate the moving platforms will be considerably lower than is now used in operating cars.

The relative dead load per seated passenger in cars and in the proposed moving platform is as follows: In the local subway service, 1,241 lbs. of dead weight must be carried for each seat provided, and in the Manhattan elevated six-car local service the dead weight per seat is 790 lbs., whereas it is claimed that the dead weight per seat on the moving platform will only be about 437 lbs., or practically a saving of two-thirds of the dead weight carried in the subway. Another assumed saving in power, as compared

with an ordinary train service, arises from the fact that there is a steep grade in East 34th street, but it is estimated that the effect of gravity upon the units descending will tend to counterbalance the pull upon those ascending. This assumes, however, that the friction at the turn is small, otherwise a perfect balance could not be obtained. The platforms are to be made up of sections and the method of connecting these sections together is clearly shown in the detailed illustration, Fig. 3. We are indebted to Max E. Schmidt, General Manager and Chief Engineer, of the Continuous Transit Securities Company, for the above information and illustrations.

## Cylinder Clearance and Valve Events.*

BY O. W. YOUNG.

In the numerous papers on this subject that have appeared during the past year there is one phase of the question that seems to have been given but little attention, and, as it happens to be in the line of research that the writer is especially familiar with, this paper has been prepared for the purpose of inviting investigation to determine the limit of effectiveness attainable in the cylinders of a locomotive.

Is it not a fact that the modern locomotive to-day is taxed to its utmost to perform its daily work, and that requirements in the way of faster schedules and heavier trains, especially in passenger service, have outstripped the development of increased power in the locomotive? If so, it should be of first importance to produce an engine of sufficient capacity to haul its load to the terminal on schedule time, and of enough reserve to do this even when opposed by unfavorable weather and some unusual delays; and the cost of this service should be of second consideration.

Effective pressure on the piston is the power that pulls a train. The higher that pressure, the faster the train will run; and the heavier the train, the higher must be the piston pressure to move it. The limit of effectiveness at high speeds is fixed by the capacity of an engine to expel steam from its cylinders. Look at the fastest indicator cards you have been able to obtain and they will show a mean back pressure equal to or exceeding the mean effective pressure; and it is only by reducing this back pressure that the effective work can be economically increased.

One feature of the Stephenson link motion that is sometimes unfavorably criticised, but which, in my opinion, is one of its most essential elements for producing high speed, is the early release its motion causes for the shorter cut-off. At what period of the stroke during high speed does exhaust occur? Is it not between the point of exhaust opening and the end of the stroke? The indicator very rarely shows a lower back pressure in mid-stroke than at the beginning. On the contrary it is usually higher, and it is very evident that the advancing piston is obliged to push out whatever pressure of steam remains in the cylinder at the moment of its return stroke, as it is impossible for this steam to escape with greater rapidity than that of the decreasing cylinder volume caused by the moving piston. In order to secure a low back pressure during the entire stroke a low initial back pressure is very essential, and to secure this an early and free pre-release must be provided. The point of exhaust closure for compression should then be delayed sufficiently late to prevent the terminal pressure from exceeding that of the steam chest.

The accompanying indicator cards are imaginary diagrams and are presented merely to illustrate the points sought to be made. They are not claimed to be absolutely correct in every respect, but have been prepared with considerable care and are drawn to conform to known effects of the various conditions considered, and are thought to be sufficiently close to what would actually occur in the premises, that, while figures might vary slightly in actual tests, their relative differences would remain practically unchanged. They are all supposed to be taken from cylinders 20 in. x 26 in., drivers 80 in. above the rail, revolutions per minute 250, which is equivalent to about 60 miles per hour, and the initial pressure is assumed to be 200 lbs.

Card No. 1 shows a steam distribution produced by a well-designed Stephenson link motion, with 6 per cent. cylinder clearance, when an engine is cutting off at 6 in. The mean effective pressure is 60 lbs.; mean back pressure or negative work 21 lbs., or 35 per cent. of the effective work.

No. 2 shows what would occur if a longer cut-off were used in an attempt to get greater power into the cylinder. This position would obtain wider port openings for admission, but, owing to the rapidly increasing piston speed soon after the beginning of the stroke, practically the same wire-drawing would take place, causing a large drop in pressure at the point of cut-off, as compared with the initial pressure, and, while some gain in power would be admitted, the later release openings, together with the higher pressure at release, would probably overtax the nozzle capacity to expel sufficient steam during pre-release to secure a low initial back pressure, and, in consequence, the back pressure would be high, but the later exhaust closure would prevent compression from raising higher than initial pressure. The negative work under these conditions is 39 per cent. of the effective work.

No. 3 is based upon the supposition that sufficient port openings were secured to admit steam up to the point of cut-off with very slight drop in pressure. It would then be found that, owing to the large volume of steam admitted, release would not be sufficiently early to complete the exhaust during pre-release, and a high back pressure and excessive compression would result. It would seem, therefore, that an attempt to provide greater freedom of admission during short cut-off would result disastrously unless greater freedom of pre-release were also provided.

In No. 4, the cylinder clearance is supposed to have been reduced from 6 per cent. to $2^4/_{10}$ per cent. Owing to this decrease in volume of steam confined in the clearance space, the expansion line would drop to a greater extent than in the first three cards, and the pressure at release would be lower, and, in consequence, a lower back pressure could be expected, but an early exhaust closure combined with small clearance space would cause the terminal pressure of compression to be so high as to probably exceed the initial pressure. Lengthening the cut-off as in card No. 5, or providing more free admission as in No. 6, would simply aggravate the defects shown in card No. 4.

From the cards so far considered, it is apparent that the most economical combination is produced by No. 1; the most powerful is No. 2, but at a greater loss through negative work. No. 7 supposes a 6 per cent. clearance, a late release and late compression, with the usual wire-drawing during admission. As previously explained, the moment of exhaust and practically the whole time allowable for exhaust during high speeds, occurs during pre-release, and, if exhaust opening is abnormally delayed until nearly the end of the stroke, a high back pressure is sure to remain during the return stroke, provided sufficient steam has been admitted into the cylinder to accomplish especially effective work, and, with generous clearance space, very late compression would not entrap sufficient steam to raise the terminal pressure of compression to an economical point, and the boiler would have to supply steam for filling the clearance space each stroke.

No. 8 in a longer cut-off would raise the back pressure still higher, but there would be less drain upon the boiler for raising the terminal clearance pressure during pre-admission. No. 9, with less wire-drawing during admission, would produce ideal results, excepting that the back pressure would be excessive. Card No. 10 has $2^4/_{10}$ per cent. clearance, and, owing to the usual drop in pressure during admission, and the lower expansion line, on account of the small clearance volume, has sufficiently low pressure at its late release to exhaust to a fairly low back pressure, and, under these conditions, its late exhaust closure causes a very nice showing in the negative work of compression, and the entire negative work is but 21 per cent. of the effective work; but if, as in card No. 11, a greater volume of steam were admitted, the insufficient length of the period of pre-release would then cause a negative work equal to 36 per cent. of the effective work, and No. 12, with more liberal port opening while admitting, would result practically the same as shown in No. 11.

The valve events shown in this group (Nos. 7 to 12 inclusive) would teach that No. 10 should give excellent results in the way of economy, but no especially high degree of efficiency could be effected in the way of high speed, as it would be impossible, under these conditions, for an engine to free itself of unusually large volumes of steam. In the way of efficiency, No. 9 would accomplish some very effective work, but at considerable cost per unit of work done on account of the high percentage of loss from back pressure.

In No. 13, with 6 per cent. clearance, not only are the valve events supposed to be changed, giving a slightly earlier exhaust opening, and later exhaust closure than in the first group, but the area of the exhaust port during pre-release is supposed to be increased, and a slight loss is here shown on account of the atmospheric line being reached before the end of the stroke. No. 14 in a longer cut-off, entailing later release and earlier compression, produces a strong card, and, considering its power, a very economical one; but No. 15, in a short cut-off and high pressure up to the point of cut-off, shows not only the highest mean effective pressure of any, but the percentage of loss is the least, and this card appears to be as near ideal as it is practicable to obtain in locomotive practice, if exceptional power at high speed is desired.

Cards 16, 17 and 18 show that the valve events, now under consideration, are not so well suited to small clearance.

The best card from each of the three groups shows:

| | No. 1. | No. 10. | No. 15. |
|---|---|---|---|
| Mean effective pressure | 60 | 66 | 91 |
| Mean back pressure | 21 | 14 | 13 |
| Percentage of loss | 35 | 21 | 14 |
| Indicated horse-power | 309 | 340 | 469 |
| Lbs. of steam per hr. per i.h.p. | 19.6 | 18.9 | 17.9 |

It will be seen from the above that No. 15 is not only the most powerful card, but it uses less steam per horse-power developed than any of the others.

The objection might be made that this card caused considerable loss of heat on account of the high pressure at the point of release, but if this steam has been held in the cylinder as long as it is practicable to

* A paper presented to the December meeting of the Western Railway Club.

hold it, and the atmospheric line is not reached during pre-release but at the end of the stroke, there is no loss that could be avoided without entailing a greater loss from back pressure if the steam were expanded further before release. Another thing that must be remembered is that in designing valve motion for a locomotive, the effect of the exhaust upon the fire must be taken into account, and the higher the pressure at exhaust, the larger nozzle becomes practicable, and this has a beneficial influence upon the back pressure.

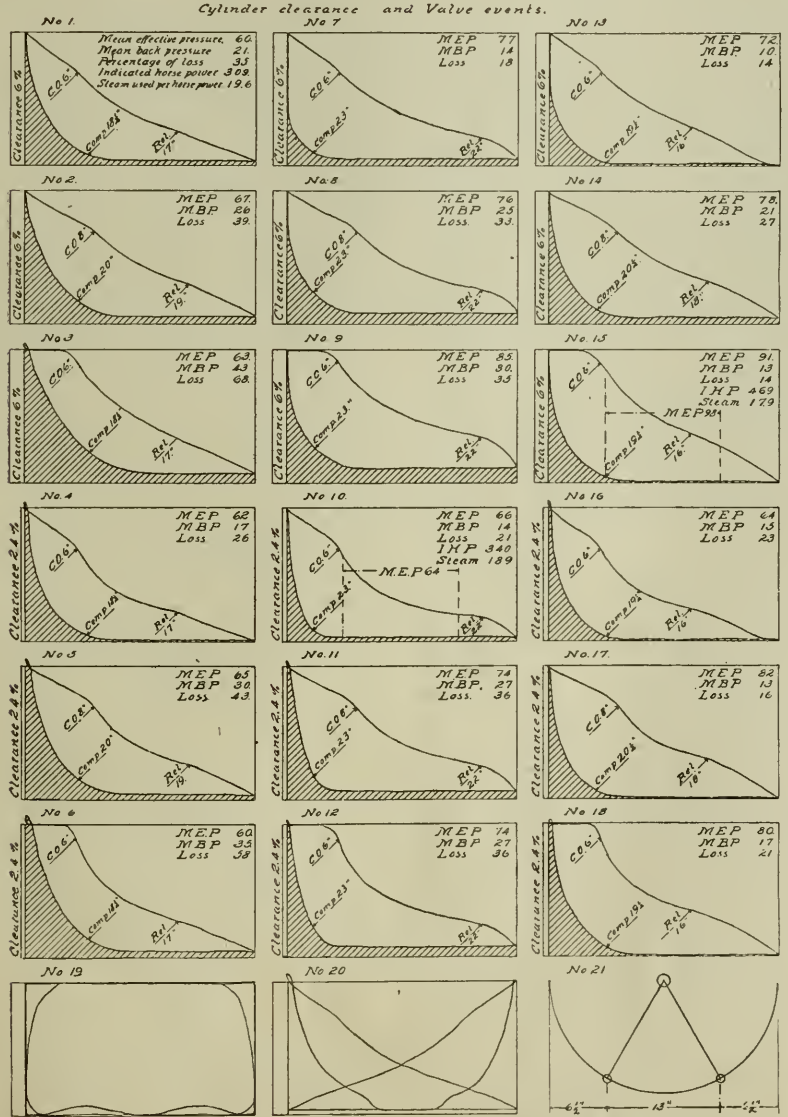
It is sometimes claimed that a reduction in clearance space is in the interest of economy. Now, the amount of clearance space is merely a matter of expediency, and must be determined by the events of the particular valve motion which is to be used, and, provided the terminal pressure of compression equals but does not exceed the initial pressure, there is no choice from an economical standpoint between large and small clearance. It would cost more to compress a large volume into a large space than a smaller volume to an equal terminal pressure into a proportionately smaller space, but the reaction of the larger volume in the way of sustained pressure upon the piston during its return stroke would be greater for the larger volume in exactly the same ratio as was its loss during compression.

To illustrate this point, the mean effective pressure has been measured on cards Nos. 10 and 15, for the middle half of the stroke, with the result that for card No. 10, with a given mean effective pressure of 66 lbs. during the entire stroke, the mean effective pressure during the middle half of the stroke, which practically embraces the period of expansion, is 64 lbs. or 98 per cent. of what it was for the whole stroke; while for card No. 15 with a given mean effective pressure of 91 lbs. that during expansion is 98 lbs., or 110 per cent.; and when it is remembered that it is during the middle half of the stroke that the crank leverage is greatest (see Fig. 21), it will be seen that the larger clearance exerts a very useful crank effort at the time it is most needed.

An analysis of the retarding effort of the negative work shows that the term "mean back pressure" does not tell the whole story. Cards Nos. 10 and 15 each show nearly the same mean back pressure, but, while that of No. 15 is practically all included in compression at that point of the stroke when the crank leverage is shortening, the back pressure of card No. 10 is distributed during the entire stroke, and exerts a greater retarding effort as compared with that of No. 15, as a larger percentage is against the crank during the middle portion of the stroke when its effect is more disastrously felt. It is better, therefore, to secure the lowest possible initial back pressure so as to confine as much as possible of the negative pressure to that period between exhaust closure and the end of the stroke. Card No. 15, then, appears from every standpoint to represent the best that can be attained, and the effort should be to approach as nearly as possible such conditions.

In an effort to hasten exhaust opening and delay exhaust closure, care must be taken not to give the valve too much inside clearance, or it will result in steam blowing through from one end of the cylinder to the other at a certain point of the valve travel, and cause such lines as are shown in the back pressure and compression lines in cards Nos. 19 and 20.

While the foregoing conclusions are drawn from imaginary conditions and are to a certain extent of a theoretical nature, it is only fair to state that the writer has applied this theory to actual practice; and, while conditions as perfect as those shown in card 15 have not yet been secured, very gratifying progress in that direction has been made, and he believes it feasible to attain as perfect a steam distribution as is there shown, for the idea has not yet been carried to the limit of its capabilities.




Theoretical Indicator Diagrams Showing the Relation between Cylinder Clearance and Valve Events.

## Train Accidents in the United States in November.[1]

bc, 1st, Chicago, Rock Island & Pacific, Laddsdale, Iowa, butting collision between a work train and a freight engine; two laborers killed and five injured, one of them fatally. The freight engine after the collision ran backward five miles to Eldon.

bc, 2d, Louisville & Nashville, Livingston, Ky., butting collision between a northbound regular freight train and a southbound extra freight, wrecking both engines and several cars. One engineman and one fireman were killed. There was a dense fog at the time.

bc, 2d, Augusta, Ga., a switching engine of the Charleston & Western Carolina collided with a switching engine of the Central of Georgia, causing the death of one employee and the injury of another.

unx, 2d, Missouri, Kansas & Texas, Moran, Kan., passenger train No. 21 was derailed and the engine was overturned. The fireman was killed and the engineman and a mail clerk were injured.

xc, 4th, Pennsylvania road, Portage, Pa., passenger train No. 19 collided with an empty engine, and three employees were injured. There was a dense fog at the time.

dn, 4th, Grand Trunk, Cassopolis, Mich., a freight train was derailed at a derailing switch and the engineman was badly injured.

†unx, 4th, Atlanta, Knoxville & Northern, Ball Ground, Ga., a freight train was derailed on a trestle bridge and fell into a

[1]Accidents in which injuries are few or slight and the money loss is apparently small, will as a rule be omitted from this list. The official accident record published by the Interstate Commerce Commission quarterly is regularly reprinted in the *Railroad Gazette*. The classification of the accidents in the present list is indicated by the use of the following

ABBREVIATIONS.

| | |
|---|---|
| rc | Rear collisions. |
| bc | Butting collisions. |
| xc | Miscellaneous collisions. |
| dr | Derailments; defects of roadway. |
| eq | Derailments; defect of equipment. |
| dn | Derailments; negligence in operating. |
| unf | Derailments; unforeseen obstruction. |
| unx | Derailments; unexplained. |
| o | Miscellaneous accidents. |

An asterisk at the beginning of a paragraph indicates a wreck wholly or partly destroyed by fire; a dagger indicates an accident causing the death of one or more passengers.

pond. Two men were killed and three were injured.

eq, 4th, Baltimore & Ohio, Mansfield, Ohio, a passenger train was derailed by the failure of the tire of a wheel of the engine, and the engineman was killed. Two passengers were slightly injured.

xc, 5th, Bessemer & Lake Erie, Greenville, Pa., a special train carrying officers of the road collided with a freight train which appears to have been on the main track at a meeting point without right, and the engine of the special and two freight cars were damaged. Two trainmen were injured.

dn, 6th, 3 a.m., Norfolk & Western, Radford, Va., a freight train was derailed at a derailing switch and the engine was overturned. The engineman and a brakeman were killed and the fireman was injured.

unf, 6th, New York, Susquehanna & Western, Middletown, N. Y., passenger train No. 3 was derailed by a malicious obstruction and three passenger cars were overturned. The conductor was injured.

xc, 7th, 10 p.m., Boston & Albany, Springfield, Mass., a freight train broke in two on a descending grade, and the rear portion afterward ran into the forward one, wrecking several cars. An unknown man was killed and two brakemen were injured.

dr, 8th, St. Louis, Iron Mountain & Southern, Alexandria, La., a freight train was derailed by a loose rail, and the engine and eight cars were overturned. Three employees were injured.

8th, Chicago & Eastern Illinois, Lyford, Ind., a freight train of the Evansville & Terre Haute collided with a work train of the Chicago & Eastern Illinois, overturning a car in which were 40 laborers. Three of these men were killed and 27 were injured. There was a dense fog at the time. It is said that the freight train was running at uncontrollable speed because it had broken in two and the engineman was trying to keep the front portion moving fast enough to avoid having it run into by the rear portion.

bc, 9th, 2 a.m., Southern Railway, Selma, Ala., butting collision of freight trains, one of which it is said was on the time of the other in consequence of the misreading of an order. One of the engines was overturned and five trainmen were injured.

dr, 9th, Northern Pacific, Wadena Junction, Minn., an eastbound passenger train was derailed and the two rear cars ran against a freight train standing on an adjoining track. Three passengers were injured The derailment is said to have been due to a defective switch.

dn, 9th, Erie road, Orange, N. J., a passenger train was derailed by running over a misplaced switch and on to a turn-table, from which the engine fell into a meadow some feet below the track. A boy stealing a ride on the rear end of the tender was killed.

unx, 9th, International & Great Northern, Malone, Tex., a freight train was derailed and several cars were wrecked. One man was killed.

unx, 9th, St. Louis, Iron Mountain & Southern, Pollock, Ark., a freight train was derailed and the engine and eight cars were wrecked. The engineman and fireman were injured.

dn, 10th, Erie road, Susquehanna, Pa., a freight train drawn by two engines was derailed at a misplaced switch and one of the engines fell down a high bank into the river. The engineman and fireman were injured.

*rc, 11th, Lake Erie & Western, Beaver Dam, Ohio, passenger train No. 2 ran into the rear of a preceding freight, wrecking the caboose and three cars, which took fire and were burnt up. The fireman was injured.

dr, 11th, Southern Railway, Cochran, Ga., passenger train No. 14 was derailed in consequence of faulty track, and several passenger cars were overturned; 13 persons were injured. The accounts appear to indicate the existence of some evidence that the rails had been maliciously tampered with.

unx, 11th, Missouri, Kansas & Texas, South Mound, Kan., the tender of the engine of a passenger train was derailed while running at full speed, and the engine and part of the cars were ditched. The fireman was killed and eight passengers and one trainman were injured.

bc, 12th, 1 a.m., Union Pacific, Azusa, Wyo., butting collision between a westbound passenger train and an eastbound fast freight, wrecking both engines and many cars. Six trainmen, two postal clerks, one express messenger and four other persons were killed, and 20 or more were injured. All of the men riding on the engine were killed. The line is straight at the place of collision and the only explanation of the failure of either engineman to stop when he saw the headlight of the other is that each supposed the other to be standing on the side track at Azusa station. An order had been sent to the freight that the passenger train was running 1 hour 30 minutes late, but this order, it is said, was taken to read 1 hour 50 minutes.

xc, 12th, 2 a.m., Baltimore & Ohio, Boyds, Md., collision between an eastbound and a westbound passenger train, one of which was entering a side track. One sleeping car fell down a bank. Ten passengers and two trainmen were injured.

unf, 12th, Southern Railway, Cleola, Ga., a passenger train was derailed by running over a horse, and crossed a trestle bridge on the sleepers.

bc, 13th, Yazoo & Mississippi Valley, Peyton, Miss., butting collision of freight trains, wrecking both engines and three cars. One fireman was killed and one engineman injured.

dn, 13th, Terminal Railroad of St. Louis, St. Louis, Mo., an eastbound passenger train of the Wabash Railroad was derailed while running over a curve at high speed and the engine was overturned. The engineman was killed and the fireman and five passengers were injured. It is said that the train was running at the rate of 60 miles an hour through a curve of 10 deg.

xc, 14th, Chadd's Ford Junction, Del., a freight train of the Philadelphia, Baltimore & Washington broke in two on a grade and several cars ran back down grade into the head of a passenger train standing near the crossing of the Philadelphia & Reading. The engine of this train was overturned and the passenger car was knocked back against the engine of a passenger train of the Philadelphia & Reading, standing on the crossing, pushing that down a bank. One passenger was killed and three others were injured.

†rc, 15th, Philadelphia & Reading, Silver Creek Junction, Pa., a locomotive ran into the rear of a preceding passenger train occupied by miners, crushing the rear car. Six of the passengers were injured, two of them fatally.

*xc, 15th, Denver & Rio Grande, Vallie, Colo., collision of two freight trains at a meeting point, one of them being at the time partly on the side track and partly on the main line. One engine and several cars were wrecked and the wreck took fire. Two trespassers were killed.

dn, 15th, Pennsylvania road, Brownsville, Pa., a switching engine was derailed at a misplaced switch; engineman killed and the fireman and one brakeman injured, the former fatally.

*rc, 16th, Alabama & Vicksburg, Bovina, Miss., a freight train ascending a grade was run into at the rear by a following passenger train and the caboose and one freight car were wrecked. The wreck took fire from the engine and the combustible portion of it was burnt up. Three employees were injured.

†rc, 16th, Pere Marquette, Elmdale, Mich., passenger train No. 34, standing at a junction, was run into at the rear by following passenger train No. 6, in consequence, it is said, of a misplaced switch. The rear car of the standing train, a parlor car, was badly damaged. Two passengers and one trainman were killed and six passengers and two trainmen were injured.

bc, 16th, Chicago, Rock Island & Pacific, Chickasha, Ind. T., butting collision of freight trains, wrecking both engines and several cars. Six trainmen were injured.

unx, 16th, 4 a.m., Atchison, Topeka & Santa Fe, Ardmore, Ind. T., passenger train No. 5 was derailed and the engine was overturned. The engineman was killed and the fireman and one mail clerk were injured.

xc, 17th, Cleveland, Cincinnati, Chicago & St. Louis, Union City, Ind., a freight train switching in the yard became uncontrollable and the caboose and several cars were pushed into the head of a passenger train standing on a side track. Two trainmen were injured.

dr, 17th, Cincinnati, Hamilton & Dayton, Wellston, Ohio, a freight train was derailed by a loose rail and the fireman was killed.

dr, 17th, Cincinnati, Hamilton & Dayton, Wellston, Ohio, a freight train broke through a trestle bridge and the engine and several cars were wrecked. The engineman was killed and two other trainmen were injured.

unx, 17th, Yazoo & Mississippi Valley, Memphis, Tenn., the two rear cars of a passenger train were derailed at a switch and overturned. A man at work on the track was injured.

*rc, 18th, Erie road, Port Jervis, N. Y., a freight train was run into at the rear by a milk train, wrecking the caboose of the freight, which took fire and was burnt up. The conductor of the freight train was burnt to death and two other trainmen were injured.

bc, 19th, Wabash road, Bement, Ill., butting collision of passenger trains, due to a misunderstanding as to the point in the yard where the two trains were to meet. Five employees and 20 passengers were injured, most of them slightly.

†*rc, 20th, Baltimore & Ohio, Wyland, Pa., a freight train standing at a water tank was run into at the rear by a following freight, and the caboose and several cars were damaged. The caboose took fire and was burnt up; and in it two drovers were killed, one of them being burnt to death.

unx, 20th, Washington & Columbia River, Hunt's, Wash., several cars of a freight train were derailed and wrecked and two tramps were killed.

*rc, 22d, 5 a.m., St. Louis, Iron Mountain & Southern, Swifton, Ark., a freight train entering a side track was run into at the rear by a following passenger train, making a bad wreck. The fireman was killed and the engineman, two other trainmen and eight passengers were injured. The wreck took fire and three passenger cars and 10 loaded freight cars were burnt up. Four passengers were severely burnt.

rc, 22d, Yazoo & Mississippi Valley, Lake Cormorant, Miss., a freight train ran into the rear of a preceding freight, and six trainmen were injured. There was a dense fog at the time.

xc, 23d, St. Louis & San Francisco, St. Louis, Mo., passenger train No. 26 ran over a misplaced switch and collided with a freight car standing on the side track. Three trainmen were injured.

dr, 23d, Dry Fork Railroad, Harman, W. Va., a passenger train was derailed by a broken rail and two passenger cars were overturned. Of the 20 passengers in the cars nearly all were injured, but only one seriously.

xc, 24th, Pennsylvania road, McGarvey's, Pa., two empty engines, coupled together, running at high speed on a descending grade, collided with a switching freight; two employees killed and two injured.

eq, 24th, 7 p.m., Cincinnati, New Orleans & Texas Pacific, High Bridge, Ky., a freight train was derailed by the breaking of the axle of a freight car; and one of the two engines propelling the train (which engine was back of the car on which the break occurred) was derailed, together with nine other freight cars. The engineman was killed and three other trainmen were injured.

dn, 24th, Iowa Central, Glenville, Minn., a freight train consisting of an engine and three cars was derailed at a point where track repairs were in progress; and the engineman and fireman were injured.

*o, 26th, Atchison, Topeka & Santa Fe, Pontoosuc, Ill., the locomotive of a freight train was wrecked by the explosion of its boiler, and the station building was damaged and set on fire. The fireman and one

brakeman were killed and the engineman was injured.

unx, 27th, Mobile & Ohio, Columbus, Miss., passenger train No. 4 was derailed and the cars fell down a bank; 35 passengers injured.

dn, 29th, New York, Philadelphia & Norfolk, Pocomoke, Md., a southbound freight train ran on to the drawbridge spanning Pocomoke river when it was not locked in position, and ran most of the length of the bridge on the sleepers. One of the two bridge attendants, in the excitement of his efforts to stop the train, was run over by the engine and killed. It is said that the engineman of the train disregarded a stop signal.

## The Great Western Motor Omnibus Services.

BY W. B. PALEY.

It is well-known that the Great Western, almost alone so far amongst British railroad companies, has made a determined effort to meet the growing competition of road motor vehicles, literally on their own ground. What this competition will really lead to no one can possibly yet foresee, but in a country of small distances it is decidedly a thing to be reckoned with. The principal object is to develop districts adjacent to, but not on, the railroad, in which local enterprise has so far failed to provide facilities for getting to the trains that a hopeless condition of stagnation, not to say retrogression, has resulted. A railroad company can undoubtedly supply these with better prospects of success than private parties acting independently. In some cases the Great Western has not hesitated to compete with its own line, where the road motors could tap traffic which the railroad could not; in fact, its policy has been marked with boldness, originality, and success. Some of the services are mainly for summer tourists, one or two others have not answered expectations, but it is understood that the company is well satisfied with the experiment as a whole.

The commencement of the system was made in August, 1903, at the height of the tourist season in Cornwall. A motor waggonette, with a light roof overhead and driven by a 16 h.p. four-cylinder Milnes-Daimler petrol engine, was put on between Helston station and The Lizard, the promontory well-known to Atlantic voyagers to Plymouth or Southampton. The wagonettes had gear transmission, solid rubber single tires, and carried 22 passengers. A reduced service was carried on throughout the winter, a mail omnibus performing part of it, with a trip once each way daily. The length of the journey is 11 miles, done in 75 minutes, at a fare of 1s. 6d. (37 cents). Very little population exists in the neighborhood served, nor does the road go through, but only near to, the few villages on the way. There is a good hotel at The Lizard, and at many of the small coves or bays farmers, fishermen and others take in lodgers. Many people like quiet, cheap places for their holidays, and the extraordinary mildness of the Cornish climate in winter is very favorable for invalids. This year the Helston and Lizard service was again increased for the summer traffic, being raised on July 1 to five trips each way, on week-days only. Omnibuses with room for luggage were added, in addition to the motor cars, as it was found essential that visitors should be able to take their necessary belongings with them. Lower fares were charged by the luggage busses, which took 90 minutes en route. They made two trips each way daily, the motor car two, and the mail car one, all five trips being available for passengers. The first up journey of the motor car in the morning, and its second down trip, were in connection with the fast train that ran between Plymouth (North Road) and Paddington, 245¾ miles, in 266 minutes without a stop. Naturally, however, the efficiency of such a service depended not a little upon the state of the road, and this was distinctly bad. The local authorities refused to properly maintain it, and with the close of the tourist season the whole service has been withdrawn until further notice. By a curious chance the four vehicles used were destroyed by fire at Helston the night before the running ceased. In other parts of Cornwall the Great Western's policy has been welcomed by those concerned in its efficiency. From Penzance, the terminus of the railroad in the west, so many as five different services of motor omnibuses were running during last summer, three of which are still in operation, though not with the same frequency.

The Penzance services still running consist of a short one between the town and its suburb of Newlyn, every half-hour in each direction all day; about 10 minutes ride at a fare of 3d (6 cents). In the opposite direction a motor bus leaves Penzance station for Marazion every hour from 8 a.m. till 8 p.m., except at 9 a.m. To far as Marazion station, about 2½ miles, this service is parallel to and in direct competition to the railroad, but the busses go on another mile to the town named and thus accommodate the public better than the railroad alone can do. The fare is 4d (8 cents); time taken about 15 minutes. On July 1 a motor bus began running between Penzance station and the small town St. Just, seven miles westward, and about four miles north of the Land's End. Five trips were made each way daily, two on Sundays and an extra late one on Thursdays and Saturdays, the time taken being one hour and the fare 1s. (25 cents). The service has been increased, from Oct. 3, to seven trips each way on week-days, the Sunday and extra late services being withdrawn.

In the eastern portion of Cornwall a motor omnibus was started during the summer from Saltach station to Collington, Albaston and Gunnislake. Two busses are now used; the fare is 1s. 3d. (30 cents). The time taken 90 minutes. On August 22 the company started a motor-car between Newquay, a small North Cornwall sea-side place reached by the railroad, and Quintrell Downs. Four runs were made each way, taking 25 minutes, at a fare of 6d. (12½ cents). The car filled up the intervals by running nine trips to the golf links and East Pentire and back, the fare being 3d. (6 cents). This was a purely summer service and is not now in operation.

On Sept. 12 a motor bus began running between Plymouth (Millbay) station and Roborough village, on the Tavistock road, six or seven miles distant. Three trips a day are made to Roborough and back, taking 37 or 38 minutes, besides two other trips to Crownhill Barracks, and one to the George Hotel, these places being not so far as Roborough. On Wednesdays and Saturdays the two afternoon runs are prolonged to Roborough Rock, some nine miles, or 55 minutes journey from Plymouth, and on Sundays the service consists of two journeys to the Rock, at 2.30 and 6.30 p.m. Just beyond the village, and at the Rock, the visitor will have an opportunity of inspecting the disused Dartmoor Railway of 1826, described in the *Railroad Gazette* of Dec. 19, 1902. The motor bus used is of a type the company much favor, with seats for two alongside the driver, then an open-sided compartment seating eight, and a closed one for 10, the last being entered from the rear. Smoking is allowed on the front or middle seats, the latter are hinged and can be let down if not wanted, so as to make room for a reasonable quantity of luggage. Small parcels go on the roof. The vehicles weigh three tons, and have double solid rubber tires on the driving, and single on the leading wheels; Milnes-Daimler engines of 16—20 h.p. A jack is carried. The fare from Plymouth to Roborough Park is 1s., and to the outskirts of the town the bus competes with the corporation tramways. The lack of traveling facilities on this side of the town has retarded its development very much hitherto, horsebusses at long intervals toiling up the long rise having been the extent of them. The motor leaves these far behind and is usually full, and over-full, of passengers. Tickets of railroad type are issued on the busses, numbered but not dated.

West of Plymouth a motor bus has been running since July between Yealmpton station, the terminus of a branch line, and the small town of Modbury, some four miles farther on. At present there are five trips each way on week-days, with an extra late trip on Thursdays and Saturdays, and two on Sundays. Twice daily, and once on Sundays, however, the trips are prolonged to and from Plymouth, about seven miles more, the journey taking 80 minutes, with eight regular stops and as many more, of course, as may be necessary. The single fare to Modbury is 1s. 3d. (30 cents), return tickets 2s. (50 cents), which are available going back either throughout by bus or by rail by Yealmpton and bus onward. The through busses obviously compete with the railroad, touching it at four different places, but they enter and leave Plymouth quite another way. Another bus is run over the same ground by the South Hams Motor Company; in fact, the accommodation between Plymouth, Yealmpton and Modbury is now more likely to be too great rather than too little.

A third Devonshire bus service of the Great Western's is between Torquay and Paignton, a trip of about 3½ miles. Here again they compete with their own railroad, crossing it, in fact, twice. But Torquay station lies so far from the center of the town that you are half way to Paignton when you have reached it, and all sorts of miscellaneous vehicles have done most of the traffic The bus used is different from the others, being a big machine by Milnes, of Hadley, Thropshire, with Shrewsbury-Challiner tires, carrying, inside and out, 36 passengers. It leaves each end hourly, 12 times a day, but does not run on Sundays. Four pence (8 cents) is charged to or from the Promenade at Paignton, the journey taking 20 to 22 minutes. Other parties also run a motor vehicle over the same route. Tickets of the tramway sort are issued.

Motor busses have been running since March 31 from Slough to Beaconsfield, seven miles north. This little town will be on the new line from London to High Wycombe, which at present is not open beyond Greenford; and has no other railroad connection. Other Great Western stations are nearer to it than Slough, but a fairly populous district, quite capable of development if rendered accessible, lies between the two points. Four trips each way were put on, three being via Farnham Royal and the other via Stoke Pogis. Three other trips were made by another bus through Stoke to the "One Pin" Inn, near Hedgerley. This latter service, however, proved a failure and was discontinued after June 30, beyond Stoke. On July 1 the Beaconsfield trips were increased to six each way, with two others only so far as Farnham Common. These were both taken off before long and on August 10 the whole service was simplified by running half

the trips by Farnham and half by Stoke. These villages are little more than a mile apart, the roads being parallel and cross-connected. Since Nov. 7 the service has been reduced for the winter to four trips to Beaconsfield, two via Farnham and two via both Farnham and Stoke, with an evening trip to Farnham Common only. Since June 5 there have been two journeys on Sundays to Beaconsfield. The run takes 45 minutes either way, for which the fare is 1s. The omnibuses have only one compartment, seating 12 or 14 people, and two can sit beside the driver. Luggage and parcels are carried on the roof.

On July 18 a motor bus service was started between the Slough and Windsor stations, passing through Eton. This paralleled the company's own branch line, which, however, keeps about half a mile west of the high-road and has no intermediate station. Eton College owns the land it runs through and wishes to preserve it for the future needs of the school. Along the road population is almost continuous, and the bus service has proved very useful. It runs hourly in each direction, beginning from Slough at 9 a.m. till 9 p.m., and on Sundays from 2 p.m. till 9. Three pence (6 cents) is charged for the whole journey of about 2½ miles, or 2d. from either end to Eton. The vehicles carry 16 passengers inside, 18 on the top, and two in front, are 24 ft. long over all, 7 ft. 2 in. outside width, and are 12 ft. 6 in. high to the top rail, on a wheel-base of 11 ft. 3 in. The four-cylinder petrol engines are nominally 20 but really 25 h.p. Four speeds and a reverse are provided, the maximum rate being 12 miles an hour. Solid Shrewsbury-Challiner tires are on all the wheels, the drivers having double ones. Another service has been established very recently to link up disconnected branch termini not far apart by road but a long way by rail. These places are Calne and Marlborough, small Wiltshire towns 13 miles from each other by the route taken, but 33 by rail. Eight villages of some importance are passed through, and as the district is of extraordinary archæological interest a good deal of tourist traffic may be expected at the proper time. Three trips are made each way, on week-days only, the time taken being 85 minutes and the through fare 37 cents. The vehicle used is of the same kind as the Plymouth and Roborough one; it began running on October 10.

A second case of "linking-up" the railroad system is the bus service between Wolverhampton and Bridgnorth, commenced on Nov. 7. These towns are barely 15 miles apart by road, but quite twice as much by rail. The country between is hilly and very thinly populated and could not possibly maintain a railroad. Either of the present routes involves two changes of train and a deal of delay, which is obviated by the new busses. They do the run three times each way on week-days and twice on Sundays, in 90 minutes, the fare, station to station, being 2s. A separate service is run from Wolverhampton along the same road only to the village of Wightwick, hourly from 9 till 9, taking 25 minutes. This, of course, is to develop local traffic. On Sundays it is from 2 till 9. A "light railway" or tramway had been projected between Wolverhampton and Bridgnorth, which the Great Western successfully opposed, pledging themselves to provide improved accommodation all the same. The Severn Valley at Bridgnorth is highly picturesque, but very inaccessible from the east, where most of the population is.

A new development, at the time of writing, is the motor bus service from Wrexham, in Denbighshire, to Farndon, about seven miles. This place and Holt, virtually one, form a large agricultural center entirely away from railroad communication. Fruit growing has much increased and the neighborhood much needs traveling facilities. Since Nov. 21 there have been four trips each way, taking 40 minutes, at a fare of 6d., which it will be noticed is cheaper than the other fares. Two extra trips are made on Thursdays and Saturdays, but there is no Sunday service.

In all these services the busses take up anywhere, on payment of fare from the previous stages. Bicycles are always charged 1s. At first 6d. (12½ cents) was the rate, but they are such a nuisance in transit that the higher charge is perfectly justified. The company, after its experience on the Lizard route, now always add "condition of roads permitting" to the announcements of these services. Through railroad tickets are not issued on, or by the busses or motor cars. That they meet a public want is already evident and it is probable that the system will be largely developed before long; in fact, two or three other lines are already experimenting in a tentative way.

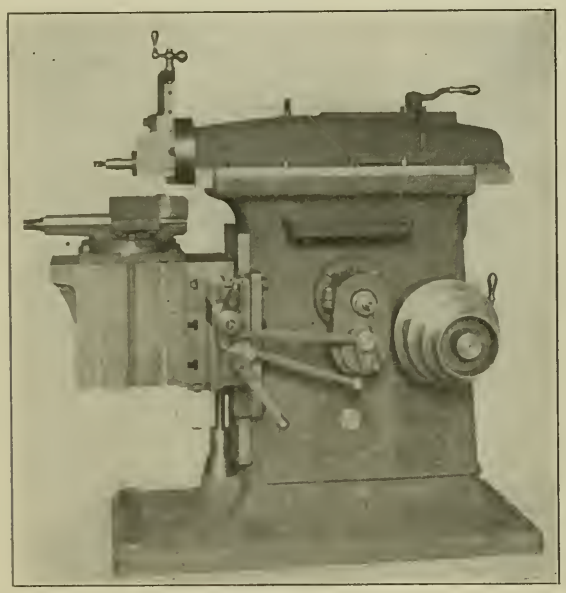


Fig. 1—The Queen City Shaper.

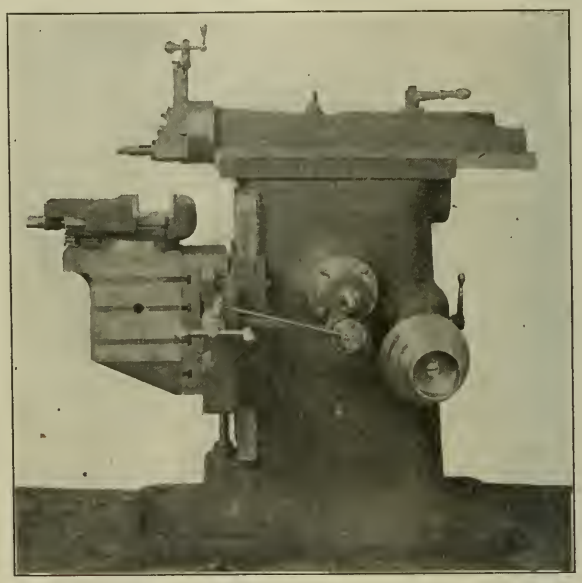


Fig. 3—The Springfield Shaper.

## Railroad Shop Tools.

*(Continued.)*

### SHAPING MACHINES.

The 16-in. crank shaper shown in Fig. 1 is made by the Queen City Machine Tool Company, Cincinnati, Ohio. This machine is designed for heavy work, and to insure durability, ample bearing surfaces are provided for the different parts. The ram has a bearing of 30¼ in. x 10 in. It is of arch construction and is designed to that the section gradually increases in strength, and is strongest at the point where the leverage is greatest, which is when the cutting tool is at its extreme position. The construction of the rocker arm is shown in Fig. 2. It is connected to the ram by a link, by means of which a direct pull and an even cutting speed is imparted to the ram. The wear of the crank shoe can be compensated for by means of the adjusting screw, shown in the illustration. The ram has four speed changes and the length of stroke and the position of the ram can be changed while the machine is in motion. The rail has a 9-in. front and a 1½-in. top bearing surface. It has a cross

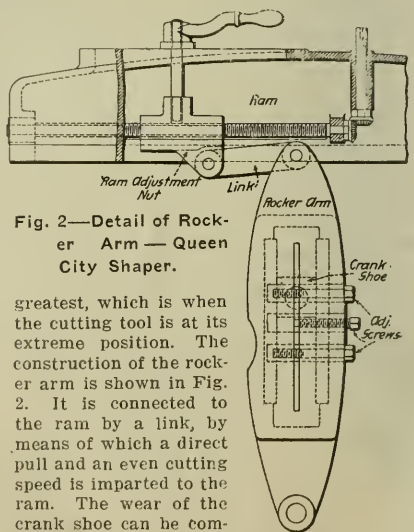



Fig. 2—Detail of Rocker Arm — Queen City Shaper.

traverse of 21 in. and the traverse screw has a graduated collar. Vertical adjustment of the rail is effected by means of a telescopic screw and bevel gears; the gears are protected from chips and dirt and are provided with ball bearings, which reduce the friction to the minimum. The table has T-slots on its top and sides, and it also has a V cut in its side for holding shafts and similar work vertically. It can be detached from the saddle, and an extension on the table provides a broad clamping surface. The base of the vise can be firmly bolted to the top or sides of the table, and the swivel is held to the base by two steel planer-head bolts. The head swivel is held in the same manner; both are graduated, and can be set to any angle. A down feed screw on the head is provided with a graduated collar and a large opening under the ram provides for the key-seating of shafts or similar work of any length. This machine is provided with a back gear ratio of 20 to 1, and the changes from one set of gearing to the other are made by a lever by means of which either one of two gears, which are keyed to a sleeve sliding on the driving shaft, may be thrown in or out of mesh with the gears on the back shaft. The cone pulleys have four steps, and the countershaft, which is fitted with tight and loose pulleys 12 in. in diameter, should run at 225 r.p.m. The net weight of this tool is about 2,450 lbs., and if it is to be electrically driven a 2½ h.p. motor is recommended.

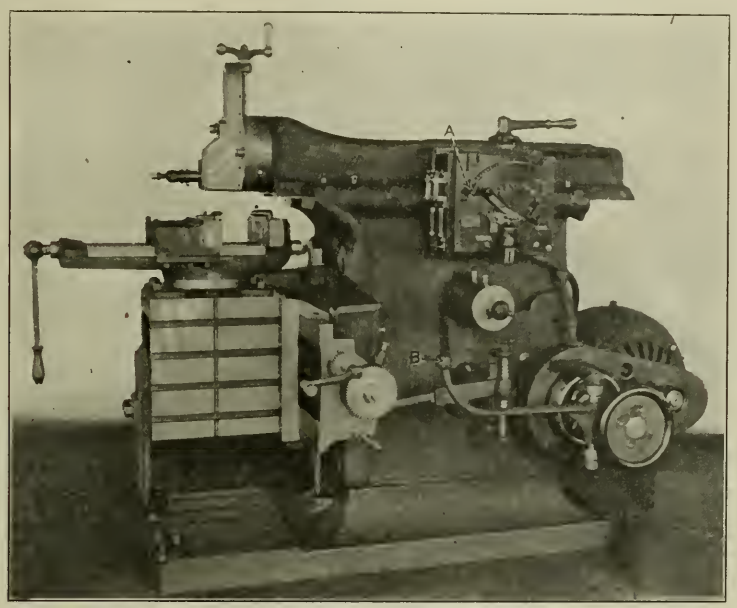



Fig. 4—The Gould & Eberhardt Shaper.

The accompanying illustration, Fig. 3, shows a 16-in. back-geared shaper made by the Springfield Machine Tool Company, Springfield, Ohio. The column of this machine is in one piece and contains bored seats for the journal boxes of the mechanism. The bearing surface for the ram is 26 in. long and extends beyond the column, as shown, and the surface to which the cross rail is clamped is long enough to allow of a vertical adjustment of 15 in. The ram is of semi-circular section and has a maximum stroke of 17 in., and its stroke can be adjusted to suit the work while the machine is in motion. The tool head has a graduated swivel, adjustable to any angle, and it is secured to the ram by two bolts. The down feed screw has an adjustment of 6 in. It has a micrometer collar and can be furnished with an automatic feed, if desired. A ball-bearing thrust is provided for the elevating screw of the cross rail. The cross motion of the table is 20 in. and the cross feed screw has a power feed in either direction and is fitted with a micrometer collar. Adjustable gibs are provided on the cross rail for taking up lost motion. Two studs and one bolt secure the box table to the cross slide. The top of the table is 13 in. x 11¼ in. and it has T-slots on three of its sides. Steel-faced jaws are provided for the vise, which has a graduated circular base. An index pin is also provided, which locks the vise when it is set parallel or at right angles to the ram. An opening large enough to pass a 2¼-in. shaft through is provided under the ram. The driving mechanism is arranged for two speeds which, in connection with the four-step cone, gives eight speeds in geometrical progression. The driving shafts are journalled in ring oiling bearings, and fitted with gears which are controlled by a lever at the rear of the column. Both sets of gears cannot be engaged at the same time, hence breakage from such cause is avoided. The stroke of the ram is varied by means of a heavy wrist block, which is adjustable in large guides planed into the crank gear. Quick return motion is given to the ram and the motion of the cutting stroke is nearly uniform. The driving cone has four steps measuring 10 in., 8½ in., 7 in. and 5½ in. respectively; the countershaft pulleys are 10 in. in diameter and 3 in. wide, and should run at 200 r.p.m. The floor space required for this tool is 38 in. x 80 in., and its net weight is 2,200 lbs.

Fig. 4 shows a direct-connected, motor-driven shaper made by Gould & Eberhardt, Newark, N. J. The motor is of the variable speed type, single voltage, and the speed variations are obtained by changing the field resistance. A combination starting box and field rheostat with the switch and fuses mounted on the side is attached to the machine, as shown. With this drive it is possible to get a series of speeds ranging from five strokes per minute, back-geared, to about 110 strokes per minute, single-geared. The speed changes are obtained by moving the small slider A along the curved rail, which brings it in contact with the different buttons in the field rheostat. The connection between the motor and the machine is by a Morse silent chain drive. The machine is also supplied with a convenient clutch and brake arrangement designed by Gould & Eberhardt. This device is controlled by the long curved lever B, by one movement of which it is possible to instantly stop the shaper at any part of its stroke, without cutting out the motor, and waiting for it to run down; by a reverse movement of the lever the machine is again started up at full load. This device is not only a time saver, but is also convenient in setting, adjusting and when examining the work, and in addition to the above it saves the wear and tear on the motor which would occur with frequent stoppages. All the controlling handles are placed within convenient reach of the operator while standing in the working position at the machine. The illustration shows a 24-in. extension base shaper with an outside support to the table. A number of machines of this pattern are being used in railroad shops both in this country and in Europe.

*(To be continued.)*

## Program of the International Railway Congress.

The International Railway Congress which meets in Washington next May will hold its first session on the morning of Thursday, May 4. Delegates are expected to arrive during the four days from April 29 to May 2 and on Wednesday, May 3, the registration bureau for the delegates will be opened. After the formal opening of the Congress in the morning, the various sections will meet and organize on Thursday afternoon. The different sections will hold meetings at 9:30 a.m. and 2 p.m. on Friday and Saturday of that week and on each of the first five days of the following week. On Saturday, May 13, the sections will meet in the morning, and in the afternoon the Congress will meet together and formally adjourn. The delegates and visitors will leave on Monday for tours of inspection through the country.

The following is a list of subjects which will be considered by each of the sections and the reporters for different countries who will present papers:

SECTION 1.—WAY AND WORKS.

*I.—Wooden Sleepers or Crossties. Selection of Species of Timber Used and Processes of Preservation.*

*A.*—Study of the selection of kinds of wood and of the processes of preservation of railway sleepers or ties.

Reporters:

*America.*—Mr. J. W. Kendrick, Third Vice-President, Atchison, Topeka & Santa Fee Railway, Chicago, Ill.

*Other Countries.*—Mr. Hausser, Chief Engineer of Maintenance of Way of the Southern Railway of France, 54 Boulevard, Haussmann, Paris.

*B.*—Study of the causes of the deterioration of wooden sleepers or crossties in tropical climates and of the methods for preventing such deterioration.

Reporters:

*All Countries.*—Mr. F. J. E. Spring, Director of Railway Construction in India, Office of the Secretary of Public Works, Calcutta.

*II.—Rails for Lines With Fast Trains.*

Cross-sections of heavier rails; manufacture and inspection; best metal to use for rails and tires; nickel alloys; rail joints; improvements in suspended joints; experiments with supported joints; experiments with a view to reducing the number of joints; methods for preventing creeping, especially on double-track lines and on steep gradients.

Reporters:

*America.*—Dr. P. H. Dudley, Inspecting Engineer New York Central & Hudson River Railroad, New York City.

*Germany, Netherlands, Roumania, Russia, Denmark, Sweden, Norway and Switzerland.*—Mr. J. W. Post, Principal Engineer of Way and Works to the company for working the Netherlands State Railways, Utrecht.

*Other Countries.*—Mr. Van Bogaert, Chief Engineer to the Belgium State Railways (on leave), Director of the Society for the Survey of Railways in China, Montagne du Parc, 2a, Brussels.

*III.—Improved Rail Crossings (Frogs).*

Improvements in rail crossings; spring frogs, movable point frogs and crossings and continuous rail-crossings in which the gas at the throat of the

frog is done away with, which shall satisfy all the requirements of modern traffic and stand heavy locomotives being run over it at high speed without any shock.

Reporter:

*All Countries.*—Mr. C. W. Buchholz, Consulting Engineer Erie Railroad, 21 Cortlandt St., New York City.

*IV.—Concrete and Imbedded Metal.*

The use of concrete strengthened by the use of imbedded metal in railway works.

Comparison, from the point of view of cost, of bridges of concrete, strengthened by the use of imbedded metal, with those of metal.

Reporters:

*America.*—Mr. J. F. Wallace, Chief Engineer Panama Canal Commission, Evening Star Building, Washington, D. C.

*Russia.*—Mr. Serge Kareischa, Councillor of State, Professor of the School of Ways of Communication, Assistant Inspector of Imperial Trains, and President of the Bureau of Consulting Engineers of Maintenance of Way, Jagorodny Pros., No. 70, Log 4, St. Petersburg.

*Other Countries.*—Mr. W. Ast, Royal Councillor, Civil Engineer of the Nord Empereur Ferdinand Railroad of Austria, 50 Nordbahn Strasse, Vienna.

SECTION 2.—LOCOMOTIVES AND ROLLING STOCK.

*V.—Locomotives of Great Power.*

Increase in the power of locomotives by the adoption of high pressures and of the compound principle. Improvements in construction from this point of view. Use of nickel steel.

Reporters:

*America.*—Mr. J. E. Muhlfeld, General Superintendent Motive Power, Baltimore & Ohio Railroad, Baltimore, Md.

*Other Countries.*—Edouard Sauvage, Chief Consulting Engineer of the Western Railway of France, 14 Rue Eugene Pinchat, Paris.

*VI.—Pooling Locomotives.*

The use of two or more crews. Advantages and disadvantages of the practice and the result of such common use with respect to the efficiency and the care of the locomotive.

Reporters:

*United States.*—Mr. G. W. Rhodes, General Superintendent Wyoming District, Lines West of Missouri River, Chicago, Burlington & Quincy Railway, Alliance, Neb.

*Belgium, United Kingdom and Colonies, Netherlands, Denmark, Sweden, Norway and Russia.*—Mr. Hubert, Director of the Belgian State Railways, 13 Rue de Louvain, Brussels.

*Other Countries.*—Mr. Boell, Chief Engineer of Mines, Chief Engineer of Rolling Stock and Motive Power of the State Railways of France, 136 Boulevard Raspail, Paris.

*VII.—Automatic Couplers.*

Advantages and disadvantages of automatic couplers. Improvements effected in their construction. Their use in conjunction with other couplings.

Reporters:

*America.*—Mr. A. W. Gibbs, General Superintendent of Motive Power, Pennsylvania Railroad, Altoona, Pa.

*England.*—Mr. W. F. Pettigrew, Locomotive, Carriage and Wagon Superintendent Furness Railway, Barrow-in-Furness.

*Other Countries.*—Mr. G. Nolteln, Director of the Moscow-Kazan Railway, Moscow.

*VIII.—Electric Traction.*

Progress made in electric traction on important lines of railways. Continuous current, alternating current, polyphase current, Experiments made with high tension currents.

Reporters:

*America.*—Mr. W. D. Young, Electrical Engineer, Baltimore & Ohio Railroad, Baltimore, Md.

*France.*—Mr. Paul Dubois, Engineer of Bridges and Highways, Engineer of the Central Service Motive Power of the Orleans Railway, Boulevard de la Gare, 41, Paris.

*Great Britain and Belgium.*—Mr. Ernest Gerard, General Inspector, Chief of the Cabinet of the Belgium Minister of Railways, 25 Avenue des Arts, Brussels.

*Other Countries.*—Mr. Victor Tremontani, Engineer, Chief Inspector of the Electrical Section of the Mediterranean Railway of Italy, Milan.

SECTION 3.—WORKING.

*IX.—Lighting, Heating and Ventilation of Trains.*

*(Sections 2 and 3 Conjointly.)*

Improvements made in the lighting, heating and the ventilation of trains.

Reporters:

*America.*—Dr. C. B. Dudley, Chemist Pennsylvania Railroad, Altoona, Pa.

*Other Countries.*—Mr. Cajetan Banovits, Ministerial Councillor, Superintendent of Rolling Stock and Motive Power of the Hungarian State Railways, Budapest.

*X.—Automatic Block System.*

What are the recent improvements in automatic block-signaling apparatus, and what progress has been made in their introduction?

Reporters:

*America.*—Mr. C. H. Platt, ex-General Superintendent Western District New York, New Haven & Hartford R. R., Room 1410, 20 Broad St., New York City.

*Other Countries.*—Mr. Margot, Engineer, Assistant to the management of the Paris, Lyons & Mediterranean Railway Company, 88 Rue Saint Lazare, Paris.

*XI.—Baggage and Express Parcels.*

(*a*) Baggage—Handling and protection of baggage. Methods of avoiding detentions, losses and diversions in transporting.

Reporter:

*All Countries.*—Mr. Geo. H. Daniels, General Passenger Agent New York Central & Hudson River Railroad, New York City.

(*b*) Express Parcels—Handling and protection of express parcels for quick or slow delivery. Methods for avoiding detentions, losses and diversions in transporting.

Reporter:

*All Countries.*—Mr. J. H. Bradley, General Traffic Manager American Express Company, 65 Broadway, New York City.

*XII.—Suburban Traffic.*

Arrangements for suburban passenger traffic.

Reporters:

*America.*—Mr. A. W. Sullivan, General Manager Missouri Pacific Railway, St. Louis, Mo.

*Other Countries.*—Mr. H. G. Drury, Superintendent of the Line Great Eastern Railway, Liverpool Street Station, London, E. C.

SECTION 4.—GENERAL.

*XIII.—Slow Freight Rates.*

General principles and description of the different systems of rating slow freight goods.

Reporters:

*America.*—Mr. M. C. Markham, ex-Assistant Traffic Manager Illinois Central R. R., 4956 Madison Ave., Chicago, Ill.

*England.*—Mr. Smart, Secretary Railway Clearing House, Seymour St., Euston Square, London, N. W.

*Italy, Spain, Portugal, France and Belgium.*—Mr. Mange, Engineer, Assistant General Superintendent of the Paris & Orleans Railway Company, Place Valhubert, 1, Paris.

*Other Countries.*—Mr. W. J. Van Overbeek de Meyer, Chief of the Division of Tariffs of the Company operating the Holland State Railways, Utrecht.

*XIV.—Bookkeeping.*

Bookkeeping generally: Description of the different existing systems; comparison from the double point of view of efficiency and economy. The question of adopting one uniform system on the different railways.

Reporters:

*America.*—Mr. A. H. Plant, Comptroller Southern Railway, Washington, D. C.

*Russia.*—Mr. Jean de Richter, Assistant Chief of the Line St. Petersburg-Warsaw of the Empire Railways of Russia, Gare de Varsovie, St. Petersburg.

*Other Countries.*—Chevalier von Lohr, Engineer, Royal Councillor, Auditor of the Nord Empereur Ferdinand Railroad of Austria, III. 2, Gartnergasse, 18, Vienna.

*XV.—Duration and Regulation of Work.*

Length of time on duty and working regulations for railroad employees and laborers.

Reporters:

*America.*—Mr. G. L. Potter, Third Vice-President, Baltimore & Ohio Railroad, Baltimore, Md.

*Switzerland.*—Mr. Placide Weissenbach, President of the Swiss Federal Railways, Berne.

*Other Countries.*—Mr. Philippe, General Inspector of the North Belgium Lines, Member of the International Commission of the Congress, Liege.

*XVI.—Provident Institutions.*

General principles of plans for the retirement and insurance railroad employees and workmen.

Reporters:

*Countries using the English Language.*—Mr. M. Riebenack, Assistant Comptroller Pennsylvania Railroad, Philadelphia, Pa.

*Other Countries.*—Mr. Lemercier, Doctors of Laws, Secretary of the Eastern Railway Company of France, 21 Rue d'Alsace, Paris.

SECTION 5.—LIGHT RAILWAYS.

*XVII.—Influence of Light Railways on the Main Line.*

Influence which the construction of light railways may have on the traffic of the main lines.

Co-operation of the main lines in the construction and working of light railways.

Reporter:

*All Countries.*—Mr. de Burlet, General Manager of the National Light Railways of Belgium, Member of the International Commission of Congress, 14 rue de la Science, Brussels.

*XVIII.—Direct Financial Co-operation by Public Authorities.*

Financial co-operation by the State (general government) and by localities interested (counties, districts, parishes, etc.), in the development of light railways.

Results obtained in Belgium by the institution of a central authority for studying the projects, supervising the construction and organizing the working of secondary railways, constructed with the financial assistance of the State and of the districts affected.

Reporters:

*France, Belgium, England and Germany.*—Mr. Colson, Councillor of State, Chief Engineer of Bridges and Roads, Member of the International Commission of the Congress, 139 Boulevard Saint-Germain, Paris.

*Other Countries.*—Mr. F. A. Ziffer, Civil Engineer, President of the Lemberg-Czernowitz-Jassy Railway, I. Operming 5, Vienna.

*XIX.—Organization of a Cheap Service on a Main Railway's Branch Lines which carry Little Traffic and on Light Railways. (Sections 3 and 5 conjointly.)*

Simplifications in the conveyance of passengers, parcels (express packages), and goods. Special motors and rolling stock.

Reporters:

*All Countries, except America, Austria-Hungary, Germany and Holland.*—Mr. Joseph Rocca, Engineer, Chief Inspector of the General Direction of the Mediterranean Railway of Italy, Milan.

*Austria-Hungary, Germany and Holland.*—Mr. Cornel Tolnay, Principal Inspector and General Superintendent of the Hungarian State Railways, Debreczen.

*XX.—Traffic Conveyed by Automobiles. (Sections 4 and 5 conjointly.)*

Organization of services by automotors on routes where there is not enough traffic for a railway.

Reporters:

*All Countries.*—Messrs. Lechelle, Superintendent of Transportation of the Northern Railway of France; Eugene Sartiaux, Engineer, Electrical Superintendent of the Northern Railway of France, and Kercomes, Principal Engineer of the Machine Shops of La Chapelle and Hellemmes, of the Northern Railway of France, 95 Rue de Maubeuge, Paris.

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METHOD OF CONDUCTING THE WORK OF THE SECTIONS.

In conformity with Article 14 of the rules, each section names its president, its principal secretary and its assistant secretaries. As it is important that the offices of president and principal secretaries should be equitably divided among the different nationalities represented at the Congress, and in order that the candidates may prepare themselves to fulfill their duties, the International Commission selects the candidates in advance and submits their names for ratification by the sections.

The president of each section nominates, subject to the approval of the assembled section, such other secretaries as he may desire to have associated with him as collaborators.

The International Commission will also designate, if the case requires it, one or more secretary reporters for each section, to serve as interpreters for the members who do not speak the French language.

In conformity with Article 16 of the rules, "the discussions take place in French or in the language of the country in which the Congress is held." The interpreters will translate into French, remarks spoken in any other language. In order to carry out this article of the rules, the members of the sections, and in case of necessity, the secretary reporters, will kindly lend their aid to the president or to the principal secretary of each section.

At the beginning of the session of the section, the president of each section will determine, in accordance with the wishes of the assembly, the arrangement of the days for the meetings, in order to fix, as exactly as it is possible to do it, the day upon which each of the questions submitted to the section alone, or discussed with other sections, will be handled.

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The Prussian State Railroads recruit their enginemen from their shop hands, and the rules require that only those be admitted as firemen who have the school education required for enginemen, to which position they may be promoted in course of time. The authorities have found that very many of these aspirants for the locomotive service lack the required schooling, and have recently given orders that hereafter when this is the case with otherwise capable shop hands, the defects in their education be remedied by instruction furnished gratuitously by the shop and locomotive officials while theyare shop employees.

RAILROAD GAZETTE

## RAILROAD BUILT IN 1904.

Official returns from the majority of the railroad companies in the country, supplemented by our own records and figures furnished by the State Railroad Commissions show that approximately 3,832 miles of new main track have been built in the United States during the calendar year 1904. These figures do not include second track, sidings nor electric lines. The sum total is the smallest reported since 1898, when 3,265 miles were built. The falling off from last year amounts to about 33 per cent. and is undoubtedly due to the suspension of work by some of the larger railroads on all construction which was not absolutely necessary until such time as the business outlook warranted the completion of the work. A concrete example of this is the Chicago, Rock Island & Pacific, which suspended work early in 1904 on its proposed line from Amarillo, Tex., to Tucumcari, N. Mex., 111 miles, on which grading had already been about 50 per cent. finished. Another example of this retrenchment policy as affecting construction is the Pennsylvania System, on which all work which not absolutely necessary was stopped. In this connection, it is interesting to note that the Pennsylvania has recently given orders to resume work on the low-grade line between Parkesburg and Columbia, this being a part of the construction work which was stopped early in 1904.

New main track mileage is reported in 43 states and territories, including Alaska, where 15 miles of new track were built. Texas leads the list with track laid on 323 miles, a slight decrease over 1903. Missouri is second, with 270 miles; Mississippi third, with 268 miles, and Minnesota fourth, with 221 miles. The largest decrease is reported in Oklahoma Territory, where only 163 miles were built, as compared with 661 miles in 1903. This is largely due to the fact that several of the leading railroad systems, including the Atchison, Topeka & Santa Fe, the St. Louis & San Francisco and the Chicago, Rock Island & Pacific reported the completion of their new lines in Oklahoma in 1903, and, owing to the unsettled times, did not begin any fresh work this year. In addition to the above mileage reported, California, Nevada, West Virginia, Pennsylvania, Indian Territory, Illinois, Arkansas, Colorado, Louisiana, Alabama and Georgia built over 100 miles of main track in 1904. No new mileage was reported in Connecticut, Delaware, Massachusetts, New Hampshire, Nebraska or Vermont. The number of miles built in Canada was 316, as compared with 687 last year. Mexico also shows a decrease, the mileage built being 116, against 299 in 1903. The following table shows our figures for mileage built in the United States during the last twelve years:

| | | | |
|---|---|---|---|
| 1893 | 3,024 | 1899 | 4,569 |
| 1894 | 1,760 | 1900 | 4,894 |
| 1895 | 1,428 | 1901 | 5,368 |
| 1896 | 1,692 | 1902 | 6,026 |
| 1897 | 2,109 | 1903 | 5,652 |
| 1898 | 3,265 | 1904 | 3,832 |

A table of this year's mileage, classified by states, is given elsewhere in this issue.

## ARE RATE-MAKING COMMISSIONS SUCCESSFUL?

It is an interesting phenomenon, in connection with the agitation for the enlargement of the powers of the Interstate Commerce Commission, that so much effort is expended in the exploitation of the evils alleged to exist that none is available to show the applicability of the proposed remedies. Without for a moment admitting that the frictional evils incident to the mutual adjustments necessary between a rapidly developing transportation system and an industrial organization, of which the former is a part, which is moving forward with equal speed, are as great as the proponents of the Quarles-Cooper bill contend, it is worth while to ask whether, if they were, the remedy proposed would correct them. Thirty states of the American Union now have railroad commissions, and in twenty-two instances these commissions have rate-making powers. Would it not be reasonable to investigate the results in these states before adopting similar legislation concerning interstate commerce? Such data as are now available indicate that official rate-making has not been very satisfactory to those states which have tried it. Georgia, for example, was one of the earliest states to adopt a drastic railroad commission law, and has consistenly followed the plan of interposing its authority between the buyers and sellers of railroad transportation. Yet the newspapers of Georgia to-day declare that the shippers of that state pay more than their neighbors in adjoining states, and that interstate traffic, which the Interstate Commerce Commission so loudly complains is not subject to effective regulation, is carried similar distances at much lower rates. A recent editorial in the Atlanta Journal contains the following:

> A merchant in Marietta can ship certain goods to Chattanooga for fifteen cents per hundred; to Knoxville for nineteen cents per hundred. To ship the same goods to Atlanta, he must pay thirty cents per hundred; to Macon, seventy cents per hundred. Atlanta is twenty miles from Marietta; Chattanooga is one hundred and twenty-eight miles, and yet the Chattanooga merchant pays just one-half the freight the Atlanta merchant does. Why? Because Chattanooga is out of the state and Atlanta is in it. This is merely one of a hundred instances where Georgia points are placed at a positive disadvantage in freight rates, because they are located in the state.

The editorial from which the foregoing is an extract shows traces of feeling which suggest the attitude of an advocate rather than one of judicial impartiality; but in spite of this it is clear that the results of a drastic regulative system are not now wholly satisfying to the people of Georgia. It has been suggested that the psychological aspect of railroad regulation of this sort is too often ignored, and that where the reduction of rates is more or less vigorously looked after by public authorities, railroad officers are not unlikely to leave the duty of looking for desirable reductions wholly to the body with which the legislature has required them to share it. Something of this sort seems to have occurred to the shippers of Georgia, for in the editorial already quoted there appears the following explanation of the situation against which the complaint is made:

> . . . when a merchant approaches the railroad for rates in Georgia, he is met with the reply that the railroad commission regulates that, and he can get no reduction.

If, however, they are asked for rates to towns outside of Georgia, the application receives immediate and favorable consideration, and the best rates are granted, because the point of destination is beyond the limits of the state, and therefore not controlled by the State Commission.

In another paragraph of the same editorial the situation is summarized with similar effect, and perhaps even more forcibly as follows:

> As matters now stand the plain logic of the situation is that within the state of Georgia, rates being regulated by the railroad commission, shippers are powerless to receive fair treatment from the railroads, while to points just beyond the limits of the state they can receive the most favorable rates, and shippers from these points into the state receive the lowest rate than can be obtained; much lower, as a rule, than the Georgia shipper can get.

Anyone would underestimate the significance of the foregoing who failed to note that the state rates and the interstate rates are over the same railroads and must be promulgated by the same officers; the controlling, and, in fact, the sole difference being that in the case of the interstate rates the shippers deal at first hand and face to face with the railroads and their officers, while in the case of the state rates the legislature has interposed its authority, and that of the State Commission, between the two actual parties to every contract for railroad service, thus requiring the negotiations to be conducted at much more than an arm's length. The method of doing business thus imposed upon the shippers of state traffic, and the railroads carrying it, is cumbersome and absurd; it is only natural that its consequences should be so burdensome.

If rate-making power is conceded to the Interstate Commerce Commission the shippers of interstate freight may find themselves in the situation that is now distressing the local shippers of Georgia. Left to himself, the competent railroad rate-making officer devotes much time and thought to the search for opportunities to assist in the development of the regions contiguous and tributary to this system and to increase net revenue by reducing rates. In order to avoid overlooking any such opportunity his door is always open to those who seek reductions, and he investigates patiently every industrial situation that affords even the most meagre promise of additional traffic in return for lower rates. The creation of an official board with authority to compel reductions transforms such an enlightened and useful officer into an advocate of the existing rates. He is told, in effect, that the state will look out for the needs of business in the way of reduced rates of transportation, and he knows that, until driven to plead confiscatory taking of property without due process of law at the bar of justice, the revenues of his corporation will have no defender but himself and his fellow officers. He knows that a justifiable reduction will be made an argument for others that are wholly devoid of justification, and he naturally assumes an attitude of hostility to all reductions. Again, capital is reluctant to engage in railroad enterprises where the rate-making power has been taken from its employees and lodged in political officers, and the states which have the most drastic regulative laws have usually seen the slowest development of railroad facilities, with the natural accompaniment of slow development, the retardation of the natural decline in rates.

## THE GOVERNMENT AND RAILROAD ACCIDENTS.

Since the first day of last July there have been in this country seven important train accidents, killing 252 persons and injuring over 500. These accidents have been put so prominently before the public that they have called out vigorous inquiries and criticisms concerning their causes.* Similar but less severe "epidemics" have occurred before. But this particular series of accidents, following ten very bad ones in the year ending June 30, has aroused an unusual interest. By October, when the facts concerning the Newmarket and Warrensburg collisions became known, the state of public opinion had become so pronounced that President Roosevelt referred to the subject in his annual message to Congress; and as 140 of the 252 fatalities were due to collisions, and 8 of the 10 accidents in the preceding year were of this class, he quite naturally indorsed the recommendation of the Interstate Commerce Commission that a Federal law be passed to enforce the use of the block system. This proposed law, it may be observed in passing, is a rather mild one (it was printed in the *Railroad Gazette* of January 1, 1904).

This action of President Roosevelt has drawn from Mr. Slason Thompson, of Chicago, an angry protest, which he has presented to the Western Railway Club in a paper, the main parts of which we reprint in another column. Mr. Thompson will be recollected by our readers as the author of a paper last February (*Railroad Gazette*, page 112), containing some utterly worthless comparisons between the accident reports of the British Board of Trade and those of the Interstate Commerce Commission. He makes some other comparisons of a similar kind now; and they are equally worthless. He does, however, make comparisons of one year with another, in the records of this country, in more rational form. He shows, what it was hardly necessary to show, that in the last 14 or 15 years the fatalities to passengers and employees, as recorded in the Government Annual Reports, have not increased so fast as the volume of traffic has increased; though he does not bring his comparisons down to date, and so omits two disasters, killing four score people, which have been the most potent factors in arousing public indignation. He also has found 35 roads, operating 31,000 miles of line, on which not a single passenger was killed in a train accident during a whole year. The density of passenger traffic on these 35 roads is about the same as in Group 3 (Ohio, Indiana, Michigan). But all these comparisons are almost valueless because they afford no new or useful lessons; and Mr. Thompson, as a quasi representative of the railroads, does harm by perpetuating a seeming disagreement among railroad interests. In trying to get up a quarrel with the Interstate Commerce Commission he wearies the Western Railway Club with a lot of irrelevancies. No American railroad officer finds satisfaction in the accident statistics either of this country or of England, whether interpreted by Mr. Thompson or Mr. Moseley, or the Secretary of the British Board of Trade. Practically all progressive railroad men are agreed that the block system ought to be rapidly extended. The most outspoken among the railroad officers who have complained that the Interstate Commerce Commission is crying too loudly for the adoption of the block system, is the managing officer of a company which has already determined to block signal all of its main lines as soon as possible and to increase its block signaling more than 100 per cent. within the next six months.

We do not take the reader's time to verify Mr. Thompson's percentages or to refute his grotesque conclusions, for any reader who has considered the facts must see without assistance the inapplicability of these conclusions. What sense can be made of the assertion that "in three cases out of four" the value of the block system is neutralized by the failure of the men who work it? He praises the Board of Trade for saying that the railroads of England cannot reduce their collision record by the adoption of new methods of operation; but to properly illuminate this statement one must add that the most important "new method," the block system, has been adopted already.

The Interstate Commerce Commission rightly omits from its discussions the trespassers killed and injured, because these figures do not affect the main question. (What Mr. Thompson means by charging that trespassers' casualties have been attributed to the lack of the block system, is a mystery.) The Commission is also right in omitting derailments, for the reason that the prevention of derailments is a complicated question which the Government is not dealing with. And, finally, it could very reasonably omit its tabular statistics altogether and confine its attention entirely to the dozen notable collisions. These are what have aroused the public, and the causes of these are what everybody desires to grapple with. It may be true that the train despatchers of America, performing highly exacting duties with great fidelity and skill, have come out successful 999,995 times out of a million. But if the other five cases produce disastrous butting collisions, and the collisions cause harrowing scenes of death and suffering; if a change of system reduces the errors from five in a million to one in a million, and the new system has a record of years to prove its merits, the public will demand the change.

*One of these accidents was the flood disaster in Colorado, killing 94 but the others were due to causes constantly recurring.

## RAILROAD SHOP TOOLS.

Those who have followed the articles on 'Railroad Shop Tools" printed in the *Railroad Gazette* during the past six months, could not have failed to notice the marked similarity in the general design of different makes of tools of the same type. This similarity is due to the fact that modern machine tools have the same essential parts that they had ten years ago. For example, a shaper still consists of the base, the ram, the cross rail, the table, the head, etc. Of course, the modern machine tool is a much more efficient machine, owing to the number of important improvements and differences that are to be found in the details of its design, such as labor-saving devices, different types of feed and adjusting mechanisms, etc., all of which go to reduce the cost of production. The latest machine tools are heavier and stronger than those designed several years ago. This is due to the fact that the makers give attention to the increased stresses which are imposed on the different parts of the machines owing to the wide use of modern high-speed tool steel. Before the advent of high-speed steel most machine tools were designed more or less by the "rule of thumb" method; but now the makers realize that their designs must be based on thoroughly scientific principles, so that the metal will be placed where it will do the most good. Almost every type of modern machine upon the market is equipped with some sort of a variable speed mechanism. These devices are thought by many to be more of a fad than an actual necessity, especially in railroad shops, where, as a rule, each machine is bought to do a special class of work. Of course, where a machine handles a wide range and variety of work a variable speed attachment is useful. In general, however, a few speed and feed changes will meet the requirements of railroad shops. A marked increase in the number of direct connected, motor-driven tools is noted. This type of drive is efficient and convenient, especially for heavy isolated machine tools, as it makes it possible to place them in the most advantageous position regardless of line shafts. For the smaller tools it is still a question whether a direct connected drive is the best method. It is generally admitted, however, that small tools should be group driven. When the group drive is employed, constant-speed motors are used. It is best to use the same size and make of motor for driving each group, thereby reducing the number of repair parts to be carried in stock. New tools should also be selected so as to minimize the variety of designs. This practice will be found particularly economical in cases where jigs are used, for then the jigs can be made to fit more than one machine. Many machine tool users are demanding positive drives and feeds. Positive feeds are a necessity in many cases—as, for example, when fine, accurate work and thread cutting is to be done—but on the larger machines where precision work is not essential, the friction drive, whether a belt or disc, is preferable, as it acts as a safety device when the tool becomes jammed and will relieve the machine of dangerous strains. Two machines which have been described in the *Railroad Gazette* that are gaining in popularity in railroad shops, are the horizontal and vertical turning and boring mills. These machines are now used for turning cylinder ring castings, boring out driving boxes, etc., work which was formerly done on a lathe. The double-head boring mill is especially useful in many cases, and the ease and quickness with which work can be chucked on this type of machine, has had much to do with their almost universal use. Because of the great variety of work which these machines are called upon to do, it may almost be said to be an unwritten rule never to chuck a piece of work vertically, as in a lathe, when it can be chucked horizontally, as in a boring mill.

Several months ago we had occasion to point out the absurd disparities and blunders in the annual reports of the Railroad Commission of Connecticut. The report for 1904 just published brings some of those

flaws out in grotesque relief. The report for 1902 returned the "average cost of the equipment" of the steam roads of the state at $6,984 per mile (cents omitted). This item was changed in the report of 1903 to $84,848 a mile, which now drops (for 1904) to $13,624 a mile—itself almost double the return for 1902. In other words, if we take these astonishing returns as an index, the equipment of Connecticut's steam roads increased about twelve-fold one year and fell some 84 per cent. the next. Such dizzy vagaries of "official" figures the statistician may well be excused from further analyzing. Again, another point of our attack was a huge blunder of the Commission last year (1903) in the simple addition of its own figures showing capitalization per mile of the electric roads of the state in stock, bonds and floating debt. In its report now (1904) the commission balks at that simple summation of mileage capitalization and shifts the process to "cost of construction and equipment," $86,612 a mile, a big leap from the $80,773 returned last year for the same item and a still more fantastic contrast with the blundered $71,728 returned last year for stock, bonds and floating debt capitalization combined. The Commission, however, this year sets up a kind of apology in a statement that the inclusion of gas, electric light, water and power plants "plays havoc" with the Connecticut street railway statistics, and it very gently lays the blame on the State Legislature. But when did the Connecticut Railroad Commission ever seriously press that matter on legislative attention? When did it suggest or bring forward a remedial or preventive measure? What has it ever done to thwart the enormous over-capitalization of Connecticut trolley roads, and what general policy of any kind has it ever urged or adopted? At the time when the State Legislature ordered street railway returns to be made did not the Commission leave to the voluntary initiative of a private citizen the measure which compelled those returns to be printed? But words are almost wasted in commenting on a commission of such a character. It is simply the by-product of a lax and usually partisan state policy that creates a perquisite in place of what should be an office of useful and exalted public service—a policy by no means restricted to Connecticut. The so-called "political" commission is so familiar an evil that it interprets itself by the simple adjective.

Steel sheet piling for foundation and caisson work is of comparatively recent origin, but because of its manifest superiority over timber sheet piling in a great number of applications it has met with the approval of contractors and other users and has been extensively employed. The chief advantage claimed for it is that it is practically indestructible and can be used over and over again. It is also claimed that it is driven more easily than timber piling. This claim seems to be substantiated in practice, but the withdrawal of the piling, after the completion of the work, has been found to be exceedingly difficult in a number of cases. This may be ascribed to several causes, the chief of which is corrosion. Steel which is imbedded in damp ground for from one to four months is sure to rust, and this rusting takes place chiefly in the interlocking grooves and on the surfaces next to the earth. When the piling is withdrawn this rusting adds greatly to the resistance and increases the difficulty of pulling out the separate piles. Some little time ago a contractor attempted to withdraw some steel piles which were badly corroded, having been in the ground some time. Bolts 1¼ in. in diameter were passed through holes in the web near the top, and in attempting to pull the piles with these bolts the bolts were sheared off clean. Although the effort was finally successful, the contractor thought that it cost him about as much as the piling was worth to save it. A large user of steel piling has suggested that one way to get rid of corrosion to a large extent is to fill the interlocking grooves with a heavy grease before putting the piles in the ground, and though a large part of this grease would doubtless be forced out in driving, enough would remain on the surfaces in contact to prevent corrosion and to act as a lubricant to facilitate withdrawal. Some designs of interlocking steel piling which are built up from rolled sections, riveted together, are difficult to withdraw because of the increased resistance furnished by the rivet heads. This, of course, could be overcome by countersinking the rivet heads. As a general rule, where difficulty is experienced in withdrawing steel piling because of corroded joints, one or two blows on top of each pile with the hammer of a pile driver, if it is conveniently near, will break the rust joint and loosen the pile from those on each side of it, so that it can be drawn easily and quickly with a steady upward pull with block and tackle, or other means.

As Mr. Slason Thompson mixes some truth with his curious compilations of errors, we have in another article noticed his Chicago paper to the extent of restating the main facts on which is based the demand, constantly becoming more widespread, for the extension of the use of the block system. Mr. Thompson seems to be trying to show that this demand is of no account or does not exist; but he does not disturb the facts, though to the superficial reader he might seem to be doing so. But there is one of his assertions in which he may have the support of some railroad men, and it will be proper to add a word concerning it. We mean the allegation that "the inevitable tendency of the block system is to beget carelessness in the train crews." In another place he seems to think that block signals are likely to "overburden public traffic," meaning, we suppose, that they will delay trains unreasonably. But what particular brand of carelessness is it that so materially improves the safety of passengers? If reference is made to the neglect of rear flagmen to flag, in cases where they know that their trains already have the protection of the block signal, it may be answered that many superintendents who require flagging to be kept up the same with the block signals as without them, do succeed in enforcing flagging as well as before. This indicates that the trouble is with the superintendent, not with the system. Something seems to "beget carelessness" in trainmen under all systems, unless the superintendent keeps after the men constantly. One great merit of the block system is that the superintendent can readily watch the men on whom he depends for the protection of his trains from collision, whereas under the old system he must always depend largely on the flagman, who performs his duties under such varied and elusive conditions that it is difficult to watch him effectively. Neither is the block system responsible for delaying trains. It is possible, of course, to make block sections long enough to keep trains an hour a part. But, on the other hand, it is possible to make them short enough to reduce the time interval between trains to two minutes or less. No rational minded superintendent is going to blame the system for the length of his block sections; he knows that the trouble is due to his own attempt to accomplish the impossible; to secure both safety and celerity without increasing his expenses. Where trains are run at 30 miles an hour four minutes apart, they may with good luck get along for years without the block system, for they will usually be about two miles apart. But if the road decides to abandon dependence on luck, introduces the block system, and sets the signals four miles apart, the time interval must at once be lengthened to eight minutes. There is no mystery about this. The capacity of the road is reduced 50 per cent. On the other hand block signals one mile apart would increase the capacity of the road approximately 100 per cent. as compared with the four-minute time interval.

## NEW PUBLICATIONS.

*Locomotive Operation.* A technical and practical analysis. By G. R. Henderson. Chicago: The Railway Age, 1904. Cloth, 536 pages. Price, $3.50.

Previous books on the locomotive relate to locomotive design, locomotive running or a combination of these in the form of a catechism intended for engineers and firemen. There is the classic work by Holly and Colburn, which is out of date, and other elaborate works in French and German; but there is no modern work in English in which the subject of locomotive operation on American railroads is treated in such an original and satisfactory manner. The author is a mechanical engineer, well known on account of his valuable reports written for the Master Mechanics' Association on locomotive proportions, tonnage rating, train resistance, etc. He has had a large experience as a machinist, a mechanical engineer and a motive power officer, and has a thorough technical education. The book is written from the technical and practical standpoint, and is intended for the men employed in mechanical departments of railroads, as well as for students in the railway course in technical schools. For the latter, the mathematics necessary for derivation of various formulæ are given in full, and the treatment is as scientific as could be desired. For the practical man the final formula is given in simple form for direct application, and much of the information is given in the form of tables and diagrams, from which data can be taken directly. It is exceptionally well illustrated with carefully prepared drawings. It is a complete treatise on the subject of locomotive operation, and the aim has been to apply scientific principles to modern locomotive practice, and the derivation of the formula is given so as to avoid the necessity of reference to other text-books. The book treats of inertia and its application to starting and stopping, centrifugal force on curves, the effect on rods and reciprocating parts, counterbalance, steam action, valve motion quantity of steam, condensation in cylinders, rotative force, pressure on rail, strains induced in pistons, cranks and axles and rods, drifting and relief valves, slipping, traction increasers, steam capacity, hauling, water and fuel consumption.

## TRADE CATALOGUES.

*Machine Tools.*—The Pratt & Whitney Co., Hartford, Conn., sends a pamphlet bearing the title "New Designs." Illustrations and descriptions of engine lathes, turret lathes, shaping machines, milling machines, multiple drills, etc., are given.

*Mechanical Stokers.*—The Westinghouse Machine Company, East Pittsburg, Pa., sends an illustrated boklet entitled "A Few Words About Mechanical Stokers." A full detailed description of the Roney stoker is given as

well as a number of cross section drawings which show the details of its construction. Illustrations of some important power plants equipped with this stoker are also shown.

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*Union Pacific* issues a 14-page pamphlet giving a tabulated statement of the crop yields of all counties in Nebraska for 1904, McPherson county excepted. The report shows the acreage of all crops produced in the state during the year, with estimates of the yield per acre for each. A similar bulletin has been issued for Kansas, making the eighteenth agricultural bulletin issued by the passenger department, the practice having been only recently begun.

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# CONTRIBUTIONS

## Design for Reinforced Concrete Retaining Wall.

Chicago, Dec. 1, 1904.

To the Editor of the Railroad Gazette:

Considerable data have been published from time to time concerning reinforced concrete structures for all railroad purposes with the exception of retaining walls. In track elevation, concrete retaining walls, usually very massive, are being used quite extensively, and it would appear that reinforced concrete could be used quite economically in such walls, if the volume of concrete could be reduced to some extent, at the same time keeping the cost of supervision, of forms, and the mixing and placing of the concrete the same as for the plain wall. The design presented here was intended to meet these requirements and at the same time have as much, if not more, stability than the average design of retaining wall.

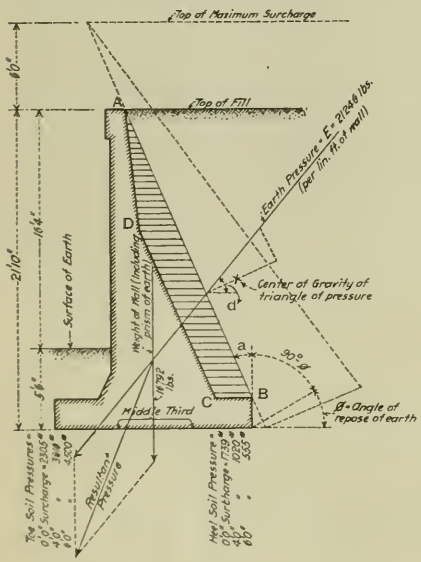

Top of Maximum Surcharge
Top of Fill
Earth Pressure = F = 21248 lbs. (per lin. ft. of wall)
Surface of Earth
Center of Gravity of triangle of pressure
Middle Third
β = Angle of repose of earth
Resultant Pressure
Hor. Soil Pressure
Vert. Soil Pressure

Fig. 1.

The following assumptions, methods of design and ideas of construction, were used in this design:

*Type of Wall.*—A wall having the same general outline as an ordinary retaining wall, to which any reliable theory could be applied.

*Assumptions.*—The plane A B (Fig. 1) was assumed to be the back of the wall and the prism of earth A-B-C-D-A a part of the wall. The weight of this prism is less than one-fourth the total weight of wall.

*Resultants.*—The resultant pressure due to weight of wall and earth pressure (without surcharge) must cut the center, or very near the center, of the base. The resultant due to the above pressures, and including the surcharge, must cut the base inside the middle third. At the same time the allowable soil pressure must not be exceeded at the toe.

*Forms and Reinforcing.*—The forms must be as simple and readily constructed as those for plain walls. The reinforcing bars must not have any difficult kinks or bends, so as to avoid the necessity of skilled labor in the field.

*Volume of Concrete.*—The volume of concrete shall not be reduced to such an extent that the cost per yard of machine mixing, handling and placing of concrete will exceed that for a plain wall.

*Formulae.*—Retaining wall formulæ were taken from "Retaining Walls for Earth," by Prof. M. A. Howe, and the following are the ones used for the resultant earth pressure and its pitch:

$$E = \frac{H^2 Y}{2} \sqrt{\tan^2 a + \tan^4\left(45^0 - \frac{\phi}{2}\right)}$$

$$\tan d = \frac{\tan a}{\tan^2\left(45^0 - \frac{\phi}{2}\right)}$$

where H = vertical height of wall plus the surcharge.

W = weight of 1 cu. ft. of concrete = 150 lbs.

Y = weight of 1 cu. ft. of earth = 150 lbs.

$\phi$ = angle of repose of earth = 30 deg.

a = angle back of wall makes with the vertical.

E = resultant earth pressure in lbs. per lineal ft. of wall.

d = angle resultant E makes with the horizontal.

The formula used for the reinforced concrete is by Mr. A. L. Johnson. This formula

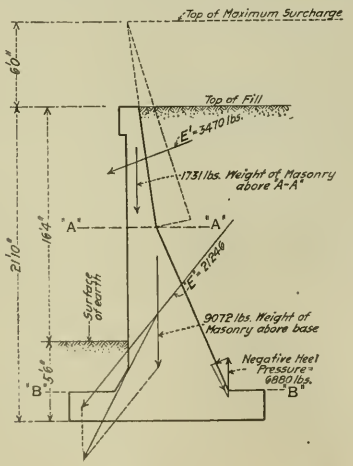

Top of Maximum Surcharge
Top of Fill
E' = 3470 lbs.
1731 lbs. Weight of Masonry above A-A'
E = 21248
Surface of earth
9072 lbs. Weight of Masonry above base
Negative Heel Pressure = 6680 lbs.

Fig. 2.

can be adapted to either a high or low elastic limit steel.

*Unit Stresses.*—The metal reinforcing used is a high elastic limit steel and the allowable unit stress for tension is 12,500 lbs. per sq. in., which gives a factor of safety of 4 where the elastic limit is 50,000 lbs. per sq. in. If 32,000-lb. elastic limit steel is used, the allowable unit stress should be 8,000 lbs. per sq. in. in order to have the same factor of safety. The allowable working stress for imbedment of the bars shown is 250 lbs. per lineal inch of imbedment, and for plain material about 160 lbs. per lineal inch of imbedment. These unit stresses are based upon tests made at six of the leading universities of this country, which tests prove without a doubt that the ultimate strength of the reinforced concrete structure is the elastic limit of the reinforcing steel.

The method of procedure was as follows:

Fig. 1 shows the direction and intensity of the resultant for 6 ft. of surcharge. The soil pressure at the heel and toe are shown for 0, 4 and 6 ft. of surcharge. The toe is reinforced for the maximum soil pressure and the heel for the actual weight of the earth prism. Fig. 2 shows the resultant earth pressure, E, applied directly to the back of the masonry and combined with the weight of the masonry above the plane "BB." The resultant pressure cuts the plane "BB" just inside of the masonry at the toe and produces a negative pressure at the heel. Care must be taken not to exceed the allowable pressure on the masonry at the toe in the plane "BB." Reinforcing bars are

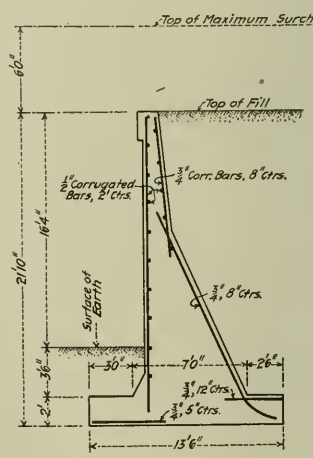



Fig. 3.

to be provided to take the stress caused by negative pressure at the heel. Fig. 2 also shows the resultant pressure on the upper portion of the wall. This portion is treated as a simple cantilever beam.

Fig. 3 shows a cross-section of the completed wall, giving sizes and spacing of reinforcing bars. It is very probable that there should be additional bars placed in the bottom of the wall, running longitudinally, to give additional safety for possible settlement.

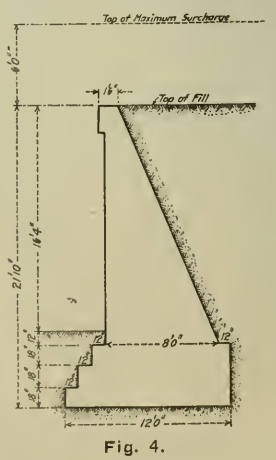



Fig. 4.

Fig. 4 shows cross-section of a plain concrete wall having the same stability as the steel-concrete wall. The following comparison of costs is for the total cost of wall, in-

cluding contractor's profit, and exclusive of excavation.

*Plain Concrete Wall, Per Lin. Ft.*

| | | In place. |
|---|---|---|
| Concrete | 4.8 cu. yd. at $4 per yd. | $19.20 |
| Forms | 115 ft.B.M." 31 " M.. | 3.56 |
| Total | | $22.76 |

*Steel-Concrete Wall, Per Lin. Ft.*

| | | |
|---|---|---|
| Concrete | 3.45 cu. yd. at $4.10 per yd. | $14.18 |
| Forms | 115 ft.B.M. " 31.00 " M. | 3.56 |
| Steel bars | 109 lbs. " .03¼ pr lb | 3.54 |
| Extra fill | 1.34 cu. yd. " .20 per yd. | .27 |
| Excavt'n. | 0.32 cu. yd. " .20 per yd. | .06 |
| Total | | $21,61 |

These estimates show a saving of $1.15 per lineal foot of wall, in favor of the steel-concrete wall. If the cost of materials is higher, there will be a greater saving made.

F. F. SINKS.

## Economic Length of Trestle Spans.

CINCINNATI, OHIO, Dec. 10, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

For the purpose of obtaining the economic length of spans for trestles of various heights, the following estimates were prepared and are submitted as being of value in estimating on the type and span of structures of this kind. The assumed loading is that given in Cooper's latest railroad bridge specifications, class E 50. This loading is gradually coming into almost universal use on the principal American railroads.

With towers 30 ft. center to center of bents, comparative estimates were made to ascertain the economical length of intermediate spans for plate girder construction. The assumed height is 120 ft.

*Weight of Steel in Trestles, for Various Lengths of Intermediate Spans.*

| Length intermediate span. | Weight per lin. ft. of single track, lbs. | | | |
|---|---|---|---|---|
| | Spans. | Bents. | Traction bracing. | Total. |
| 30 | 433 | 1,130 | 380 | 1,943 |
| 40 | 493 | 1,080 | 360 | 1,933 |
| 50 | 556 | 1,040 | 345 | 1,941 |
| 60 | 622 | 995 | 324 | 1,941 |
| 70 | 741 | 952 | 315 | 2,008 |
| 80 | 860 | 910 | 300 | 2,070 |
| 90 | 988 | 867 | 285 | 2,140 |
| 100 | 1,117 | 800 | 270 | 2,187 |

Taking the cost of steel in place at 3½ cents per pound for girders, and 4 cents per pound for bents and bracing, and the cost of concrete piers in place at $10 per yard, then the cost of trestles for varying lengths of intermediate spans is as follows:

*Cost of Steel Trestles 120 Ft. High, for Varying Lengths of Intermediate Spans.*

| Length intermediate span. | Cost per lin. ft. of trestle. | | | | |
|---|---|---|---|---|---|
| | Spans. | Bents. | Traction bracing. | Piers. | Total. |
| 30 | $15.15 | $45.2 | $15.2 | $12.00 | $87.55 |
| 40 | 17.25 | 43.2 | 14.4 | 10.00 | 84.85 |
| 50 | 19.46 | 41.6 | 13.8 | 9.00 | 83.69 |
| 60 | 21.77 | 39.2 | 13.0 | 8.00 | 82.57 |
| 70 | 25.90 | 38.0 | 12.6 | 7.20 | 83.76 |
| 80 | 30.10 | 36.4 | 12.0 | 6.60 | 85.17 |
| 90 | 34.58 | 34.6 | 11.4 | 6.00 | 86.58 |
| 100 | 39.09 | 32.0 | 10.8 | 5.50 | 87.39 |

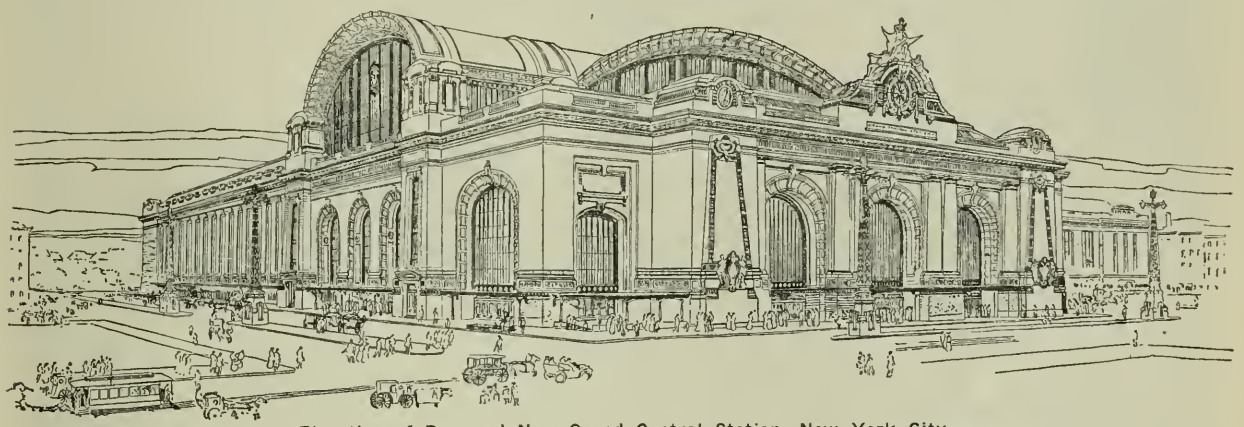
These estimates show that the most economical length for intermediate spans for the assumed height of 120 ft. is 60 ft., though there is no great variation for 10 ft. greater or less length. The decreased cost of spans is balanced by the increased cost of towers and foundations.

As the height of trestles decreases towards the ends, the length of the intermediate spans will decrease also, down to 30 ft. Or if the trestle be low throughout, it will be economical to reduce the lengths of all the spans to 25 or even 20 ft.

H. G. TYRRELL,
CHIEF ENGINEER BRACKETT BRIDGE CO.

## The New Grand Central Station.

The New York Central on December 24 submitted to the Board of Estimate and Apportionment of the City of New York for approval the plans of the terminal improvements which are to be made in New York, including the magnificent new passenger station which it is proposed to build on the site of the present station. When the first Grand Central Station was built in 1871 it was considered one of the largest and finest terminals in the world. It covered four acres and had two acres of glass in the train shed roof. In 1899 the station was entirely remodeled and enlarged, but with the constant growth of the through and suburban traffic of both the New York Central and the New York, New Haven & Hartford, which shares the terminal under a perpetual agreement, it has become entirely inadequate to the present or future needs of both roads. In the *Railroad Gazette*, Jan. 2, 1903, a preliminary report of the engineers in charge of the improvement work was published together with a plan of the proposed arrangement of approach tracks, yards and station building. Since that time the plans have been revised and changed in many ways as new problems arose but the general scheme remains the same.



Elevation of Proposed New Grand Central Station, New York City.

The plans submitted for approval by the city contemplate the use of an area of 19 city blocks between Forty-second and Fifty-seventh streets, Madison and Lexington avenues. The station proper, together with the post office and express buildings, will cover the blocks between Vanderbilt and Lexington avenues from Forty-fifth to Forty-third streets inclusive, and the block fronting on Forty-second street between Vanderbilt avenue aud Depew place.

The buildings will be set back from Forty-second street about 40 ft. and back from Vanderbilt avenue about 70 ft., so as to afford a generous approach to the station and give the effect of 140 ft. open space on the Forty-second street front and 130 ft. open space on the Vanderbilt avenue front. The frontage of these buildings will be 680 ft. on Vanderbilt avenue, 625 ft. on Forty-fifth street, 460 ft. on Lexington avenue, 275 ft. on Forty-fourth street, 260 ft. on Depew place, and 300 ft. on Forty-second street.

In addition to the public streets, there will be connections by a number of wide private roadways and walks to Madison avenue on the west and Lexington avenue on the east; thus giving the traveling public facilities for entering the station not only from Forty-second street, Vanderbilt avenue and Depew place on the south, but from Madison avenue on the west and Lexington avenue on the east.

The suburban trains will come in on a lower level than the express trains, thus separating the two classes of passengers and affording better facilities for both. The suburban concourse will provide for nine tracks. The express concourse will be slightly depressed below the street level and will provide for 22 passenger train tracks, two baggage tracks, two mail tracks and eight express tracks, making 43 tracks in all, with the platforms so connected by subways and elevators that baggage, mail and express can be quickly transferred without crossing the tracks.

The main entrance to the station will be on Forty-second street. Its architectural composition is three massive arches, each arch being 33 ft. wide and 60 ft. high. Beyond these arches is an enormous ticket lobby 90 ft. x 300 ft. This ticket lobby is on the level with the street. On the right of this lobby, and practically a part of it, is the outgoing baggage room. After purchasing his ticket and checking his baggage, the passenger proceeds to the express trains by entering a gallery overlooking the grand concourse and thence to this concourse, which is on the level of the express tracks. This concourse is approached by four grand staircases, each 25 ft. wide. This concourse is the largest in the world, being 160 ft. by 470 ft. and 150 ft. high, with wide entrances at each end extending to Madison and Lexington avenues. Adjoining this concourse are the usual waiting rooms, retiring rooms, cafés, telephone and telegraph facilities, etc. The waiting rooms will contain twice the area of the waiting rooms in the present Grand Central Station. The departing and arriving passengers will pass through this concourse, but the arriving passengers are separated from the departing passengers, thus avoiding the usual confusion in a railroad station caused by the meeting of incoming and outgoing passengers. In the train shed the platforms are of ample width, averaging from 15 ft. to 18 ft. wide, whereas the narrowest platform of the present station is but 8 ft. wide and the widest is but 12 ft. wide. These wide platforms afford ample facilities for quickly leaving the train and

avoid the usual crowding. The suburban train shed has platforms on either side of the train. These platforms are even wider than the express platforms, ranging from 17 to 29 ft. wide. The concourse end of all express train platforms has the additional advantage of being free from the handling of baggage.

The exit from the station is along Vanderbilt avenue, approached by ample staircases. To the north and along Vanderbilt avenue is the incoming baggage room, conveniently placed for arriving passengers. The company's cab stand is on the level of the concourse and the express tracks. It will be about 100 ft. x 200 ft. and can be reached with equal facility by the suburban and the express passengers.

Besides the main entrances and exits there are additional entrances and exits for the suburban passengers, so that these need not enter the main part of the station, but can go directly from the street to the train or from the train to the street by an easy incline, avoiding all staircases. There is to be provided at the express level a passageway to the subway station. There is also a splendid entrance and exit to the station by way of an incline from Madison avenue, enabling the cab or foot passengers to approach or leave the station at the west end of the grand concourse. At the subway level there is provided a subordinate concourse with ample waiting and retiring rooms. At this level there will be a loop for quickly despatching the suburban trains, and provision has also been made for a possible connection with the tracks of the rapid transit system. Pipe galleries will be run in Forty-second street, Vanderbilt avenue and Depew place.

The baggage room adjoins Depew place, Forty-fifth street and Vanderbilt avenue, with 1,300 ft. of street front and 47,000 sq. ft. of floor space, sufficient to care for baggage in rush seasons without the delay in delivery now experienced at all large stations.

In preparing the plans for the new station everything has been sacrificed to the comfort and convenience of the traveling public. The distinguishing features of the arrangement of the yards, platforms and head house may be summarized as follows: Ample facilities for getting to and away from the station. Cab stand situated in most convenient place for arriving passengers. Outgoing baggage room convenient to the ticket offices and incoming baggage room convenient to the exits. Separation of incoming and outgoing passengers, thus avoiding confusion. Ample waiting rooms and accessories and a grand concourse large enough to accommodate the largest holiday or excursion crowds. Separation of suburban and through passengers but with arrangements for easily getting from one part of the station to the other. Waiting vestibule for those desiring to meet incoming passengers. Ample baggage handling facilities.

North of the main concourse and extending entirely around this part of the building above the level of the train shed will be the company's offices containing about 250,000 sq. ft. of floor space exclusive of corridors. The entrances to the offices will be at Forty-fifth street and Park avenue.

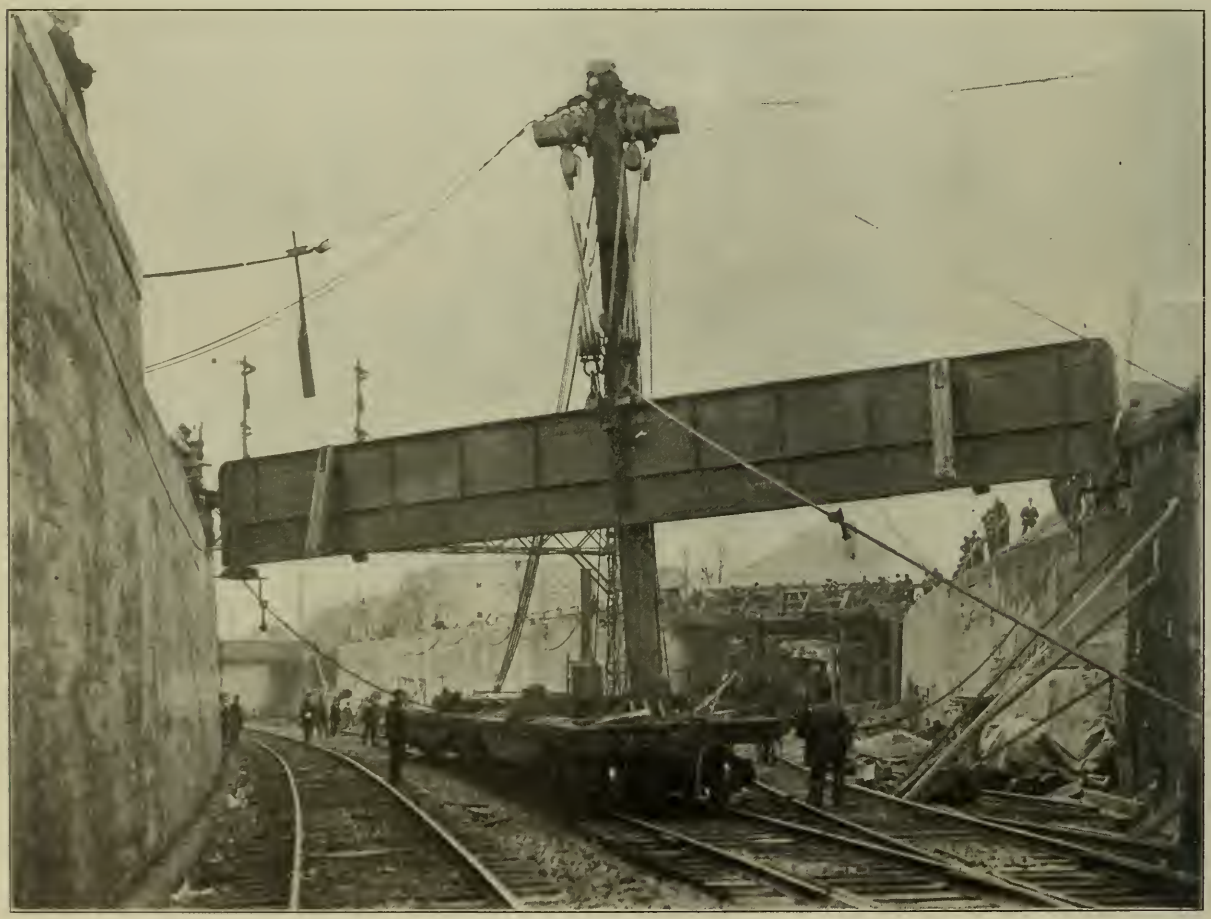
The plans have been so drawn that at any future time the capacity of the station can be doubled without in any way interfering with the architectural features or the general scheme. The accompanying illustration from the architects' drawing gives some idea of the size and magnificence of the proposed building.

Messrs. Warren & Wetmore, associated with Reed & Stem, are the architects for the station.

## Erecting a Plate Girder Bridge With a Gin Pole.

BY J. W. PHILIPS.*

One of the most interesting engineering feats in connection with the Lackawanna improvements in Newark, N. J., which were described in the *Railroad Gazette* November 27, 1903, was the erection of the highway bridges over the depressed tracks in the western part of the city. The bridge which carries Roseville avenue over the tracks is a through plate girder bridge with floor beams and stringers, having concrete arches between the stringers which form the foundation for the asphalt roadway. Just east of Roseville avenue the Montclair Branch begins to turn north from the main line and under the bridge the main line is on a 2 deg. 30 min. curve to the left, and the branch line is on a 7 deg. 19 min. curve to the right. A single span was decided upon for the bridge at this point and this called for one girder 66 ft.



Erecting a 37-Ton Plate Girder with a Gin Pole at Newark, N. J.—Delaware, Lackawanna & Western.

*Assistant Engineer, D., L. & W.

2 in. long weighing 28 tons for the east side, and one girder 76 ft. 11 in. long, weighing 37 tons, for the west side. The two girders are spaced 41 ft. center to center, leaving a clear width of roadway of 39 ft.

The tracks in the depression at Roseville avenue are 20 ft. below the crown of the roadway or street level, and as the girders were carried to the site on cars it was necessary to unload and to raise them to this height from the cars standing in the cut. To do this job, a gin pole was designed in the office of Mr. Lincoln Bush, Chief Engineer. It was made up of three sticks of yellow pine, 8 in. x 16 in. x 50 ft. long, giving a total cross-section of 16 in. x 24 in. The three sticks were securely bolted together and the pole was trussed on all four sides with 1¼ in. truss rods. A cross-arm 10 ft. long and projecting out on each side of the pole was attached on top and to this the lifting blocks were fastened.

In raising the girders an endless rope arrangement was used. One end of a 2-in. manilla rope was fastened to one of the winding drums of a 50-ton steam wrecking crane and the other end was fastened to one of the drums of a stationary hoisting engine provided for the purpose. This arrangement made it possible to pull on either end or on both ends simultaneously in raising the girder. Two sets of 35-ton, 3-sheave blocks were used with an extra set of single snatch blocks placed in between to equalize the load. The weight was taken from the girder to the blocks by means of clamps. Two 50-ton clamps weighing 500 lbs. each were fastened to each of the sets of 35-ton blocks and a smaller clamp weighing 150 lbs. was fastened to the snatch block. One set of 3-sheave blocks was also fastened from the top of the gin pole to an anchor west of the bridge so that the pole could be leaned in placing the girder in position. Five sets of guy lines were fastened to the top of the gin pole to keep it in an upright position.

In raising the east or shortest girder, the gin pole could not be placed nearer than 10 ft. from the center line of the final position of the girder on account of the junction of the Montclair Branch with the main line, and this girder was shifted about 10 ft. east after it was raised and placed on the abutments. This shift was made with jacks, the shoes being placed on rollers. The girder was placed on cars on the westbound main line beside the gin pole and the ends were pulled around in position by hand lines.

To raise the largest or west girder the pole was shifted to a position just west of the final position of this girder. The pole was moved to the new position by sliding it along, being kept upright by tightening and slackening off the guy lines. This girder was loaded on two extra long flat cars and the cars were placed on the westbound main line. An extra empty flat car was placed on the Montclair Branch track opposite the flat car on the main line standing farthest to the west. The west end of the girder was shifted by a 50-ton steam wrecking crane from the flat car on the main line to the car standing on the branch track. The empty flat car thus released on the main line was drilled out of the train and the girder was moved up near the gin pole by pulling one end up the Montclair Branch and the other end west on the main line. It was necessary to allow the ends of the girder to swing slightly on their bearings during this operation, but this was accomplished without any trouble. This girder was placed on an exact line east and west when it was lowered, but it had to be moved about two feet north to get it in its final position. This was accomplished by leaning the gin pole. It required 30 minutes to raise the small girder into position and 40 minutes to raise the large girder. The work was done between 11 a.m. and 12 noon, when traffic is very light, and but little delay to regular trains resulted from either operation. Two days elapsed between the raising of the first and second girders. These girders were raised and all the iron work on this improvement is being erected by a gang of journeymen iron workers employed by the Lackawanna Railroad under the direction of W. J. McNeely, General Foreman.

**Erecting a 37-Ton Plate Girder with a Gin Pole at Newark, N. J.—Delaware, Lackawanna & Western.**

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It has been decided to double-track sections of the Siberian Railroad (not the whole road), and $5,000,000 has been appropriated therefor. The Ministry of War and the General in Chief have united in praising the admirable way in which the railroad has been worked and its capacity increased since the war began. When it opened the line could pass only four trains each way daily; now several times as many. Troops and supplies have been forwarded regularly and in sufficient quantities, and at the same time the work of construction vigorously prosecuted.

## Railroad Built in 1904.

*Table Showing Mileage Built in 1904, Classified by States.*

| | No. of Cos. building. | 1904. | No. of Cos. building. | 1903. |
|---|---|---|---|---|
| Alabama | 5 | 110.64 | 4 | 129.39 |
| Alaska | 2 | 15 | 1 | 10 |
| Arizona | 1 | 59.66 | 3 | 107.07 |
| Arkansas | 9 | 142.43 | 14 | 230.77 |
| California | 11 | 191.3 | 8 | 169.55 |
| Colorado | 5 | 139.1 | 6 | 89.07 |
| Florida | 4 | 54.67 | 5 | 53.05 |
| Georgia | 7 | 119 | 11 | 133 |
| Idaho | 1 | 13.39 | .. | .. |
| Illinois | 7 | 162.78 | 6 | 114.3 |
| Indiana | 3 | 39 | 4 | 43.32 |
| Indian Ter. | 4 | 150.49 | 6 | 386.8 |
| Iowa | 2 | 29 | 5 | 229.2 |
| Kansas | 1 | 29 | .. | .. |
| Kentucky | 1 | 20 | 5 | 69.45 |
| Louisiana | 7 | 128.61 | 11 | 389.63 |
| Maine | 2 | 20 | 1 | 6.5 |
| Maryland | 1 | 15.8 | 2 | 12.82 |
| Massachusetts | .. | .. | 1 | 2.37 |
| Michigan | 5 | 21.7 | 13 | 158.68 |
| Minnesota | 2 | 221.49 | 6 | 262.1 |
| Mississippi | 7 | 267.93 | 6 | 116.4 |
| Missouri | 7 | 270.44 | 7 | 236.2 |
| Montana | 2 | 67.29 | 2 | 70.5 |
| Nevada | 2 | 176.50 | 1 | 20 |
| New Jersey | 2 | 7.64 | 1 | 4.84 |
| New Mexico | 2 | 10.62 | 2 | 158 |
| New York | 1 | 2 | 3 | 33.83 |
| North Carolina | 6 | 49.2 | 7 | 94.5 |
| North Dakota | 1 | 32.85 | 4 | 130.57 |
| Ohio | 5 | 83.3 | 9 | 134.19 |
| Okla. Ter. | 4 | 163.22 | 8 | 660.6 |
| Oregon | 1 | 23 | 3 | 21.75 |
| Pennsylvania | 15 | 195.85 | 16 | 286.37 |
| Rhode Island | .. | .. | 1 | 3.4 |
| South Carolina | 3 | 17.3 | 4 | 34 |
| South Dakota | 1 | 20 | 1 | 15.56 |
| Tennessee | 3 | 98.9 | 3 | 114.9 |
| Texas | 9 | 323.28 | 15 | 361.26 |
| Utah | 2 | 10 | 4 | 186.16 |
| Vermont | .. | .. | 1 | 5.25 |
| Virginia | 2 | 12.94 | 3 | 27.42 |
| Washington | 3 | 53.31 | 7 | 111.22 |
| West Virginia | 8 | 174.78 | 9 | 103 |
| Wisconsin | 5 | 81.85 | 6 | 125.48 |
| Wyoming | 1 | 7 | .. | .. |
| Total, U. S. | 172 | 3,832.26 | 235 | 5,652 |
| Canada | 7 | 316.39 | 11 | 687 |
| Mexico | 4 | 115.75 | 5 | 299 |

### UNITED STATES.

#### ALABAMA.

Alabama Central—Booth to Autaugaville. 10.00
Alabama Northern—Pyriton to Ashland. 9.00
Atlanta & Birmingham Air Line (S. A. L.)—Coal City to Birmingham ..... 38.00
Bay Minette & Fort Morgan—Bay Minette South. ..... 10.00
Louisville & Nashville—Turkey C'k branch, Fedora to Indio, 2.95 miles; Hogeland branch, 0.65 mile; Graves branch, 2.62 miles; Boyle's Gap branch, 2.08 miles; Deming branch, 1.73 miles; total. ..... 10.03
North Alabama (L. & N.)—Cain Creek branch ..... 18.05
Oneonta & Attalla (L. & N.)—Altoona to Attalla ..... 15.56
110.64

#### ALASKA.

Alaska Central—Not specified ..... 10.00
Council City & Solomon River—From point 10 miles out of Dickson City to mile-post 15 ..... 5.00
15.00

#### ARIZONA.

Santa Fe, Prescott & Phoenix—Florence to Winkelman, 48.49 miles; Bradshaw Mountain branch, Saddle to Crown King, 6.17 miles; Arizona & California Junction to end of track, 5 miles; total..... 59.66

#### ARKANSAS.

Cache Valley—Sedgwick to Sach ..... 7.00
Chicago, Rock Island & Pacific—De Valls Bluffs to Des Arc ..... 13.80
Cotton Belt & Northern—Onalaska to Pritchard ..... 13.00
3.50
De Queen & Eastern—From end of track towards Murfreesboro ..... 21.00
Freco Valley—Eagle Mills northeast ..... 5.00
Mississippi, Arkansas & Western—Not Specified ..... 8.00
Missouri Pacific—Eldorado to Louisiana and Arkansas State line, 5.37 miles; Cotter to Oregon Flat, 35.27 miles; McGehee to point north, 20 miles; Arkansas & Southwestern connection to point north 3 miles; total ..... 63.64
Perla Northern—Perla to end of track.... 8.00
St. Louis & San Francisco—From point 4 miles out of Big Creek to Evadale..... 12.49
142.43

#### CALIFORNIA.

Boca & Loyalton—Beckwith to 6 miles west 6. miles; spur line, 2 miles; total..... 8.00
Butte County—Parker to Sterling City... 8.50
California Northwestern—Reclamation to Napa ..... 10.00
Holton R. R.—Imperial to Holtville ..... 15.00
Ione & Eastern—Ione towards Amador.... 12.00
McCloud River—McCloud to Barth ..... 15.00
Oakland & East Side (At., T. & S. F. Coast Line)—Richmond to Emeryville..... 11.47
Oregon & Eureka—Camp 13 to Big Lagoon 18.00
Placerville & Lake Tahoe—Placerville to Camino ..... 8.00
San Francisco & Northwestern (A., T. & S. F.)—Camp 9 to Shively..... 2.30
San Pedro, Los Angeles & Salt Lake—From point 40 miles east of Daggett to California-Nevada State line..... 65.50
Southern Pacific—Imperial to Calexico, 12.71 miles; Simi tunnel to New Chatsworth, 4.82 miles; total ..... 17.53
191.30

#### COLORADO.

Colorado & Northwestern—Sunset to Eldorado ..... 20.00
Colorado Springs & Cripple Creek District Ry..... 1.10
Denver, Northwestern & Pacific—Arena to Arrowhead ..... 59.00
Rio Grande R. R.—Pictou to Sunnyside Coal Mines ..... 7.00
Uintah R. R.—Mack to Utah State line ... 52.00
139.10

#### FLORIDA.

Florida East Coast—Nomans to Homestead 18.00
Florida West Shore—Ellenton Junction to Ellenton ..... 1.67
Natural Bridge R. R.—Moody to Wacissa.. 15.00
South Georgia & West Coast—Greenville to Perry ..... 20.00
54.67

#### GEORGIA.

Atlanta & Birmingham Air Line (S. A. L.)—Howells to Rockmart ..... 44.00
Darien & Western—Darien Junction to Liberty City ..... 18.00
Dublin & Southwestern—Rentzville to Eastman. ..... 17.00
Garbutt & Donovan Short Line—Lyons to Selma ..... 14.00
Milltown Air Line—Milltown to Alapaha River, 3 miles; Milltown to Banks Mill, 3 miles; total ..... 6.00
Tallulah Falls—Tiger to Clayton..... 3.00
Wadley & Mt. Vernon—Douglas to Willachoochee ..... 17.00
119.00

#### IDAHO.

Northern Pacific—Thornton to Kootenai.. 13.39

#### ILLINOIS.

Chicago & Eastern Illinois—14 miles southwest Woodland Jct. to Villa Grove, 47.50 miles; completion of Findlay-Pana line 0.42 mile; total ..... 47.92
Chicago, Burlington & Quincy—Fenton to Ebner ..... 14.8
Cleveland, Cincinnati, Chicago & St. Louis—Hillsboro to Lenox..... 43.30
Elgin, Joliet & Eastern—Rockdale to Rockdale Junction ..... 7.00
Illinois Central—Matthews to Sand Ridge 17.26
Illinois, Iowa & Minnesota—Aurora to De Kalb ..... 28.00
Toluca, Marquette & Northern—McNabb Jct. north ..... 4.50
162.78

#### INDIANA.

Cincinnati, Bluffton & Chicago—Pennville to Portland ..... 10.00
Cleveland, Cincinnati, Chicago & St. Louis—Lawrenceburg Junction to Sunman, 18 miles; Greensburg to Gobbs Fork, 6 miles; total ..... 24.00
Southern Indiana—Terre Haute north.... 5.00
39.00

#### INDIAN TERRITORY.

Choctaw, Oklahoma & Gulf (C., R. I. & P.).—From point 7 miles out of Haileyville to Wilburton ..... 9.79
Midland Valley—Bokesha to Tulsa ..... 125.00
Missouri, Kansas & Texas—Spur to M., K. & T. mines. ..... 3.70
Muscogee Union—Muscogee to Corretta.. 12.00
150.49

#### IOWA.

Chicago, Anamosa & Northern—From Anamosa northwest ..... 10.00
Newton & Northwestern—Gowrie to Rockwell City ..... 19.00
29.00

#### KANSAS.

Kansas City, Mexico & Orient—Millton to Wichita ..... 29.00

#### KENTUCKY.

Chesapeake & Ohio—Big Sandy branch, Elkhorn City to Prestonburg ..... 20.00

#### LOUISIANA.

Donaldsonville & Napoleonville (T. & P.)—Donaldsonville to Napoleonville ..... 15.70
Louisiana Railway & Navigation—Irene to Angola, 37 miles; Sarto to Naples, 7 miles; total ..... 44.00
Missouri Pacific—Little Rock & Monroe connection to Farmersville ..... 22.21
Monroe & Southwestern—Monroe towards Winnfield ..... 15.00
Morgan's Louisiana & Texas—Raceland to Lockport ..... 7.70
New Orleans, Natalbany & Natchez—Natalbany to Montpelier ..... 16.00
Tremont & Gulf—Eros to Chatham ..... 8.00
128.61

#### MAINE.

Eustis R. R.—From point on main line of Phillips & Rangeley to lumber section... 15.00
Somerset R. R.—Bingham towards Deadwater ..... 5.00
20.00

#### MARYLAND.

Western Maryland—Big Pool to Hancock 9.70 miles; Wallbrook to Port Covington 6.10 miles; total ..... 15.80

#### MICHIGAN.

Detroit & Mackinac—Last 3 miles into Cheboygan ..... 3.00
Harbor Springs—Extension of Chrystal Springs branch ..... 2.00
Manistique—Diller to Portage ..... 6.00
Munising Ry.—Extension of East branch.. 2.50
Wisconsin & Michigan—Quinnesec to Cundy 1.20 miles; Nathan to the Menominee River, 7.00 miles; total ..... 8.20
21.70

#### MINNESOTA.

Minneapolis, St. Paul & Sault Ste. Marie—Detroit City to Emerson ..... 177.00
Minnesota & Great Northern (Great Northern)—Thief River Falls to Greenbush, 41.1 miles; Forest mine spur, 2.39 miles; Yates mine spur, 1 mile; total..... 44.49
221.49

#### MISSISSIPPI.

Gulf & Ship Island—2 miles north of Shines to Silver Creek ..... 15.13
Illinois Central—Brookhaven to Monticello 40.00
Liberty-White R. R.—McComb to Liberty.. 24.00
Mississippi & Eastern—Quitman to the Alabama State line ..... 20.00
Mobile, Jackson & Kansas City—Stringer to Newton, 39.50 miles; Ellisville Jct. to Ellisville, 6.50 miles; Ackerman to Naxapater, 36 miles; New Albany to Dewey, 51.50; total ..... 133.50
Natchez, Columbia & Mobile—Booneville towards Pearl River ..... 2.50
Yazoo & Mississippi Valley—Belzona to Yazoo City, 21.80 miles; Lambert to Swan Lake, 11.00 miles; total..... 32.80
267.93

#### MISSOURI.

Cape Girardeau & Chester—Cape Girardeau to Jackson ..... 10.00
Chicago, Burlington & Quincy—Old Monroe to Mexico ..... 63.00
Kansas City, Fort Scott & Memphis—Spur to coal mines in Bates County ..... 3.56
Mississippi River & Bonne Terre—Hoffman branch, Bonne Terre to Hoffman, 7.4 miles; Flat River to Federal, 1.6 miles; total ..... 9.00
Missouri Pacific—Carthage to point southeast of Galena..... 67.48
Missouri Southern—Ellington to Tralaloo . 15.00
St. Louis, Kansas City & Colorado—Stover to point near Leeds ..... 102.40
270.44

#### MONTANA.

Great Northern—Whitefish to Rexford..... 59.85
Northern Pacific Bitter Root branch, Charlos to Darby. ..... 7.44
67.29

#### NEVADA.

San Pedro, Los Angeles & Salt Lake—From 20 miles south of Caliente to 18 miles east of California-Nevada State line..... 115.50
Tonopah—Sodaville to Tonopah ..... 61.00
176.50

#### NEW MEXICO.

Atchison, Topeka & Santa Fe—Extension of Hot Springs branch ..... 0.62
Santa Fe Central—Moriarty towards mines 10.00
10.62

#### NEW JERSEY.

Central of New Jersey—West Second St. branch ..... 0.64
Morristown & Erie—Whippany to Essex Fells ..... 7.00
7.64

#### NEW YORK.

Lowville & Beaver River—Lowville to Illingsworth ..... 2.00

#### NORTH CAROLINA.

Aberdeen & Rockfish—Rockfish to Hope Mills ..... 7.00
Bee Tree—Swannanoa to Craggy Mountain 8.00
Durham & Charlotte—Little River to Troy 4.00
Norfolk & Southern—Mackey's Ferry to Plymouth ..... 10.70
Pamlico, Oriental & Western—Newbern to Bayboro ..... 17.50
Suffolk & Carolina—Norfolk & Southern Junction to Elizabeth City..... 2.00
49.20

#### NORTH DAKOTA.

Dakota & Great Northern (Great Northern)—Mohall to Sherwood, 14.85 miles; Edmore towards Munich, 18 miles; total.. 32.85

#### OHIO.

Cincinnati, Findlay & Fort Wayne (C., H. & D.)—Delphos to East Mandale..... 11.50
Lake Erie & Pittsburg—Lorain to Berea.. 13.00
Mahoning Valley Western—Niles to Newton Falls, 14.40 miles; Newton Falls to Ravenna, 13.70 miles; Ravenna to Cuyahoga Falls, 14.70; total ..... 42.80
Newburgh & South Shore—Cleveland to Newburgh ..... 7.00
Wheeling & Lake Erie—Adena branch, Maynard to point south of St. Clairsville.... 9.00
83.30

OKLAHOMA TERRITORY.

| | |
|---|---|
| Arkansas Valley & Western (St. L. & S. F.)—Enid to Avard | 58.47 |
| Choctaw, Oklahoma & Gulf (C., R. I. & P.)—From 20 miles out of Chandler to Guthrie | 10.45 |
| Denver, Enid & Gulf—Enid to Coldwater | 14.00 |
| Missouri, Kansas & Texas—Oklahoma City to Ada | 84.30 |
| | 163.22 |

OREGON.

| | |
|---|---|
| Sumpter Valley—Sumpter to Tipton | 23.00 |

PENNSYLVANIA.

| | |
|---|---|
| Buffalo & Susquehanna—Driftwood to Sykesville | 50.00 |
| Buffalo, Rochester & Pittsburg—Parkwood to Iselin, 10 miles; Indiana to near Black Lick, 11 miles; Newcastle to Cement Works, 7 miles; total | 28.00 |
| Cherry Tree & Dixonville (N. Y. C. & H. R.) Cherry Tree to Possum Glory Jct. | 21.00 |
| Clearfield Southern (N. Y. C. & H. R.)—From point 4 miles from Potts Run to Irvona | 12.30 |
| Curwensville & Bower—Lumber City to Curwensville | 11.60 |
| Hickory Valley—Delight to Queen | 2.00 |
| Huntington & Broad Top Mountain—Kimber Run branch | 1.00 |
| Lehigh & New England—Bath Junction to Bath Port | 1.50 |
| Mt. Jewett, Kinzua & Riterville, | 3.15 |
| Pennsylvania—Brilliant branch, 10 miles; not specified, 23 miles; total | 33.00 |
| Pennsylvania Lines West—Burgettstown to mines, 1.7 miles; Meadowlands to mines, 1.72 miles; Burgettstown to mines, 4.25 miles; total | 7.67 |
| Philadelphia & Reading | 1,63 |
| Pittsburg, Summerville & Clarion—Summerville to Carlon, 15.5 miles; Strattonville, to Mill Creek, 3.5 miles; total | 19.00 |
| Pittsburg, Westmoreland & Somerset—Ligonier towards Somerset | 1.00 |
| Susquehanna & New York—Hillsgrove Junction to Hillsgrove | 2.00 |
| Williamsport & North Branch—Birch Creek Junction to Bernice | 1.00 |
| | 195.85 |

SOUTH CAROLINA.

| | |
|---|---|
| Alcolu R. R.—Hudsons to Beulah | 4.00 |
| Pickens R. R.—Pickens to Easley | 9.30 |
| Ware Shoals—Barmore to Ware Shoals. | 4.00 |
| | 17.30 |

SOUTH DAKOTA.

| | |
|---|---|
| South Dakota Central—Sioux Falls to Colton | 20.00 |

TENNESSEE.

| | |
|---|---|
| Chattanooga & Montlake—Montlake to coal mines | 2.00 |
| Knoxville, La Follette & Jellico—Remainder of line between Knoxville and Saxton not reported in 1903, 63.1 miles; Cow Creek branch, 13 miles; Clear Fork branch, 6.1 miles; Hog Camp branch, 2.9 miles; spurs, 4.3 miles; total | 89.40 |
| Nashville, Chattanooga & St. Louis—From point 3 miles out of Coalmont to Coalmont, 3 miles; line to Eastland, 4.5 miles; total | 7.50 |
| | 98.90 |

TEXAS.

| | |
|---|---|
| Livingston & Southeastern—Livingston to Knoxville | 7.00 |
| Missouri, Kansas & Texas—Austin division, Georgetown to Austin | 30.00 |
| Nacogdoches & Southeastern—Nacogdoches to Woden | 10.50 |
| St. Louis, Brownsville & Mexico—Harlingen to Fordyce, 56.00 miles; Point 20 miles from Robstown to Brownsville, 121.25 miles; total | 177.25 |
| St. Louis Southwestern of Texas—Monterey to end of track | 4.33 |
| San Antonio & Aransas Pass—Alice to Falfurrias | 36.00 |
| Texas & Gulf—Timpson to end of line | 15.00 |
| Trinity & Brazos Valley—Remainder of line between Cleburne and Mexia | 21.00 |
| Wichita Falls & Oklahoma—Wichita Falls to Byers | 22.20 |
| | 323.28 |

UTAH.

| | |
|---|---|
| San Pedro, Los Angeles & Salt Lake—Near Frisco to Newhouse | 7.00 |
| Uintah R.R.—Colorado State line to Dragon | 3.00 |
| | 10.00 |

VIRGINIA.

| | |
|---|---|
| Louisville & Nashville—Mile-post 198 from Louisville to coal property of Bell Jellico Coal Co., 1 mile; Pennington Gap branch Pennington towards coal lands, 3 miles; total | 4.00 |
| Norfolk & Western—Roanoke Belt line, 2.34 miles; Blair to Galax, 3 miles; Radford branch, 3.6 miles; total | 8.94 |
| | 12.94 |

WASHINGTON.

| | |
|---|---|
| Northern Pacific—Peninsula branch, mile-post 22 to Moclips, 5.9 miles; Woodinville to Renton, 16.07 miles; new lines in Seattle, Wash, 1.04 miles; total | 23.01 |
| Tacoma Eastern—Nisyually canyon to Ashford | 16.30 |
| Washington & Great Northern—Curlew to Midway | 14.00 |
| | 53.31 |

WEST VIRGINIA.

| | |
|---|---|
| Chesapeake & Ohio—Raleigh to end of track, 10.6 miles; Thurmond to mines, 4.1 miles; Piney Creek to end of track, 0.8 mile; Durbin to Bartow, 2.2 miles; total | 17.70 |
| Coal & Coke—Otter to Gassaway | 28.20 |
| Deepwater—Robson to Open Fork | 10.00 |
| Imboden & Odell—Blue Creek to Tunnel No. 2 | 10.00 |
| Kanawha, Glen Jean & Western—Thurmond to Kilsyth | 4.00 |
| Morgantown & Kingwood—Bretz to Reedsville | 2.50 |
| Norfolk & Western—Kenova to Naugatuck, 59.12 miles; Iaeger to Ritter, 4.9 miles; Widemouth branch and Spurs from Montcalm down Bluestone River, 19.13 miles; Tug Fork branch extension above Gary, 5.3 miles; Zenith branch extension into McDowell County, 1.33 miles; total | 89.78 |
| Point Pleasant, Buckhannon & Tyarts Valley (B. & O.)—Lemley Junction to Buckhannon | 12.60 |
| | 174.78 |

WISCONSIN.

| | |
|---|---|
| Chicago, St. Paul, Minneapolis & Omaha—Radisson to Winter | 10.00 |
| La Crosse & Southeastern—Viroque to Stoddard | 18.00 |
| Mineral Point & Northern—Mineral Point to Highland | 26.00 |
| Minneapolis, St. Paul & Sault Ste. Marie—Birchwood to Reserve | 18.85 |
| Stanley, Merrill & Phillips—Hannibal to Jump River | 9.00 |
| | 81.85 |

WYOMING.

| | |
|---|---|
| Laramie, Hahn's Peak & Pacific—Laramie west | 7.00 |

CANADA.

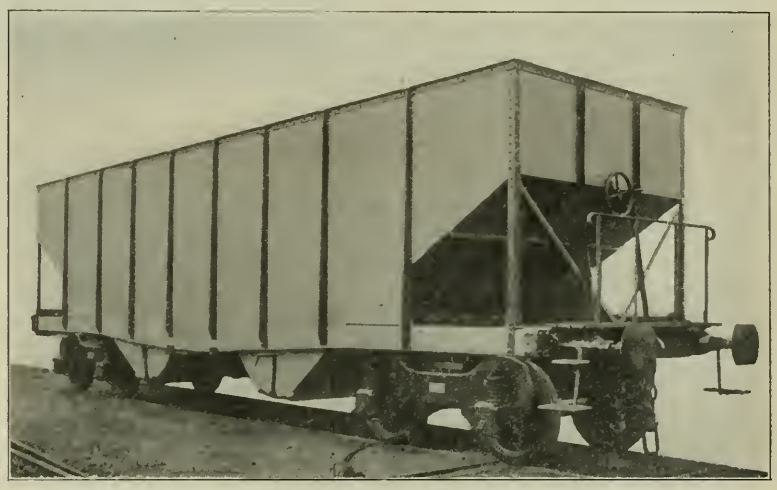
| | |
|---|---|
| Algoma Central & Hudson Bay—Mekatina branch, mile-post 64 to mile-post 66 | 2.00 |
| Canadian Northern—St. Charles to Somerset, 77.00 miles; Emerson line, 22.00 miles; Rossburn Jct. towards Rossburn, 80.00; total | 179.00 |
| Canadian Pacific—Esterhazy to Lipton | 84.00 |
| Crow's Nest Southern (Great Northern)—Swinton, B. C., to Fernie | 9.82 |
| Galt, Preston & Hespeler—Berlin to Waterloo | 2.00 |
| Orford Mountain—Eastman, Que., to Potton Springs, 12.00 miles; Kingsbury, Que., towards Winsor, 2.00 miles; total | 14.00 |
| Quebec & Lake St. John—St. Gabriel towards Gosford | 4.00 |
| Vancouver, Victoria & Eastern Railway & Navigation (Great Northern)—Grand Forks, B. C., to Granby Smelter, 4.57 miles; Grand Forks to Phoenix, 17 miles; total | 21.57 |
| | 316.39 |

MEXICO.

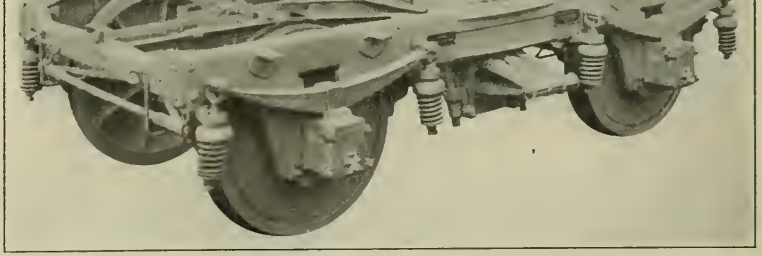
| | |
|---|---|
| Mexican Central—Remainder of line between San Pedro and Paredon | 43.00 |
| Mexican International—Mezquite to Carbon | 3.75 |
| Nacozari—Cos to Nacozari | 20.00 |
| National of Mexico—From San Juan east towards San Miguel, 20 miles; Salamanca to Gonzalez, 29 miles; total | 49.00 |
| | 115.75 |

## Fifty-ton Cars in France.

The Douai Iron Works has recently built a number of 50-ton pressed steel cars for mineral traffic which have an exceptionally light tare weight. The hopper cars, one of which is shown in one of the illustrations,



50-Ton Pressed Steel Hopper Coal Car for the Carmaux Mines.



Arbel Pressed Steel Truck, Douai Iron Works.

were built under the Fox-Arbel patents with pressed steel fish-bellied sills and double hopper doors discharging toward the center of the car. They are mounted on Fox pressed steel trucks and will be used in the coal traffic from the Carmaux mines. The body is 34 ft. 9¼ in. long inside and 8 ft. 7½ in. wide inside, and has a cubic capacity, with the load heaped to 50 deg., of 2,048 cu. ft. The maximum load which can be carried is 110,000 lbs., and the tare weight is 34,300 lbs., giving a ratio of dead load to paying load of 1:3.2. The truck journals are 5½ in. x 9¾ in., or slightly smaller than those used in the United States for cars of equal capacity.

Another type of 50-ton car which has also been built is a gondola with two doors in each side. Like the hopper cars, these cars are entirely of pressed steel, but they are

mounted on Arbel trucks with half-elliptic springs hung over each box on the outside of the frame. They were built for the Southern Railway of France and are in use between the ore mines of the Pyrenees and Cette, carrying iron ore to the Creusot Steel Works. The cars are 34 ft. 9½ in. long, 3 ft. 3¼ in. high, and 8 ft. 7½ in. wide, inside measurements. This gives a cubic capacity with a flush load of 996 cu. ft. so that 33 tons of coal, or 55 tons of ore, can be carried. The tare weight is 33,880 lbs., and the ratio of dead load to paying load is 1:3.24. One of these cars was tested with a load of 90 tons without showing any permanent set or other damage.

The Douai Iron Works is now installing some new presses for forming pressed steel sills up to 65 ft. long and expects to build in the future cars of even larger size and capacity than those which have just been turned out.

Station at Petoskey, Mich.

### Passenger Stations on the Grand Rapids & Indiana.

A few weeks ago we printed descriptions of some passenger stations of the Duluth, South Shore & Atlantic (Nov. 25, page 583). These stations had been favorably commented on in the report of the Railroad Improvement Committee of the American Park and Outdoor Art Association at the St. Louis convention. Some other stations receiving equally favorable mention were a number recently built by the Grand Rapids & Indiana. With one exception—the Union Station at Grand Rapids—these are small city stations, the accompanying views, plans and descriptive notes of which were sent by courtesy of Mr. W. B. Stimson, Superintendent at Grand Rapids. This road, in replacing its old buildings, has not only sought to plan the interiors to subserve best the public's as well as its own interests, but with a view of presenting a pleasing and attractive exterior. Special attention was given to beautifying the grounds, the work having been planned and executed by an experienced landscape architect.

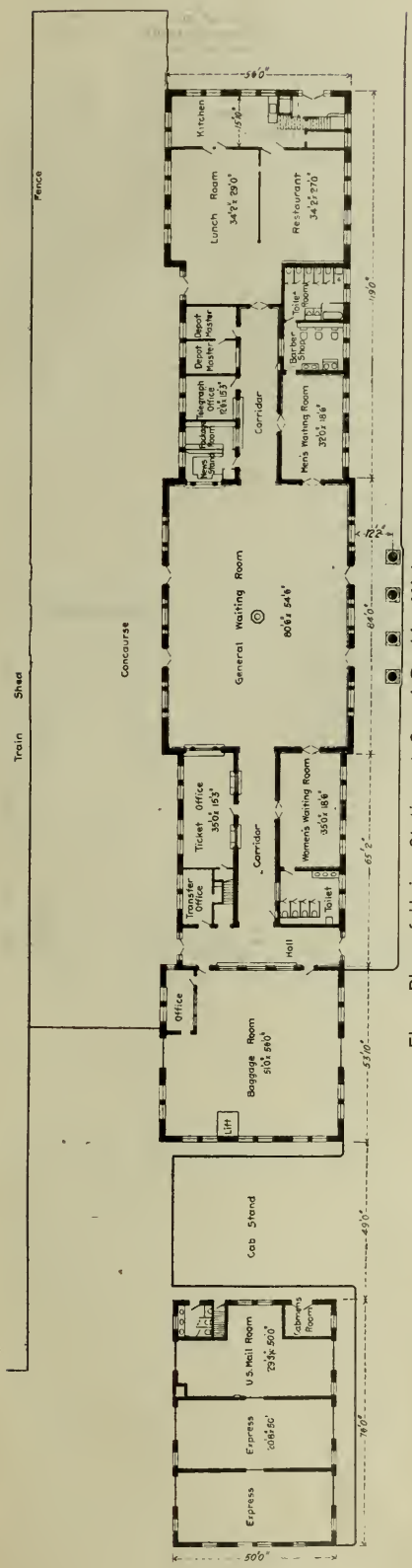
The station at Grand Rapids was completed in December, 1900. It is of brick and terra cotta with a slate roof. The building is 323 ft. long, 56 ft. wide and two stories high, with a central clock tower. Covered ways extend over the sidewalk at the front, and in the rear connect the station with the train shed. At the south end is a covered carriage stand separating the main building from the annex containing the mail and express rooms. The main waiting room is 80.6 ft. by 54.6 ft., and is two stories high. The interior arrangement is shown by the floor plan. The main waiting room is in the center, its sides being flanked by the women's retiring room, smoking, dining, lunch, parcel and news rooms, barber shop, baggage room and telegraph and ticket offices. The interior walls for two-thirds of their height are wainscoted with Tiffany white enamel brick, above which a yellow decorative brick is used. The ceiling is of plaster and stucco. The second story is fitted up for offices, and reading and bath rooms for the use of employees. The train-shed is a "through" shed, erected in 1890, having steel columns with arch trusses supporting a slate roof. It is 600 ft. long by 137½ ft. wide, containing seven tracks. Large and attractive lawns have been laid out north and south of the station building.

Station at La Grange, Ind.

The Cadillac station, built in 1900, is of brick with brown stone trimmings and a slate roof. A floor plan shows the interior arrangement with separate men's and women's waiting rooms, a rest room for women, smoking room for men, dining room, and the ticket and telegraph office and baggage room conveniently located. All of the interior walls have a 5-ft. wainscoting of white enamel brick, and the floors are mosaic tile except the baggage room, which is maple. In the second story there are reading, rest and bath rooms for employees.

Petoskey has an attractive little station

Station at Decatur, Ind.




Floor Plan of Union Station at Grand Rapids, Mich.

Exterior of Station at Cadillac, Mich.

Interior of Union Station at Grand Rapids, Mich.

Frame Station at Mendon, Mich.

of brick with stone trimmings and slate roof. Extending along the front of the building and for a considerable distance beyond each end, adjacent to the tracks, is a canopy shed. The platform surrounding the station is of paving brick. On the interior, the main, or men's waiting room, occupies the center of the building and is 50 ft. by 30 ft. The women's waiting room, 20 ft. x 20 ft., and the toilet rooms, flank it on one side, and the baggage room, 24 ft. x 30 ft., with the telegraph office, 6 ft. x 12 ft., in one corner, on the other. The ticket office is on the opposite side of the main waiting room from the tracks. The waiting rooms are finished with tutti calori floors, high ivory enamel brick wainscots, and plaster walls and ceilings.

One block south of this building is the suburban station, a frame structure used during the summer in handling the heavy suburban travel between Petoskey and Harbor Springs, and the resorts along Little Traverse Bay, Oden and Walloon Lakes. The company has laid out and beautified with trees, flower beds, and walks, parks extending south two blocks from its station along the west side of its tracks, and on the opposite side of its track extending south one block from its suburban station. It has also made into a lawn its right-of-way from Petoskey to Bay View (one mile).

The three stations just described are the ones to which reference was made in the report. The views sent us include several neat and attractive little stations at small towns in Indiana and Michigan, and are shown herewith. The Decatur, Ind., station was built last year. It is red brick with Bedford stone trimmings and slate roof. The interior has a maple floor and yellow pine wainscoting except the women's sitting room and the smoking and toilet rooms, which have tile floors and enamel tile wainscoting. The station at La Grange, Ind., was built in 1901. It is frame, with shingle roof, and the interior is celled with yellow pine, except the toilet rooms, which have a cement wainscot. All of the floors are cement. The Mendon, Mich., station is for freight and passenger service, and was built about three years ago. The interior is ceiled with light-colored wood.

## The Strength of Structural Timber.

Circular 32 of the Bureau of Forestry of the Department of Agriculture is issued under the title "Progress Report on the Strength of Structural Timber." It was prepared by Dr. W. Kendrick Hatt, Civil Engineer in the Bureau of Forestry, in response to a demand from lumber operators, engineers and architects for the partial results of the tests now being carried on by the bureau to determine the mechanical properties of the various commercial timbers of the United States. The circular contains, among other things, the results of cross-bending tests on about 250 large beams of structural timber. A more formal publication is to be issued later, giving a detailed account of methods and machines used to obtain the results, tabulating the individual tests and analyzing thoroughly the results. The data already on hand will allow the formulation of certain relations between the knots and strength, and between the rate of growth and strength, and will form the basis for an intelligent revision of the present rules for the inspection and grading of timber.

According to the circular, the bureau has limited its present programme (1) to those species that promise to be on the market for an indefinite period; (2) to actual market products, and (3) to such purely scientific work as forms the basis for correct methods of test. The programme also includes tests to determine the effect of artificial seasoning, such as is used in the operations preliminary to the preserving processes, and the effect of the presence of the preservatives themselves. One object of the tests is to aid in the framing of definite inspection rules for the various grades of structural timber.

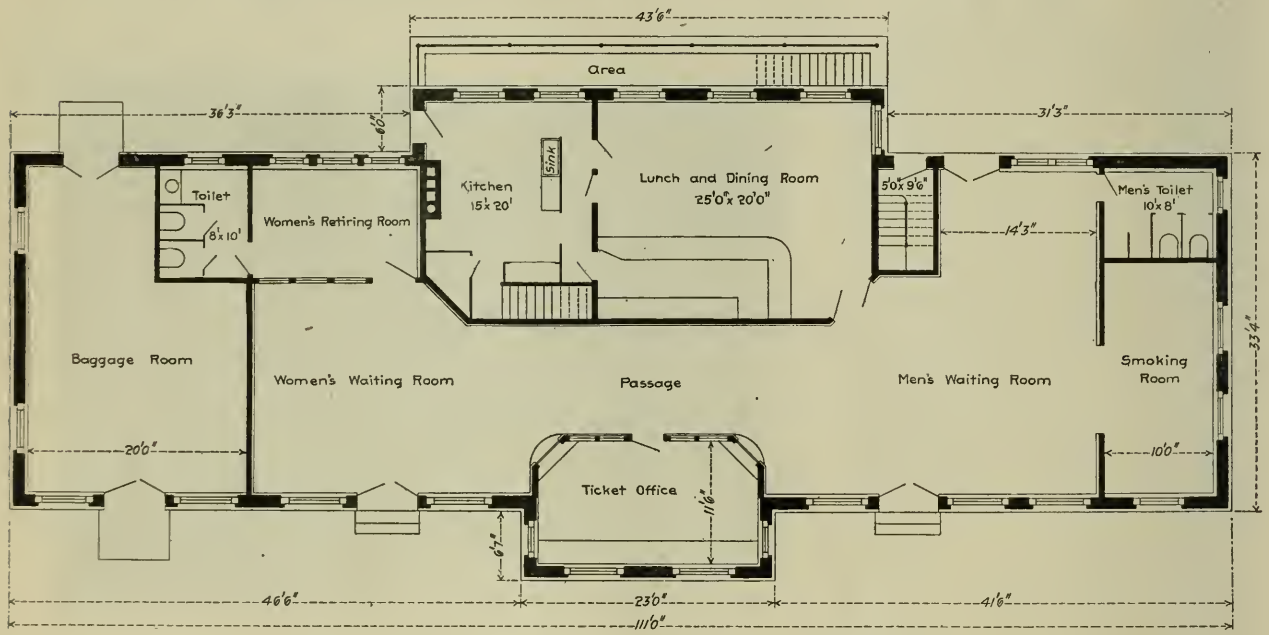
Following is the programme of the work as at present planned:

Tests to determine properties of structural timber:
- Series I. Tests of the mechanical and physical properties of timber in forms found on the market. The material will be of actual sizes and grades of commercial products. The purpose is to determine moduli for design; to determine the value of woods now considered inferior, to determine the liability to knots, and the reducing factors due to these; to arrange a table of standard weights, and rules for inspection and grading; and partly to compare the properties of species from different regions.

Tests to determine the effect of variations in conditions:
- Series II. Effect of rate of application of load, including impact tests.
- Series III. Effect of moisture.

Studies of the effect of technological processes:
- Series IV. Preservatives.
- Series V. Methods of seasoning.
- Series VI. Fire retardants.

In Series I, for instance, the structural value of loblolly pine and of the Pacific Coast timbers will be fully determined. These species are tested in the form of large sticks, such as bridge stringers, in which knots, crooked grain and other defects that occur in structural sticks, are present. The origin of the sticks and their condition of seasoning are carefully described. Photographs of the stick are taken and drawings made, locating all the knots and showing the amount of heart, sap, wane, etc. The sticks are graded by an experienced lumber inspector. The analysis of the tests of a large number of sticks will serve to determine relations between strength and kind and number of knots, and between strength and rate of growth.




Floor Plan of Grand Rapids & Indiana Station at Cadillac, Mich.

In an investigation of a wood like red gum (*Liquidambar styraciflua*) the tests include not only building material, such as floor joists, but also an examination of the merits of the wood in the form of small clear stock, such as is used for carriage construction, implements, etc. The ability of the wood to withstand the operations of steaming and bending is also investigated. In the case of this timber, the tests have been made on specimens taken directly from the forest.

It is the intention to test structural timber generally in the green state. Certain sticks will be set aside for the length of time necessary for a thorough drying, in order to develop the defects arising during seasoning.

The question of the distribution of moisture in the large sticks and the relative strength of green lumber and lumber that has been only partially dried on the surface will be taken up. It is apparent that lumber dealers do not keep large sticks on hand long enough to allow them to dry out thoroughly, and it does not seem at the present time that the surface dryness in-

creases the strength of these large sticks in any marked degree.

The species under investigation at the present time are: The Pacific Coast red fir (*Pseudotsuga taxifolia*), otherwise called Oregon pine or Douglas spruce; the western hemlock (*Tsuga heterophylla*); the red gum (*Liquidambar styraciflua*); the longleaf pine (*Pinus palustris*); and the loblolly pine (*Pinus taeda*). Later on, the redwood (*Sequoia sempervirens*) and western yellow pine (*Pinus ponderosa*) will be tested.

Tests of the loblolly and longleaf pines, of red fir and of western hemlock are given in considerable detail in the circular. The localities in which the timbers are found, their characteristics, uses to which adapted, etc., are described, and there are a number of tables giving the results of tests on different specimens of each variety. It will be possible only to indicate a few of these results here.

Sticks of green Virginia loblolly pine 8 in. x 8 in. were tested about a month after cutting, developing a modulus of rupture of 3,281 lbs. per sq. in., a modulus of elasticity of 729,000 lbs. per sq. in., the dry weight per cubic foot being 26.3 lbs. Some air-dried sticks—8 in. x 8 in., dried two years; 4 in. x 8 in., dried one year—show higher figures. The former was: modulus of rupture 4,874 lbs., modulus of elasticity 1,164,000 lbs., dry weight per cubic foot, 28.8 lbs. The 4 in. x 8 in. was of denser structure and slower growth. The modulus of rupture was 6,319 lbs., modulus of elasticity, 1,219,000 lbs., and dry weight per cubic foot, 29.4 lbs. Part of the 4 in. x 8 in. stuff was soaked to bring it to the green state, in order to obtain the relations between air-dry and green timber. The moisture was increased from 19.4 per cent. to 46.3 per cent. The modulus of rupture of the soaked timber was decreased about 20 per cent., and the modulus of elasticity about 2 per cent.

The distribution of moisture in some 8 in. x 14 in. North Carolina sticks was determined by sawing out a section 1 in. thick halfway between the ends, dividing it into nine parts by cutting lengthwise and crosswise at the quarter points, and determining the moisture in the several parts. The average shown by a diagram presented is 31.7 per cent., with 39.6 per cent. in the center section and an average of 29.9 per cent. in the four corner sections.

In regard to longleaf pine, it is stated that its tendency to check upon drying out and to fail by longitudinal shear was very noticeable in the tests. This is one reason for the belief that the engineer is not justified in using unit stresses larger than those obtained by tests upon green timber. The modulus of rupture of the Georgia longleaf was 8,384 lbs., the modulus of elasticity 1,820,000 lbs., and the dry weight per cubic foot, 42.9 lbs.

In the case of both longleaf and loblolly pine, small sticks were sawed from the uninjured portion of the large sticks after testing. Further tests were made on these small sticks to determine the relation between the strength of the large and the small sticks, the relative strength of pieces of various rates of growth, and the effect of moisture when the variations due to knots and defects were eliminated. These minor tests were also made on sticks cut from red fir and western hemlock, as noted below. One of the tables shows a comparison of these tests on the smaller sticks sawed from the larger sticks with the tests on the large sticks. It appears from this table that the modulus of rupture of small clear sticks 2 in. x 2 in. in cross section is on an average about 30 per cent. higher than that of the sticks from which they were cut. This increase varies from 100 per cent. to 2 per cent. The modulus of elasticity, however, of small beams is only 92 per cent. of that of the large beams. These values are based on a comparison of the average results of tests of sticks of various grades. Of course, the small clear sticks are relatively stronger than the parent sticks when the latter are of second grade—that is, contain large knots.

The red fir of the Pacific Coast is declared to be an ideal structural timber because of the possibility of procuring long and large pieces, combined with the exceptional strength and stiffness of the material compared with its weight. Being almost entirely heartwood, the red fir is durable on exposure to the weather. It is evident from the tabular results that red fir is of varied quality, and that specifications need to be drawn somewhat more carefully than in the case of longleaf pine to exclude the wider-ringed quick growth and knotty sticks. Certain sticks 6 in. x 8 in. and 8 in. x 16 in. are taken as representing an average quality of red fir, and including select, merchantable, and seconds, it appears that the modulus of rupture is 7,790 lbs. per sq. in., the modulus of elasticity 1,783,000 lbs. per sq. in., and the dry weight per cubic foot 28.5 lbs. The average rate of growth was nearly 19 rings per inch; that is to say, the tree added 1 in. to its radius, or 2 in. to its diameter, in 19 years. It does not appear from the results of the tests that there is any marked difference in the strength of fir of red and yellow color, provided the sticks have the same rate of growth and are equally free from defects. A series of tests on small clear sticks of straight grain indicates that a rate of growth corresponding to 21 rings per inch yields the greatest density and strength.

These red fir sticks were tested from six months to one year from the time of sawing. They were kept in a shed and sprinkled to prevent dying out. The exterior parts of the beams contained less moisture than the center, but the difference was not marked. An examination of the distribution of the moisture throughout the cross-section of six 8 in. x 16 in. beams showed an average of 23.9 per cent., the relations being shown by a diagram, as with the pine.

Western hemlock, as such, has no market standing, but large quantities of the timber are cut and sold under such names as Alaska pine, Washington pine spruce, or fir. There is a strong prejudice against the name of hemlock, which is merited only by the eastern species. The wood of the mature western hemlock is hard, straight and even-grained. It does not split readily and is light to the touch, making it especially suitable for box manufacture. For flooring, molding, paneling and all inside finish it makes a superior lumber, not easily scratched, susceptible of a high polish, and of excellent wearing qualities. The average of results so far obtained, though incomplete, shows a modulus of rupture of 5,530 lbs., a modulus of elasticity of 1,261,000 lbs., and a dry weight per cubic foot of 26.8 lbs.

Some discussion of the results of the tests in general is next given, including a summary of the first table showing the cross-bending strength of structural timber. Other results briefly discussed are: Strength and compression, longitudinal shear, and shearing strength.

One of the tables gives the results of tests of red gum (also known as sweet gum and star-leaved gum). These tests were on 4 in. x 4 in. sticks only, and included cross-bending and compression parallel to the fiber. Further tests were to be made and an analysis of the results will attempt a determination of the relative strength of the fiber throughout the height of the tree, and of the relative strength from the heart center to the bark. The specimens tested were of two kinds, namely, green and partially kiln-dried. For the former the test pieces were kept at the moisture of green timber by a cover of sacking, which was sprinkled day by day. Each test piece was put in a moist closet for two days preceding the actual test. As timber has to dry to a degree of moisture below 33 per cent. before any subsequent drying begins to affect the strength of the fiber, and the average moisture of these green specimens was 86.4 per cent., the values given are those for green timber. The partially kiln-dried material was the result of an attempt to dry some of these 4 in. x 4 in. gum sticks in a kiln without subsequent air drying. The kiln drying consisted of the following operations: The sticks were steamed for 48 hours with live steam, producing a temperature in the kiln of 110 deg. to 125 deg. F. The steam was then shut off, and the kiln heated for 35 days to a temperature varying from 85 deg. F. on the first few days to 150 deg. and 160 deg. F. at the last. Checking and twisting were most noticeable during the first four or five days in the kiln, after which no large increase was observed. It was noticed upon removal from the kiln that the surfaces of all the timber were apparently dry, having the convex surface peculiar to kiln-dried timber. Upon cutting into the pieces it was found that the heartwood had dried only to a depth of ¾ in. The sapwood had dried from a depth of 1¼ in. to thorough dryness. Subsequent kiln-drying tests on 2 in. x 2 in. red gum heartwood stock have shown satisfactory results. In the latter case a much slower and drier heat was given the specimens, which were afterwards steamed and bent into the carriage-wood stock.

To determine the effect of close piling on green wood, 34 specimens of heartwood and 22 specimens of sapwood were close-piled in a green condition in the laboratory and allowed to remain for six months, developing sap-stain and fungus growth. These specimens were afterwards tested. The results of the tests on this "blued" (sap-stained) timber are compared in a table with the results of the tests given in the table mentioned in the preceding paragraph. As has been shown in previous tests with pine, both in Germany and in the United States, the effect of this "bluing" is not detrimental to the strength of the timber.

Another series of tests, recorded in tabular form, compares hickory and red gum, the tests being made in order to determine if red gum had the mechanical properties which would fit it for use in the vehicle industry. An appendix to the report contains some notes on Table I, rules for inspection and grading, and a detailed description of the various beams tested.

## The Panama Canal—Mr. Wallace's Plans.

John F. Wallace, Chief Engineer of the Panama Canal, recently made a report of some length to the House Committee on Interstate and Foreign Commerce, in which he discussed the general situation and also outlined the several plans now under consideration, taking up more fully some of the matters touched on in his Chicago speech, last September (*Railroad Gazette*, Oct. 7, 1904). The following extract is taken from an Associated Press despatch in the New York *Tribune*.

The isthmus is traversed by a mountain range, the summit of which is approximately 12 miles from the Pacific and 35 miles from the Caribbean. Originally a gorge evidently existed from the Caribbean near Colon to

near Gamboa, and extended beyond that point in an easterly direction, forming the upper basin of the Chagres River. After filling this gorge with an alluvial deposit, the Chagres has swung itself from one side of the valley to the other. The result is that the thread of the original gorge cannot be followed or found from surface indications, and it is only by drilling to bedrock that exact information in regard to any particular locality can be obtained. The presence of boulders in this alluvial deposit also explains the reason why engineers not taking time to go into the rock far enough to determine its actual character have been misled into thinking they had struck bedrock. To determine the most feasible plan for the construction of the canal will require a most careful and comprehensive examination not only of surface conditions, but of the subsurface.

After following the valley of the Chagres to Gamboa, the line of the canal follows a tributary, called the Obispo, up to the summit of Culebra, and thence down the valley of the Rio Grande into the Bay of Panama. The summit at Culebra was originally about 300 ft. above the sea level, and is the lowest point in the divide along the entire length of the Isthmus of Panama. The plan of the former commission provided for a dam of practically 100 ft. in height, above sea level, at Bohio, with a water level of 90 ft. above sea level. This place was selected on account of the fact that at that point the hills on either side of the Chagres come comparatively close together, being about 1,500 ft. apart, and from the surface indications it seemed a favorable place to build a dam. But the indications are that this locality will be an unfavorable and expensive one for the construction of a high dam.

*Four Plans Considered.*

The first plan to be considered, the one estimated upon by the former commission, is the possibility and practicability of a high dam, or proper foundation for a high dam at Bohio, on which depends the advisability of constructing a high level canal, with the surface of the water 90 ft. above sea level.

The second plan under consideration is a summit level of 60 ft. above sea level. Constructing a canal on this plan admits of two different methods of treatment. First, by building a dam 60 ft. above sea level, at Bohio, with two locks of 30 ft., there being two locks on the western slope; second, by building a dam 60 ft. above sea level, at Gatun, eight miles from Colon, with two 30-ft. locks in the same neighborhood. The adoption of a 60-ft. level also will render it necessary to build a dam at Gamboa, in order to provide a reservoir to accumulate water enough in the wet season to furnish water for the summit level of the canal. A dam at Gamboa, in connection with this, would also control the Chagres River, except that it would be necessary to provide a safety spillway by the construction of a tunnel some eight miles in length through the divide, discharging the surplus waters of the Chagres into the headwaters of the Juan Diaz, or the alternative plan of constructing a tunnel four miles long through the divide, separating the Chagres basin from the headwaters of the Gatuncillo, a stream which enters into the Chagres Valley at Batun. Should this latter course be adopted, it would be necessary to construct an auxiliary channel for the Chagres from Gatun to the sea, in order to divert its flood waters into the bay eastward of Colon.

The third general plan under consideration would be the construction of a canal, with a 20-ft. or 30-ft. level, above the sea, with a single lock at Miraflores and a single lock at Bohio, or in the immediate neighborhood; the construction of the Gamboa dam to be required in this instance the same as in the 60-ft. level plan.

The fourth plan would be the construction of a sea level canal, with a tidal lock, at Miraflores. In this connection it is necessary to explain that, while the mean sea level of the Pacific and the Caribbean is the same, high tide in the Bay of Panama rises 10 ft. above mean sea level and falls 10 ft. below; whereas the fluctuation of the tide of the Caribbean at Colon is less than two feet. The construction of a dam at Gamboa, with the necessary spillways, as noted in the previous plan, would be the same under the sea level plan as under the 30 or 60-ft. level.

The construction of the Gamboa dam would provide the water supply for the entire line of the canal, including the cities of Panama and Colon. It would also provide a power plant for the generation of electric power sufficient to furnish ample power for the operation of the Panama Railroad and for the operation of any machinery that might be used in the construction of the canal.

It would require two years to build this dam, and, roughly estimated, its cost, including spillways, would be between $15,000,000 and $16,000,000, not including the power plant.

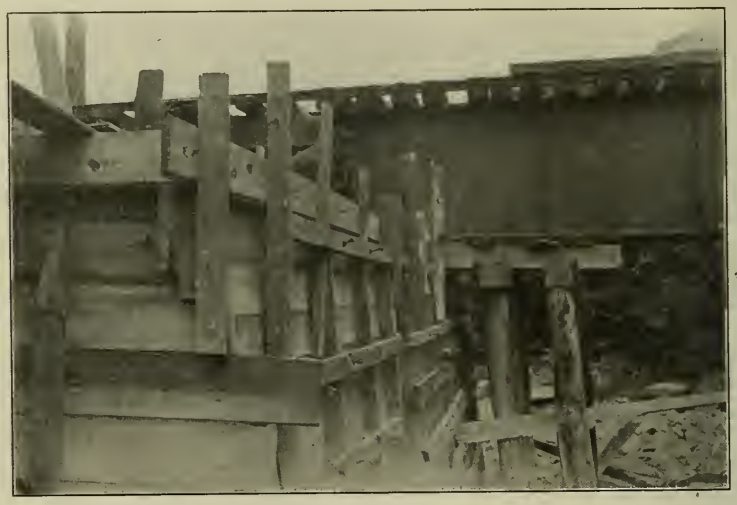
*Cost, Under Each Plan.*

Using as a basis the estimate of the former commission that a 90-ft. level canal would cost 200 millions, Mr. Wallace estimates that a 60-ft. level canal would cost 225 millions and could be completed and open for traffic in 12 years; a 30-ft.-level would cost 250 millions, to be open for traffic in 12 years, and fully completed in 15, while a sea-level canal would cost 300 millions, and could be open for traffic in 15 years and completed in 20 years. Mr. Wallace believes that the cost and the time required to complete the canal will depend on the economical and efficient handling of the material from the Culebra cut, and that every other question and problem connected with the entire work is subordinate to this. The control of the Chagres, the construction of the dams and harbor improvements and all other works are relatively less important. He points out that a sea level canal would be less expensive to maintain, less expensive to operate, save time in passage through it, and could be widened and deepened, when required, without interfering with traffic.

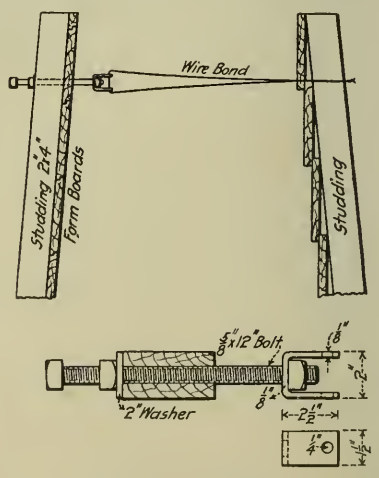
## Tie for Concrete Forms.

BY M. H. M'GEE.*

The accompanying illustrations show the details and application of a simple form of tie for concrete forms for bridge piers and abutments which has been successfully used on the Ulster & Delaware for some time. It can be used at any point on the form regardless of the thickness of the concrete, is cheap, easily applied and removed. It consists of a ⅝-in. x 12-in. bolt, threaded for its entire length, a small wrought iron U-shaped stirrup, two nuts and some strong wire. The bolt is passed through a hole bored in the studding to which the form boards are nailed after a nut and washer have been run up under the head. The U-shaped stirrup is slipped over the end of the bolt projecting on the inside of the form, and the other nut is run up to hold the stirrup on. The wire bond is run through holes in the ends of the stirrup and carried across the form, through the boards, and is twisted around the studding on the other side. After the wire is fastened the nut on the outside of the studding is turned up and the bond drawn taut. When the work is completed and the forms removed the bolt itself is turned out of the nut holding on the stirrup and is pulled out of the concrete. The stir-



Concrete Form for Bridge Pier with Wire Bonds.




Details of Wire Bond.

*Assistant Engineer, Ulster & Delaware.

rup, nut and wire bond remain in the concrete, but the removal of the bolt leaves only a small hole in the surface 5/8 in. in diameter which can be neatly plugged up with cement mortar. It has been found preferable in practice to pass the bolt through a trimmer on the outside of the studding rather than through the studding itself because when holes are bored in the studs it weakens them. When the holes are put through the trimmers all of the parts of the form can be used over and over again. As far as the writer is aware this tie is original and has not been used on any other railroad or structural work. It is not patented.

## Rock Island Motive Power Committee Report.

The committee appointed some time ago by the Rock Island to report on motive power matters has recently completed its work. The committee consisted of F. J. Cole, C. A. Seley and Robert Rennie. Through the courtesy of Mr. Robert Mather, President of the Rock Island Company, to whom the report was addressed, we are enabled to give a rather liberal extract from the recommendations and suggestions of the committee.

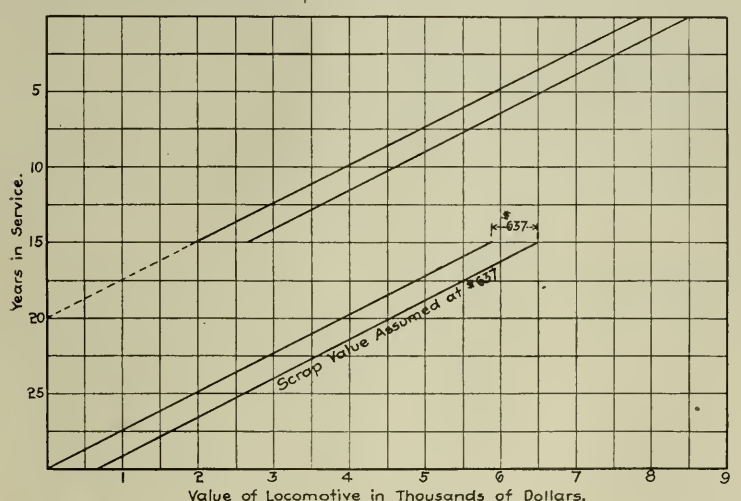
The report is divided into seven sections. The first section deals chiefly with the question of depreciation of motive power. It has been assumed that the average life of a locomotive is about 20 years. In general, it is not economical to continue to repair and keep in service old, light engines after their natural life. It is possible, however, that there may be a demand for light power, and on the Rock Island such a demand is likely to continue for several years. It thus becomes necessary to retain some of the light engines in service so as not to have a serious shortage of power. It is not desirable, however, to buy any more light engines, it being better to shift light engines from other parts of the road. Every expedient should be resorted to rather than buy new light engines. Only heavy engines should be purchased and added to the present power.

When the machinery, cylinders, frames, wheels, etc., of a locomotive are in good condition, it will be economical in some cases to renew the boilers and fire-boxes of light engines, provided the expenditure is based on some predetermined percentage of the original cost. This practice can be carried too far, however; as, for example, some roads spend 50 to 60 per cent. of the original cost of a locomotive for repairs. Furthermore, boilers having greater heating surfaces and higher steam pressures are often applied to engines having light machinery, etc., thus overstraining the bearings and other parts and ultimately causing failure in service. While such practice may temporarily improve the efficiency of a locomotive, the cost of repairs per running mile is much increased. In scrapping small switch engines careful consideration should be given to the fact that the mileage is low and hence the demands on the boiler are small. Table 1 gives the cost of repairs which should be allowed on certain light locomotives when both 20 and 25 years old and over.

*Table 1.*

| Class. | Repairs when over— 20 years. | 25 years. | Average cost of class. | Repairs allowed,— 20 yrs.old. | 25 yrs. old. |
|---|---|---|---|---|---|
| 8-wheel: | | | | | |
| 15-in. | | 5% | $7,000 | .... | $350 |
| 16-in. | | 5% | 8,000 | .... | 400 |
| 17-in. | 10% | 5% | 9,000 | $900 | 450 |
| 10-wheel: | | | | | |
| 16-in. | | 5% | 8,500 | .... | 425 |
| 17-in. | | 10% | 9,200 | .... | 920 |
| 18-in. | | 10% | 10,000 | .... | 1,000 |
| 4-whl. switcher: | | | | | |
| 15-in. | 10% | 5% | 6,000 | 600 | 300 |
| 16-in. | 10% | 5% | 6,500 | 650 | 325 |
| 6-whl. switcher: | | | | | |
| 15-in. | | 5% | 6,500 | .... | 325 |
| 16-in. | | 5% | 7,000 | .... | 350 |
| 17-in. | | 10% | 7,500 | .... | 750 |
| 18-in. | | 10% | 8,000 | .... | 800 |
| Mogul: | | | | | |
| 17-in. | 10% | 5% | 8,000 | 800 | 400 |
| 18-in. | 10% | 5% | 9,000 | 900 | 450 |

In Table 1 the amount allowed for repairs and the extension of the age limit are due to the demand for light power which still exists on the road.




Depreciation of a Locomotive.
*First Cost Assumed at* $8,500.

The accompanying diagram shows the assumed depreciation of a locomotive from 1 to 30 years old, the original value being taken at $8,500 and the scrap value at $637. The effect of renewing the boiler after the engine is 15 years old is shown graphically, the effect being to prolong the natural life of the locomotive from 20 years to 30 years.

The second section of the report deals with the question of distribution of power to secure the segregation of engines of similar character in order to reduce the number of parts which must be carried in stock and to reduce the cost of repairs. The committee is of the opinion that the motive power officers can bring together some classes of engines which are now scattered. Attention is also called to the economies to be effected by the standardization of repair parts.

The next section of the report deals with changes in design of locomotives in order to increase their capacity and usefulness or prolong their life. The committee finds that the engines now in use are being worked close to their capacity, tonnage rating being largely responsible for this. Particular attention is called to benefits to be derived by purifying water in special plants for softening and settling. The removal of a large percentage of the solid matter in the water before it is delivered to the locomotive tenders is one of the most efficient means of increasing the usefulness of the power. A large portion of boiler repairs could be thus diminished. The efficiency of locomotives could also be increased, due to the absence of scale on the heating surfaces.

The fourth section of the report gives proposed standard types of locomotives which should be used in the future. This portion of the report goes considerably into detail, but for the purposes of this article only the general dimensions of the several types will be given, as follows:

*Heavy Consolidation Locomotive.*

| | |
|---|---|
| Cylinders, in. | 22x30 |
| Drivers, in. | 57 |
| Weight on drivers, lbs. | 180,000 |
| Total weight, lbs. | 200,000 |
| Steam pressure, lbs. per sq. in. | 185 |
| Tractive force, lbs. | 40,000 |

*Medium-Weight Consolidation Locomotive.*

| | |
|---|---|
| Cylinders, in. | 22x30 |
| Drivers, in. | 63 |
| Weight on drivers, lbs. | 160,000 |
| Total weight, lbs. | 182,000 |
| Steam pressure, lbs. per sq. in. | 185 |
| Tractive effort, lbs. | 36,200 |

*Heavy 10-Wheel Passenger Locomotive.*

| | |
|---|---|
| Cylinders, in. | 22x30 |
| Drivers, in. | 69 |
| Weight on drivers, lbs. | 134,000 |
| Total weight, lbs. | 176,000 |
| Steam pressure, lbs. per sq. in. | 185 |
| Tractive effort, lbs. | 28,680 |
| Width of fire-box, in. | 68 |

*Atlantic Type Locomotive for Fast Passenger Service.*

| | |
|---|---|
| Cylinders, in. | 21x26 |
| Drivers, in. | 73 |
| Weight on drivers, lbs. | 102,000 |
| Total weight, lbs. | 182,000 |
| Steam pressure, lbs. per sq. in. | 185 |
| Tractive effort, lbs. | 24,700 |

*Six-Wheel Switcher.*

| | |
|---|---|
| Cylinders, in. | 20x26 |
| Drivers, in. | 51 |
| Weight on drivers, lbs. | 138,500 |
| Steam pressure, lbs. per sq. in. | 185 |
| Tractive effort, lbs. | 31,200 |

*Pacific Type Locomotive for Heavy Passenger Service.*

| | |
|---|---|
| Cylinders, in. | 22x26 |
| Weight on drivers, lbs. | 136,000 |
| Total weight, lbs. | 203,000 |
| Tractive effort, lbs. | 31,000 |
| Width of fire-box, in. | 68 |

The trailing trucks of these Pacific type engines are to have outside bearings instead of the inside bearings now in use.

The fifth section of the report deals with the question of superheated steam. The committee believes that some difficulties will be experienced in American practice with the use of the Pielock superheater on account of the difficulty of removing and expanding the flues. A complete description of the several types of superheaters now in use is given. Attention is called to the fact that the use of superheated steam in earlier days was handicapped by the use of vegetable and animal oils for lubricating the valves and cylinders. With mineral oils of high fire test and seamless drawn tubes the problem is now easy. Tests in Germany and on the Canadian Pacific show that valves and cylinders can be properly lubricated and that superheater pipes and flues made of seamless drawn tubes do not corrode and wear out with undue rapidity. A life of several years can be obtained from the seamless tubes. The reports of the Canadian Pacific show that in three years' service the superheated steam compounds saved 10 to 15 per cent. in coal over compounds without superheaters.

Apart from the saving in fuel which results from the use of superheaters, one of the greatest advantages is that dry steam is always furnished the cylinders. It is practically impossible to carry over water into the cylinders, thus eliminating the danger

of "water hammers." Where foaming water is used superheaters will prevent trouble in the cylinders.

In concluding the discussion on superheated steam the committee says that there is no improvement in sight at the present time which affords so many advantages and so much economy both in saving of fuel and lessening of repairs as the use of superheated steam. The additional complication of the boiler is small, and superheaters of good design are not liable to expensive repairs, nor has it been shown that failures in service are frequent. In June, 1904, an Atlantic type engine, out of a lot of 20 for the New York Central, was equipped with a Schenectady superheater. The engine went directly into passenger service and has been running satisfactorily ever since. No trouble was experienced with the superheater, the only difficulty being due to the lubricating device which was of foreign make. The oil used was also of low fire test. Orders for 26 of this type have now been received.

The next section of the report discusses at length the question of composite motor cars. In many places it does not pay to run a regular passenger train as the wages of the engineer, fireman, etc., are out of all proportion to the receipts. Better service can also be given by one car running frequently than by a train making one or two trips a day. The usual construction of motor cars has been a passenger car body with seats for about 50, having one end partitioned off for the boiler. The development of these cars has been slow and not very successful, owing to the opposition of unions to the use of but two men and to the low steaming capacity of the boiler. The heating surface in most of these designs is only about one-half of that of a modern locomotive. The fuel used has been both hard and soft coal.

The largest number of cars have been operated by steam, but at the present time the following types are used: (1) Steam; (2) gasoline or oil engines in connection with direct coupled electric generators and electric motors; (3), gasoline or oil engines with mechanical drive, operated by gearing and friction clutches.

While the use of gasoline engines provides some attractive features, being self-contained and not requiring any particular attention from the engineer except for lubrication, the construction of these engines requires running at substantially high speeds, with a variation of not more than 40 to 50 per cent. Thus, in order to control the power and connect it to the wheels so that starting can be effected with smoothness and rapidity it is necessary to expend a large sum for electrical or mechanical devices. If the car is controlled electrically it requires a generator, two motors on the wheels and the usual arrangement of wiring, switches, controllers, etc. It also involves the use of compressed air for starting the engine. It is extremely questionable if a gasoline-electric device of this kind would pay unless gasoline could be obtained at an extremely low price or coal could not be obtained except at a very high price. The same reasoning holds in the case of gasoline or oil engine cars having mechanical drive.

The committee believes that a steam driven composite car with a large properly constructed boiler (preferably horizontal) having sufficient steaming capacity and using coal or oil, is the best solution of the problem. If oil fuel is used the valves controlling the admission of oil and air can be placed close to the engineer so that it would take but a small part of his time to control and maintain the steam pressure.

A preliminary design for use on the Rock Island is shown in the report. The car has a seating capacity for 50 and also has a small baggage room. The steam connections between the engine and boiler are made with flexible ball joints. The principal dimensions of the proposed car are given in the following table:

| | |
|---|---|
| Weight on drivers, lbs. | 74,000 |
| Weight on front truck, lbs. | 15,000 |
| Weight on back truck, lbs. | 40,000 |
| Total, weight, lbs. | 129,000 |
| Total wheel base, ft. | 62 |
| Cylinders, in. | 12x16 |
| Drivers, in. | 42 |
| Engine truck wheels, in. | 28 |
| Diameter of boiler, in. | 60½ |
| Steam pressure, lbs. | 180 |
| Fire-box, in. | 48 3-16x48 3-16 |
| Tubes, No. | 297 |
| Tubes, outside diameter, in. | 1½ |
| Tubes, length, in. | 92 |
| Heating surface, tubes, sq. ft. | 875 |
| Heating surface, return tubes, sq. ft. | 350 |
| Heating surface, fire-box, sq. ft. | 75 |
| Heating surface, total, sq. ft. | 950 |
| Grate area, sq. ft. | 16.7 |
| Tractive effort, lbs. | 8,390 |
| Factor of adhesion. | 8.82 |

The driving truck of this car is of the 2-4-0 type; that is, it has a pair of leading wheels and two driving axles. The cylinders are horizontal. The boiler is horizontal with return tubes. There are two cylindrical tanks holding 1,400 gallons. The fuel capacity is one ton. Table 2 gives some comparative figures on the cost of fuel for operating different types of 300 h.p. motor cars.

*Table 2.*

| Type of car. | Cost of fuel. Per gal. or ton. | Cost of fuel. Per pint or lb. | Lbs. or pints per h.p. hr. | Cost per h. p. hr. | H. p. hrs. per day. | Cost of fuel—Per day—While running. | Cost of fuel—Per day—Addtl for raising steam. | Per 1,000 h.p. hrs. |
|---|---|---|---|---|---|---|---|---|
| Gasolene | $0.12 | *1.5 | 1 | 1.5 cts. | 1,500 | $22.50 | $22.50 | $15.00 |
| Steam car with simple engines; oil fuel. | .024 | †.32 | †2.8 | .89 | 1,500 | 13.35 | 14.70 (10%) | 9.80 |
| Steam car, compound engines, superheated steam, oil fuel. | .024 | †.32 | †2.1 | .67 | 1,500 | 10.05 | 11.00 (10%) | 7.33 |
| Steam car, simple engines, coal fuel | 2.15 | †.1075 | †4 | .043 | 1,500 | 6.45 | 8.06 (25%) | 5.33 |
| Steam car, compound engines, superheated steam, coal fuel | 2.15 | †.1075 | †3 | .032 | 1,500 | 4.83 | 6.04 (25%) | 4.03 |

*Pints. †Pounds.. Running 100 miles a day. Average horse-power assumed to be 150. Weight of oil, 7½ lbs. = 1 gallon.

The report contains the following conclusions showing the saving which may be expected by the use of a motor car instead of a two-car train hauled by a locomotive.

*Approximate Cost.*

| | |
|---|---|
| Passenger car | $5,000 |
| Baggage, mail and express car. | 5,000 |
| Engine and tender | 7,000 |
| Total | $17,000 |
| Motor car | 12,000 |
| Difference | $5,000 |

*Weight of Train.*

| | |
|---|---|
| Passenger car | 35 tons. |
| Baggage car | 30 " |
| Engine and tender | 65 " |
| Total | 130 tons. |
| Weight of motor car | 65 tons. |
| Difference | 65 tons. |

*Cost per Day for Wages.*

| | Train. | Motor car. |
|---|---|---|
| Engineer | $3.50 | $3.50 |
| Fireman | 2.25 | 2.25 |
| Conductor | 3.50 | 3.50 |
| Brakeman | 2.00 | .... |
| Baggageman | 2.50 | .... |
| Total | $13.75 | $9.25 |
| Add for roundhouse care | 3.00 | |
| Total | $16.75 | |
| Add interest on $5,000 | 1.00 | |
| Total | $17.75 | |
| Motor car wages | 9.25 | |
| Saving in wages | $8.50 | |
| Saving in fuel | 5.00 | |
| Total saving for motor car. . | $13.50 | |

The last section of the report presents a discussion of the four-cylinder balanced compound locomotive. The following advantages of this type of engine are noted: (1), balancing of reciprocating parts by similar reciprocating parts; (2), increase of weight on drivers due to absence of "hammer blow." At 60 miles an hour with 78 in. drivers the ordinary engine at each revolution increases or decreases the static weights on the rail by about 23 per cent.; (3), increase of from 25 per cent. to 33 per cent. over ordinary engine in the sustained horse-power at moderate and high speeds without change of boiler; (4), economy in the use of fuel, water and steam; (5), light moving parts. As the four-cylinder balanced compound has four sets of cylinders, cross-heads, connecting rods, etc., in place of the two sets in the case of the ordinary engine, it follows that each cylinder and connected part transmit but half the power otherwise required to be transmitted by the ordinary two-cylinder engine. It is thus to be expected that the cost of repairs for the four-cylinder balanced compound will be less than for the ordinary two-cylinder engine.

The four-cylinder balanced compound principle can be applied to Atlantic type, Pacific type and 10-wheel designs without increasing the wheel base and without making serious changes in the detail parts of the locomotive.

In concluding the report the committee calls attention to the fact that the greatest economy and refinement within the limits of good practice, as far as can now be seen, can be obtained by the use of the four-cylinder balanced compound locomotive with a superheater. As the additional weight of the superheater is only about 2,000 lbs., there seems to be no practical difficulty in its application to four-cylinder balanced compounds.

## Erie Employment Bureau.

The Erie Railroad Company has lately established an employment bureau, and Mr. W. C. Hayes, formerly Assistant Mechanical Superintendent of the road, is at its head. It is to keep the records of all applications for employment, throughout the company's lines, below the grade of superintendent, except unskilled laborers. This will be followed by a distinct change of method of employing men for the service. The list of classes in which the employment of new men must not be confirmed without the final approval of the Superintendent of the Employment Bureau, includes Master Mechanics, Road Foremen of Engines in the Mechanical Department, Trainmasters, Roadmasters, Master Carpenters in the Operating Department among the higher classes, and includes call boys, messengers, dining car employees, and all the numerous head and hand workers between these grades.

After an application is sent in from any division point, all papers concerning the movement of the employee are forwarded to the Superintendent of the Employment Bureau for file. All applications are investigated by the bureau, the replies and all information of value being kept by the bureau for reference. Out of service, transfer, promotion or re-employment notices must also be forwarded to the bureau for file.

In this way a complete record of every employee is kept showing all information of value. When an application is made for a position of any kind below the rank of superintendent, and above that of unskilled

laborer, the officer or head of department to whom it is made has the regular application blank filled out. Applicants this year are required to show where and how employed from Jan. 1, 1900, to date. The record must be continuous and chronological. For any periods that the applicant may have been idle or working for himself or relatives, he is required to furnish the names, titles and post office addresses of two responsible business men to verify his statement. A personal description of the applicant is then made by the employing officer. The place of occupation, date effective and in what capacity he is employed is filled in and the application is then forwarded to the employment bureau for investigation and file. The bureau is the only authorized medium for conducting investigations, answering all inquiries relative to the record of former employees, giving service letters, etc., thereby relieving the employing officers of this duty.

It makes no difference whether a man works on one or more divisions, all records are forwarded to the bureau and recorded under one cover. It is only necessary to refer to the file to get the complete record of any employee, the file showing his record from the day he entered the service to the date of its termination. Any employee leaving the service is entitled to a certificate showing his record. The certificate of service is of considerable value to the owner, and in order to protect the person receiving such certificate, his signature and personal description are entered thereon. This prevents it from being used by any one other than the right person.

The examination for visual defects is made with worsteds and lanterns according to the most approved plan.

The discharge of unskilled laborers, wipers, etc., must also be reported when the cause of dismissal is such as to make the person an undesirable employee. All records include a physical description, to insure satisfactory identification.

The application blank requires the applicant to give, besides the usual information, the names of relatives dependent upon him. He acknowledges the receipt of a copy of the book of rules, and agrees to keep advised of amendments which may be made; acknowledges that he has received notice of the danger of overhead bridges, etc., and that when he goes into the yards of other companies he must be particularly careful in looking out for obstructions; agrees to examine machinery, etc., before using, to see that it is safe, and to report in writing to "some person superior to myself" when defects are found. The employing officer fills in the name of the predecessor in the place for which an applicant is being engaged, and the disposition made of the predecessor; also the rate of pay.

Of the 15 blanks and other forms used by the bureau, the principal ones are the following:

2181. Inquiry to be sent to references who can verify statements made by applicants who have been out of work for some time.

2182. Certificate of examination of locomotive engineers and conductors by the division superintendent, when persons employed in these capacities have passed a satisfactory examination on train rules. In the mechanical examination of engine men then is also the mechanical examination and the certificate is signed by the Master Mechanic, when a satisfactory examination has been passed.

2183. Letter from the applicant authorizing former employers to furnish his record.

2184. Certificate of examination of eyes and ears.

2185. Letter from examiner to surgeon, requesting surgical examination.

2186. Certificate of service, to be issued only by the superintendent of the employment bureau, to be given to employees leaving the service. This certificate must have a physical description and must bear the signature of the employee.

2187. Application for employment (mentioned above). This must be attested to by a witness who has heard the whole document read over and must be sworn to by the applicant before a notary public. The record of previous service accompanying this application fills a large page and has 20 numbered lines, one line for each place or occupation. This is intended to go back five years, and if an applicant has been idle he must give the names of two responsible business men who will testify to the correctness of the record which he gives for such periods of idleness.

2196. Instructions for surgeons and other examiners. This is a circular of six pages, taken up mostly with the tests for color sense and acuteness of vision. For trainmen, etc., normal hearing, color sense and visual powers are required. For station agents, section foremen, etc., 20/40 visual power will be accepted in one eye if the other is normal; or 20/30 will be accepted in each eye. No applicant will be accepted who must wear glasses to meet the requirements. Firemen and brakemen already in the service may be promoted if they have 20/20 in one eye and 20/30 in the other, provided they have no other defects.

The list of physical disabilities which bar employment is quite long, extending from the loss of an eye, leg or arm to recurring appendicitis and marked scrofulous cachexia. The surgeon in his record must note not only physical defects which impair the usefulness of the applicant, but those which do not. All new men employed in the train, engine, and switching service must be between 21 and 45 years. Persons under 21 will be accepted only as messengers and as apprentices in shops.

2197. Record of the "practical" test of eyes and ears. This form is shown, reduced, in the accompanying cut.

2198. Surgeon's certificate of examination. The applicant must make oath, on the back of this sheet, to the truth of the answers which he has made to the surgeon's questions. The blank contains a diagram of the human body and also of the hand and of the foot, on which the surgeon is to indicate physical defects.

2199. Record of examination of eyes by Holmgren worsteds and Dr. Williams' testing lantern. If the applicant fails to pass this examination he may then take the "practical" test with the different colored flags and lamps as per Form 2197, to convince him of the fairness of the first test.

2200. Inquiry to be sent to former employers.

2202. Instructions for making up applications.

3003. Recommendations for promotion, transfer or re-employment. This is to be signed by the head of division or department and must give the record of the employee. If a person recommended for promotion is not next in line, the certificate must explain why an exception is made. Among the questions

ERIE RAILROAD COMPANY.

CHICAGO & ERIE R. R. NEW JERSEY & NEW YORK R. R.
NEW YORK, SUSQUEHANNA & WESTERN R. R.

RECORD OF EXAMINATION OF SIGHT, COLOR SENSE AND HEARING.

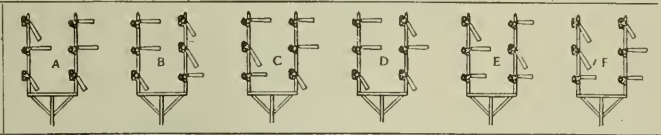
NAME OCCUPATION DATE

PLACE TIME WEATHER

SIGHT.

Order Shown

Combinations of Signals Shown. X indicates called Reverse Position.




Written train orders read correctly? (Yes or No.)

COLOR SENSE.—Standard Flags, Shown Two at a Time

| Order Shown | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Color Shown | Raw Green 1 | Rolled Yellow 22 | Rolled Red 12 | Raw Green 1 | Raw Red 11 | Rolled Red 12 | Raw Green 1 | Rolled Green 2 | Raw Blue 31 | Rolled Red 12 | Rolled White 42 | Rolled Green 2 | Rolled Red 12 | Raw Red 11 | Raw Yellow 21 | Raw Red 11 | Rolled Green 2 | Raw Green 1 | Raw Green 1 | Rolled Red 12 | | | |
| Name Given | | | | | | | | | | | | | | | | | | | | | | | |

Standard Flags, Shown One at a Time.

| Order Shown | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Color Shown | Rolled Green 2 | | Raw Red 11 | | Rolled Red 12 | | Raw Yellow 21 | | Raw Green 1 | | Rolled White 42 | | Raw Blue 31 | | Rolled Yellow 23 | | Rolled Green 2 | | Rolled Red 12 | | | | |
| Name Given | | | | | | | | | | | | | | | | | | | | | | | |

Standard Lanterns, Shown Two at a Time.

| Order Shown | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Color Shown | Light Green 1 | Dark Green 2 | Dark Red 12 | Light Green 1 | Light Red 11 | Dark Red 12 | Dark Green 2 | Light Green 1 | Yellow 21 | Dark Green 2 | Light Red 11 | White 41 | Dark Red 12 | Light Red 11 | Blue 31 | Yellow 21 | Light Green 1 | Dark Red 12 | Yellow 21 | White 41 | | | |
| Name Given | | | | | | | | | | | | | | | | | | | | | | | |

Standard Lanterns, Shown One at a Time.

| Order Shown | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Color Shown | Dark Red 12 | Light Green 1 | Blue 31 | White 41 | Dark Green 2 | Yellow 21 | Dark Red 12 | Light Red 11 | Yellow 21 | Dark Green 2 |
| Name Given | | | | | | | | | | |

Hearing Ordinary conversation heard correctly? (Yes or No.)

REMARKS.—I hereby certify that I have personally examined _____ and find that his acuteness of vision, color perception and hearing _____ conform to the standard required for _____

Date, _____ (Signed) _____ Examiner.

Form for Recording Test of Vision of Employees of Erie Railroad.
*Reduced about one-half.*

to be answered in filling out this blank is, "Does the subject of this report display industry and zeal?"

3004. Notice to be sent by the head of the division or department to the employment bureau, of cases where discipline has been ordered (to be recorded), and of dismissals or resignations. In case of violation of rules the number of the rule must be stated, and if discipline is administered in connection with an accident, the names and titles of other employees disciplined for the same cause must be given. The office of the superintendent of the employment bureau is at Jersey City, and that will be the headquarters of the department; but he will have assistants at division terminals and wherever necessary so as to provide for the transaction of business with the necessary promptness.

## American and British Railroad Accident Reports.*

British statistics of railroad accidents are collected and used not to horrify humanity, but to locate the causes and responsibility, and, where possible, to prescribe and enforce the remedy. American statistics of railroad accidents are collected, tabulated and published to establish a preconceived theory; to shift the responsibility from the human equation to the absence of some safety device; to convict our railroad management of a niggardly disregard of human life. In England the statistics are only published for the purpose of reassuring the public. In America they are given out by the Interstate Commerce Commission no less than seven times a year, with "ghoulish glee," to fill the public mind with horror over the harrowing totals of every description of frightful or trivial railroad accident.

In England in 1901 the report of the British Board of Trade very justly made much of the gratifying fact that for the first time on record not a single passenger had been killed in a train accident. This noteworthy event, which has been rolled as a sweet morsel through the disingenuous reports of the Interstate Commerce Commission, served to divert attention from the co-incident fact that the total number of personal accidents was 1,277 persons killed and 18,735 injured. If you multiply these figures by ten, which represents the difference in risk by reason of the greater mileage, tonnage and number of employees in America, you have 12,770 killed and 183,750 injured as the gross totals, which should be compared with the totals so assiduously paraded in the government reports to induce Congress to give the Interstate Commerce Commission authority to prescribe costly safety devices for the problematical protection of the people. . . . The English reports put in a separate class those accidents not caused by the movement of cars or engines; Mr. Thompson says that the inclusion of these accidents in the United States reports [They are separated here, the same as in England] can be due only to "a deliberate policy to inflame public opinion against the railroads by the inclusion of these irrelevant statistics."

The paper then goes on to quote from accident investigations made by Colonel Yorke; this to show his judicial tone. The principal extract is from the report on the accident at Glasgow, July 27, 1903, killing 16 passengers, in which Colonel Yorke recommended the English roads to follow the example of other countries in having more efficient power brakes. Discussing the totals of English records, Mr. Thompson says:

Even during the year 1901, memorable for its immunity from fatalities to passengers in accidents to trains, there were in the United Kingdom 51 collisions between passenger trains or parts of passenger trains; 55 collisions between passenger trains and freight trains; 29 collisions with buffer-stops and 65 cases of passenger trains or parts of passenger trains leaving the tracks, and there were 476 passengers injured in train accidents, the majority of whom owe gratitude to their lucky stars and not to any block signal, that the death which came so near passed them by.

Coming now to American records Mr. Thompson presents the following figures:

*Killed in Railroad Accidents.*

| | 1888. | | 1904. |
|---|---|---|---|
| Passengers | 315 | to | 426 |
| Employees | 2,070 | | 3,367 |
| Other persons | 2,897 | | 5,879* |
| Total | 5,282 | | 9,666 |

*Figures on "other persons" are for 1903, as figures are not yet out for 1904.

Against these figures any one wishing to deal honestly and fairly with the subject should set the following, taken from the earliest and latest available reports of the Interstate Commerce Commission:

| | 1889 | 1903. |
|---|---|---|
| Passengers* (millions) | 11,553 | 20,915 |
| Tons* (millions) | 68,727 | 173,221 |
| Employees | 704,743 | 1,312,537 |

*Carried 1 mile.

Here we see the following percentages of the relative increase in the totals of fatalities and factors in the hazard of railroad operation:

| | P. c. of inc. 16 yrs. |
|---|---|
| Fatalities to passengers | 32.4 |
| Fatalities of employees | 62.6 |
| | 15 yrs. |
| Passengers carried 1 mile | 93.7 |
| | 14 yrs. |
| Tons carried 1 mile | 152.0 |
| No. of employees | 86.2 |

Fatalities due to train movement were as follows:

*Killed in Train Accidents.*

| | 1889. | 1904. | Per ct. inc., 15 yrs. |
|---|---|---|---|
| Passengers | 161 | 270 | 67.7 |
| Employees | 481 | 844 | 75.4 |

These figures demonstrate that the fatalities from train accidents have not increased relatively to the number of passengers carried one mile or to the number of employees, omitting all consideration of the overshadowing increase in the ton mileage.

During the last five years from 1900 to 1904, inclusive, there were 795 passengers killed in train accidents, or an average of 159 each year. During the first five years of the Commission's statistics from 1889 to 1893, inclusive, there were 679 passengers killed in the similar class of accidents, or 135 each year: making an increase of, only 17 per cent. during a period when the average passenger mileage for the five years in question increased 52 per cent. But these comparative figures are only profitable as a refutation of the popular impression that the railroads of the United States are managed with an increasing disregard to the safety of passengers and employees The opposite is the truth.

The indictment I bring against the accident statistics of the Interstate Commerce Commission is that they not only fail to reflect the true conditions, but that they are deliberately perverted to further a preconceived and fallacious theory as to the best means to prevent railroad accidents. As I have already more than intimated, the gross totals have been paraded before the popular imagination as the frightful mortality to be reduced by block signals. With the introduction of block signals wherever practicable and where they will insure public safety without overburdening public traffic, I am in hearty sympathy.

But the accident reports of the Interstate Commerce Commission, prejudiced as they are in favor of the block signal system as the panacea for railroad accidents, cannot wholly conceal the fact that recklessness, negligence and disobedience in the human equation is mainly to blame for railroad accidents. In three cases out of four where the block system is installed the failure of the human equation to keep it in order or to observe or obey its warnings neutralizes its efficiency. The inevitable tendency of the block signal system is to beget carelessness in the train crews, as it shifts responsibility to the signal system operators or to the signal itself.

The rest of the paper is a violent attack on Secretary Moseley, of the Interstate Commerce Commission, based on statements made by Mr. Moseley in an article in the *American Monthly Review of Reviews*, for November. The author disputes Mr. Moseley's classification, in which he separates collisions caused by the block system from those occurring on the roads where it is not in use, and declares that Mr. Moseley's allegations concerning trainmen sleeping on duty and collisions caused thereby are not proved.

For the real causes of any increase which there may be in railroad accidents in this country Mr. Thompson refers to the *Locomotive Firemen's Magazine*. From an article in that magazine he quotes the opinion that greater exactions in train work, the running of locomotives three times as large as formerly, and of 50-ton cars; requiring men to run 150 to 200 miles in the same time that they formerly took for 100 miles, and, in general, the making of duties extremely complex, constitute the true explanation. The men are now sober and more closely attentive to duty than formerly, and do not loaf in saloons but spend their leisure time at home or in study of their intricate and exacting duties.

Mr. Thompson says that on 35 roads operating over 31,000 miles in 30 American states and three territories, which carried 4,886,641,267 passengers one mile, not a single passenger was killed in a train accident in the calamitous year of 1904 (year ending June 30.) Nine other roads, operating 21,655 miles in 31 states, carried 2,626,197,777 passengers one mile with a fatality of only one passenger to each road during the same year. Together these reports show that 44 American roads operating in 38 states and three territories 52,685 miles, or more than 2¼ times as much as the total mileage of British roads, carried over 7½ billion passengers one mile, last year with only nine fatilities to passengers in train accidents. . . .

The remedy for our accidents lies along the suggestion made in the President's message and following the English practice, viz.: "personal investigation through proper officers of all accidents involving loss of life which seem to require investigation, with a requirement that the results of such investigation be made public." The officers should be chosen from the engineering service of the regular army, and should be paid as well as their English compeers. The present farcical system of inspection of tens of thousands of locomotives and nearly two million cars should be abolished, and the railroads should be held to double damages where the government officials find that the fatal disaster was due to defective equipment or permanent way. But this reform should begin by removing the whole subject of railroad accidents from the hands of the Interstate Commerce Commission and placing it with the Bureau of Commerce and Labor, where it belongs. At present the subject cannot receive honest and intelligent public consideration for the stream of statistics relating to it is poisoned at its fountain head.

*Abstract of a paper by Slason Thompson, read before the Western Railway Club, at Chicago, Dec. 20.

## Railroad Shop Tools.

(*Continued.*)

### SHAPING MACHINES.

The 15-in. Universal shaping machine, Fig. 1, is made by the Potter & Johnston Machine Company, Pawtucket, R. I. This type of machine bears somewhat the same relation to the plain shaper that the universal milling machine bears to the plain milling machine.

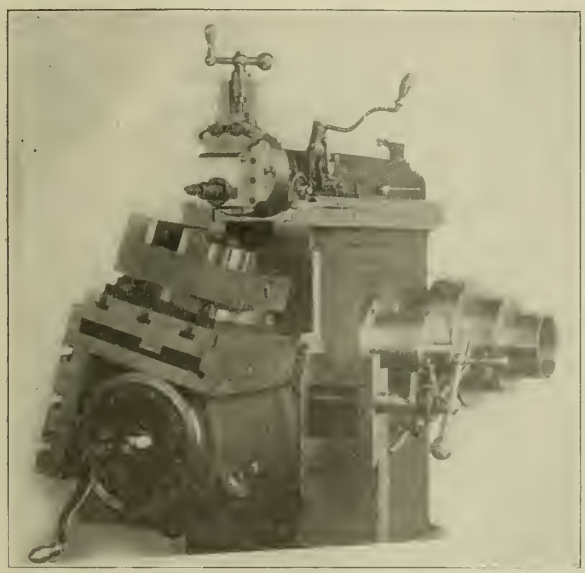


Fig. 1—The Potter & Johnston Shaper.

The ram has quick return and a graduated dial enables it to be set quickly to any length of stroke while the machine is in motion.

The cross slide is mounted on ball bearings and the cross slide feed screw has a graduated collar for adjustments, as has also the tool head feed screw. The tool slide has 10 changes of down feed and an automatic stop for duplicate work. The down feeds and automatic stops can be used while the head is in any angle from 0 to 90 deg., and feed changes can be made while the machine is in motion. The change of feed is made by throwing an index finger to the left or to the right and allowing the spring finger to engage in the desired hole in the face of the disk upon which the index finger rotates. When the pin is in the lower left-hand hole the feed is zero. The down feed is controlled by a knurled screw, which is set in a radial slot in the side of the ram and engages the stop finger.

The table or knee is graduated and swings in either direction through an arc of 90 deg. It is also fitted with an auxiliary tilting slide for compound angles, thus making it possible to plane work to any angle with the power cross feed. Rotary motion is imparted to the table by means of worm gearing. This type of machine is also made in the 24-in. size; in this size the table is raised and lowered by power. The following table gives the dimensions and weights of both the 15-in. and 24-in. machines:

| | Machine— 15-in. | 24-in. |
|---|---|---|
| Length of stroke | 15 in. | 24 in. |
| Auto. cross traverse | 20 in. | 23 in. |
| Vert. adjustment table | 12 in. | 16½ in. |
| Top of table | 14x12 in. | (plain) 21x15 in. (swivel) 17½x15 in. |
| Side of table | 14x12 in. | 18¼x17¾ in. |
| No. grades of cone | 4 | 3 |
| Swivel vise opens | 4½ in. | 6 in. |
| Length of jaws | 10 in | 12 in. |
| Tight and loose pulleys on counter | (2) 12x3 in. | 2 pr., 10 & 14 in. for 4-in. belts. |
| Revs. per min. | 150 | 170 |
| Net weight of machine with countershaft | 2,300 lbs. | 4,000 lbs. |

The accompanying illustration, Fig. 2, shows a 14-in. Pratt & Whitney precision shaper, made by the Niles-Bement-Pond Company, New York. This machine has ample power and rigidity for ordinary shop use, but is particularly designed for tool-room and die work. All adjustments are quickly made from one side of the machine and the screw which elevates the knee is provided with ball thrust collars, making it easy to adjust. The table has variable power feeds in both directions and is fitted with a swivel vise having a solid base. The vise turns on a graduated circle so that work may be adjusted to any horizontal angle. One of the jaws is V-shaped, for holding circular pieces and swivels so that either the V-shaped face or the straight face may be used. The maximum stroke of this machine is 15 in. and the table, which is 15 in. x 12 in., has a vertical adjustment of 11 in. and a horizontal traverse of 16 in.

Fig. 2—The Pratt & Whitney Shaper.

Fig. 3 shows a 20-in. single-geared crank shaper made by the R. A. Kelly Company, Xenia, Ohio. The ram of this machine is semi-circular in section and is ribbed internally to resist all undue strains. It has a bearing of 30 in. in the top of the column. The length of the stroke of the ram is changed by means of a short lever. Graduations are produced for the head which can be swiveled to any angle and locked in position by a simple locking device. The top of the table is 12 in. x 15½ in. It is of box form with extension front and is provided with T slots on both the top and sides; it also has a V slot cut in its side for holding round stock in a upright position. The table can be easily removed to allow of work being strapped directly to the apron, which has an automatic cross feed of 22 in. and a vertical adjustment of 14½ in. The vise has steeled-faced jaws 12 in. x 2 in. and has a maximum opening of 8 in. It is also provided with hardened steel centers and a graduated swivel base. The cone pulley has four steps for a 3 in. belt. The tight and loose pulleys are 12 in. in diameter by 4 in. face and should run at 175 r.p.m. The net weight of the machine, including the countershaft, is about 2,400 lbs. This machine

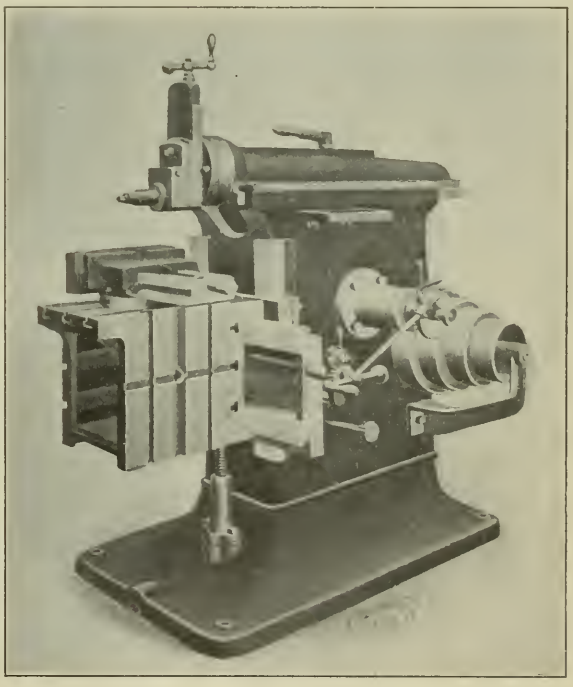


Fig. 3—The R. A. Kelly Shaper.

is also furnished with back gears and motor drive when desired.

*(To be continued.)*

## Water Famine on the Pennsylvania.

At last accounts there had been no relief from the severe drought in central and western Pennsylvania. The Pennsylvania Railroad has kept 180 tank cars fully occupied night and day in transporting water to points where it was needed by the locomotives. Much water has had to be supplied to the shops in Altoona, and in spite of the best efforts some departments of the shops have had to stop work at times. The company is hurrying the work on a pipe line six miles long which is designed to afford a new supply of water at Altoona. On Sunday, December 18, the freight movement between Pittsburg and Harrisburg was one of the heaviest on record, every available engine being put in service to clear up blockades which existed at a number of points, and the water-train service was taxed to its limit. An officer of the road is quoted in the *Altoona Mirror* as follows:

"This water famine has been tightening its grip upon the Pennsylvania Railroad and its branches west of Harrisburg since the middle of August. The trouble extends to a considerable distance west of Pittsburg. By the employment of all manner of expedients and at the expenditure of immense sums of money we have kept our passenger movements intact and recently have forced freight movements up to the point where we are only about 24 hours behind. Here in Altoona our three big reservoirs, having a storage capacity of about 300,000,000 gallons, are all dry and have been for weeks. We have put on water trains and established temporary pumping stations. Our present consumption of water is about 3,000,000 gallons daily.

"Of this 1,000,000 gallons are supplied by the streams that formerly filled our reservoirs, the water now flowing directly into the pipes. By means of tank trains we supply daily about 600,000 gallons, and the remainder, amounting to 1,500,000 gallons, is furnished by pumps. This supply is uncertain and, coming from various sources, occasionally results in conflicting pressure and breaks in the pipes. Then the perplexities of the situation multiply. Yesterday afternoon we had six big trains waiting to start westward over the mountains. Each train required three locomotives, but there was a break in the water system somewhere and none of the locomotives could be got ready without serious delay. One night the boilers in the lighting plants ran out of water and for hours the yards were in darkness. A day or two ago the air operating all the yard signals was stopped for a similar cause. Two minutes are usually required to fill a locomotive tender with water under ordinary conditions; 25 minutes were required yesterday.

"Another serious drawback is the effect of the bad water we are compelled to use. We pump mine drainage into our boilers. At the end of every trip, sometimes before the trip is completed, the locomotive has to be sent to the shops that its boiler flues may be caulked. The sulphur in the water oxidizes the iron and renders the boilers unfit for use until overhauled; but, it is mine drainage or nothing in many cases. Every water station between Altoona and Pittsburg, as well as on the branches, is dry, or supplied by pumpage. An expert tests the water at the pumping stations, and decides the amount of soda ash to mix with the sulphur-laden water put into the tenders, but even at that the locomotive is good for only one trip without overhauling.

"We have 1,000 men working day and night constructing a six-mile line of pipes from Tipton Run. We expect to bring 1,500,000 gallons of water from that source by January 1. We will divide that with the city, which is in very bad shape for water. To-day the shops are working practically with water hauled in trains from Sunbrook. There is absolutely no pressure on the water in the company's mains, the streams are so low. It has been ascertained that muskrats have bored holes in the company's reservoir at Pinecroft, permitting what little water there was in it to run away. Fifty fire extinguishers have been distributed in the shops for protection against fire, and three reels of hose, containing 100 ft., have also been added to the shop fire equipment."

## The Railroads of Natal.*

Unlike most of the other South African colonies, Natal does not depend to any extent upon gold and diamond mining, the only benefits it receives from these sources being due to the transportation of men and minerals between the mining centers of neighboring colonies and the port of Durban. It owes its importance rather to the development of agriculture, and, in a lesser degree, to manufacturing industries and coal mining. At the present time there are 762 miles of railroad in operation. Numerous surveys for new lines have been made and several of these will probably be built before many years have passed. The natural difficulties of building railroads in Natal, however, are extremely severe, involving heavy grades and sharp curves. There are very few miles of really level line, and most of this is on branches where the loads are light and gradients are not of much consequence. As an example; the ruling gradient on the main line between Durban and Ladysmith, 190 miles, is over 3 per cent. The train running from Durban to Charlestown, on the Transvaal border, has to ascend an equivalent of nearly 2½ miles of vertical elevation, crossing altitudes of from 2,000 to 5,000 ft. above sea level, which, when once reached, are often lost again and have to be recovered. Owing to these severe grades, the engine loads have to be reduced and readjusted at intervals, involving a loss of time and compelling even the most powerful of locomotives to be restricted to trains weighing 200 tons or less, whereas the same engines if working under British conditions, for example, would be able to pull an 800-ton train at full speed. With these facts in mind, such allowances as 229 minutes for 70 miles, which is the running schedule of the express train between Durban and Pietermaritzburg without any intermediate stops, appears quite reasonable.

The lines are of 3 ft. 6 in. gage. There is no second track except for about six miles in the neighborhood of Durban, where there are several long sidings to enable trains to pass one another. The main line of the Natal railroads extends from Natal to Pietermaritzburg, 70 miles, and thence to Charlestown, 306 miles, where it connects with the Central South African Railroads. From Ladysmith there is a branch to Harrismitb, 59 miles. Other branches are: Greytown to Pietermaritzburg, 64 miles; Glencoe Junction to Dundee, 59 miles, and the Richmond branch, 17 miles. From Durban, there are three branches: one in a northerly direction to Sonkele, 169 miles; another south to North Shepstone, 72 miles, and the third to Unzinto. There is also a line two miles long connecting Durban with the docks. This was the first railroad built on the African continent (in 1860), and it is on record that when, as frequently happened, both of the two small locomotives of the line were out of commission, the trains had to be pushed along by natives. At Durban are situated complete and extensive docks fitted with up-to-date appliances. It is here that connection with all parts of the world is effected.

The rolling stock employed on the Natal railroads is exceptionally good and, notwithstanding that the gage is less than the British standard, the carrying capacity, both for passengers and for freight cars, is little less than would be the case in equipment used on standard-gage lines. The first and second class carriages used on these railroads are as good as is any in Great Britain. The vacuum brake is universally employed and most of the passenger coaches have clerestory roofs with windows made to open as well as door windows, a boon for the traveler during the hot weather. The standard locomotives used at present are heavy 10-couple tank engines designed by C. W. Reid, the late Locomotive Superintendent. The first and fifth pairs of couple wheels are not provided with flanges and the engines are consequently well adapted for rounding the sharp and frequent curves. About 100 of these locomotives are now in use in Natal, and the bulk of the traffic is done by them. The engines, as a rule, weigh a trifle over 100 tons with tender.

*From a paper in the December *Cassier's*.

## Proposed Union Station for Buffalo.

The railroad terminal situation at Buffalo is exceedingly complex, not only on account of complications arising from the physical relation of the tracks of the thirteen railroad companies now entering the city, but also because of the many movements that are required in breaking up and making trains from the east destined over different routes for the west, and *vice versa*. Within the past 20 years the city of Buffalo has appointed a number of committees to confer with the different railroads with the end of securing a union station, but none of these committees was able to arrive at any definite results. A committee composed of five citizens of Buffalo, C. W. Goodyear as chairman, was recently appointed by the Mayor, and has now submitted to the railroads five proposed sites for a union station. These sites were discussed at a conference held in New York, at which the following railroads were represented: Delaware, Lackawanna & Western, Lehigh Valley, Erie, Pennsylvania, Buffalo, Rochester & Pittsburg, Buffalo & Susquehanna, New York Central & Hudson River, New York, Chicago & St. Louis, Lake Shore & Michigan Southern, Michigan Central, Grand Trunk, and Pere Marquette. The Wabash was unable to have a representative at the conference, but expressed its willingness to co-operate with the other roads. At this meeting the suggested sites were carefully considered and it was agreed that the one on Genesee street known as the Cary site would be the ideal location for a union station. Accordingly, a committee appointed by the railroads was authorized to say that the roads would consider favorably the project for a union station on the Genesee street site, to be jointly built and worked, provided suitable arrangements could be made with the city.

The approximate cost of the proposed terminal will be about $15,000,000, of which $11,000,000 is to be spent by the railroads and about $4,000,000 by the city. The general plan and further details of the station will be given in the next issue of the *Railroad Gazette*.

# GENERAL NEWS SECTION

## THE SCRAP HEAP.

The Southern Pacific has prepared plans for a hospital car, and a number of such cars are to be built at the Sacramento shops.

The embargo on freight destined for points on the New York, New Haven & Hartford has been lifted, announcement to this effect having been made by the Pennsylvania Railroad last week.

A press despatch from St. Louis says that the National Good Roads Association has arranged with the Missouri, Kansas & Texas to run an educational good roads train over the M., K. & T. lines, starting January 9. The National Good Roads Convention has been called to meet at Jacksonville, Fla., January 20 and 21.

The Chicago & Eastern Illinois is now actively competing in Chicago for freight to St. Louis and other southern points, and the newspapers say that a rate of 18 cents has been made on packing house products to the Gulf of Mexico; it is also reported that similar low rates have been made on low grade commodities from St. Louis to New Orleans.

The Subway railroad in New York City is now carrying upwards of 300,000 passengers a day. For the first month of its operation (November) the average daily traffic was about two-thirds of this number and the increase is mainly due to the opening of the Lenox avenue branch north of Central Park. The prevalence of rain, snow and cold weather has, however, turned much traffic from the surface and elevated lines to the Subway on many days of the past month.

Mr. Jackson, the Industrial Commissioner of the Erie Railroad, has issued a list of the new factories established in the towns and cities on the Erie road during the fiscal year ending June 30 last. The list is a long one and includes a great variety of manufactures from asbestos pipe covering, automobiles and bleaching works, to terra cotta, veneer and wool batting. A large majority of the establishments shown have side tracks connecting directly with the Erie lines. Mr. Jackson has in his office full information concerning the resources of the towns on all parts of the Erie system, and the circular sets forth his facilities for aiding manufacturers seeking places to set up new industries.

### Barge Canal Contracts 3 and 4.

On Dec. 23 the Superintendent of Public Works at Albany, N. Y., opened 11 bids for contract No. 3 of the 1,000 ton barge canal work, and four bids for contract No. 4. Contract No. 3 calls for the excavation of the Champlain Canal from below Fort Miller Lock, No. 60, to above the Guard Gate at Crocker's Reef, the construction of the Fort Miller lock and a bridge. Contract No. 4 calls for the construction of the Erie Canal from Lock 25 to deep water east end of Oneida Lake at Sylvan Beach, a distance of 4.83 miles. All the bids are said to be under the engineer's estimates, which were $874,000 for contract No. 3, and $934,000 for contract No. 4. It is semi-officially announced that the low bidders for contract No. 3 were Sunstrom & Stratton, general contractors, 143 Liberty street, New York City, whose bid on its face was $670,497, and for contract No. 4 L. W. Bates, civil engineer, 74 Broadway, New York City, whose bid totaled $726,815.

### The Year's Traffic at Sault Ste. Marie.

Mr. Joseph Ripley, General Superintendent of the canals at Sault Ste. Marie, submits the following annual report of traffic through the canals for the season of 1904:

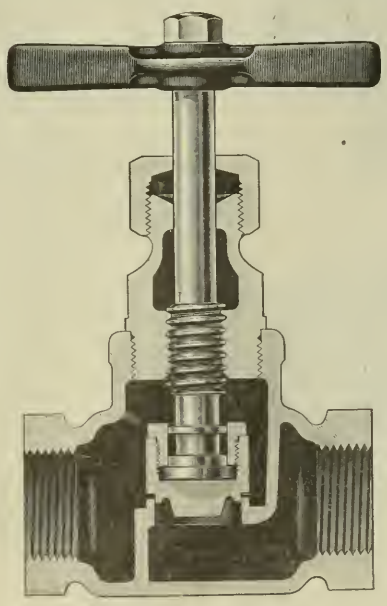
| | Seasons | | Dec., |
|---|---|---|---|
| | 1903. | 1904. | per ct. |
| Vessels: | | | |
| Steamers, No. | 14,027 | 12,188 | 13 |
| Sailing, No. | 3,569 | 2,994 | 16 |
| Unregistered, No. | 1,000 | 938 | 6 |
| Total passages | 18,596 | 16,120 | 13 |
| Lockages, No. | 11,642 | 10,315 | 11 |
| Tonnage: | | | |
| Registered, net | 27,736,444 | 24,364,138 | 12 |
| Freight, net tons | 34,671,437 | 31,546,106 | 9 |
| Passengers, No. | 55,175 | 37,695 | 32 |
| Coal: Hard, net tons | 1,149,005 | 991,228 | 14 |
| Soft, net tons | 5,788,628 | 5,463,641 | 6 |
| Flour, bbls. | 7,093,380 | 4,710,538 | 34 |
| Wheat, bush. | 61,384,552 | 49,928,869 | 19 |
| Grain,* bush. | 32,095,646 | 33,030,992 | 3† |
| Mfd. & pig iron, nt tns | 193,267 | 229,985 | 19† |
| Salt, bbls. | 454,882 | 365,459 | 20 |
| Copper, net tons | 112,877 | 109,605 | 3 |
| Iron ore, net tons | 21,654,898 | 19,635,797 | 9 |
| Lumber, M. ft., B. M. | 1,003,192 | 923,280 | 8 |
| General mdse., net tons | 659,839 | 732,009 | 11† |

*Other than wheat. †Increase.

The United States Canal was opened May 5 and closed Dec. 13, 1904; season, 223 days. The Canadian Canal was opened April 30 and closed Dec. 25, 1904; season, 240 days.

### The Hancock Valves.

The Hancock globe, 60 degree angle and cross valves, are made in both the flanged and screw types up to the 3 in. size. These valves will stand a water pressure of 1,000



The Hancock Valve.

lbs. without leaking and are guaranteed to work under a steam pressure of 500 lbs. It is claimed that in an actual test the bodies of these valves withstood a pressure of 4,000 lbs. per sq. in. without breaking. The discs are of a special mixture which does not contain zinc and the spindles are Tobin bronze. The valve is guided on the stem by two collars which gulde the disc nut, thereby compelling the disc to seat squarely. The valve seat is flat and the valve disc has a projection on it which acts as a guide when the seat is being ground. It is also claimed that when the valve is slightly raised from its seat, this projection allows the escaping steam to clean the seat of all dirt and foreign matter. These valves are made by the Hancock Inspirator Co., New York.

### An English View.

From *The Engineer* (London).

The worst accidents on British railways are derailments. We never hear of a train going through a bridge. Collisions are due to fogs, for the most part, and, secondly, to mistakes made by drivers or signalmen. Individuals are run over, and shunters are caught under trains or between buffers. In the United States the worst accidents are due to the failure of bridges or trestles, collisions, and the running over of individuals at level crossings. Simple derailments are not exceptionally numerous. We may say, therefore, that in the United States material plays a much larger part than it does in this country; and the disasters which are brought about by personal errors are largely the result of systems of working which are radically defective. Thus, in the United States there is an enormous single line mileage. Roads of this kind can only be worked safely by inflexibly observing the rule that there shall be only one train staff to each section, and that no train shall be permitted to run without this staff. . . . If the people of the United States were resolved that railroad traveling should be made safe, it would be made safe. There is nothing inherent in the country or the climate, or the conditions of working, to prevent this. Nothing stops the way but the lethargic indifference of the public. . . . Where bridges and trestles and permanent way are no longer able to carry the locomotives and rolling stock, we are reminded that the railroad companies are unable to bear the financial stress of renewing structures which have outlived their time. Keeping in mind as we do the enormous sums which appear to be available for constructing extensions and new lines, it seems that, not the want of financial power, but the want of will must be held responsible for much that is reprehensible in the conduct of traffic in the United States.

The immunity which we enjoy in this country from accidents is due to ourselves—that is to say, the traveling public will not put up with the destruction of life, limb, and property brought about by avoidable accidents. Until the inhabitants of the United States act energetically from similar motives the slaughter will continue. It is useless to denounce the single-track system and to hold it responsible for the killing and maiming. The single line can be worked just as safely as the double line if due precautions are taken. With the train staff, or on crowded roads the electric tablet system, it is next to impossible for a collision to occur. In this country the railroad companies grumble at the severity of the precautions which the Board of Trade insist on being taken to secure safety. But the companies are really largely the gainers. Juries never spare them, and the price paid for compensation would, in the long run, be much greater than the outlay rendered compulsory by legislation.

### A New Westinghouse Crane Motor.

The accompanying illustrations show the Westinghouse type K motor. This motor is designed for the operation of cranes, hoists and similar apparatus and for intermittent service in which heavy starting torques and wide speed variation are required. This type of motor is made in ten sizes, including capacities from 2 to 40 h.p.

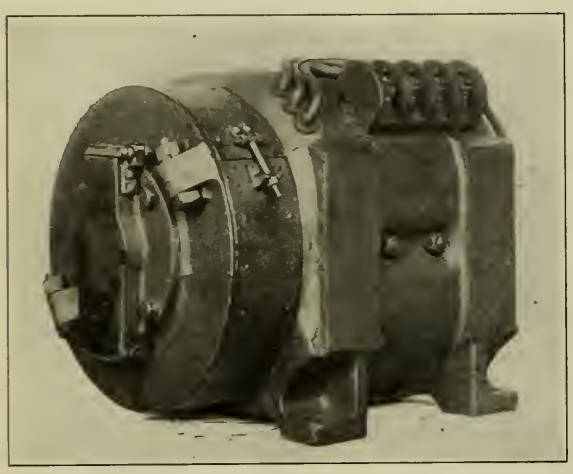
The frames are of the enclosed form, to guard against dirt and moisture, but are designed so that the working parts may be exposed for inspection or adjustment without dismantling. If local conditions permit the cover about the commutator may be removed and the motor operated open, with improved ventilation and increased capacity.

There are four inwardly projecting poles, each of which is magnetized by a separate field coil. It is claimed that this arrangement is superior to that in which but two poles are directly magnetized, the other being consequent, as has been demonstrated in both railroad and industrial service. These motors are series wound and are designed for operation on direct current circuits of 220 and 500 volts. Since the current passes successively through armature and field winding, the torque of such a motor increases nearly as the square of the current, up to the point of saturation of the iron. For this reason the series motor is particularly well suited to the starting and acceleration of heavy loads. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range, the change in the resistance of the motor circuit being made by means of a controller. The motor frames are of cast steel (except in the three smallest sizes, where they are cast iron). They are nearly square in section and two poles project inward in a horizontal and two in a perpendicular plane. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of 34 deg. with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole piece and field coils, or to remove the armature. The lower casting has two finished faces or pads to which bearings for a countershaft may be bolted or which may be used for side mounting. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush holders. The opening around the commutator is entirely closed by a $^3/_{32}$ in. sheet steel band, fastened by thumb screws, an arrangement which permits access to the commutator and brush holders at all points.

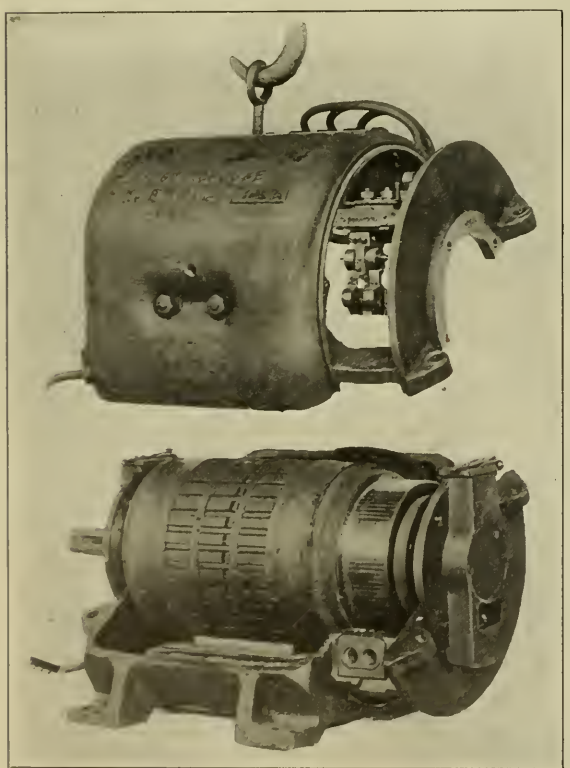
The four pole pieces are built up of soft steel punchings, riveted together between wrought iron end plates, and are secured to the frame by bolts. The coils of the larger motors are of copper strap and the terminals are insulated with asbestos ribbon. Being machine wound, they are perfectly interchangeable. The coils are fitted to the pole pieces, protected at the ends by oiled duck and held in place by the spreading tips of the pole pieces.

The bearings are composed of shells lined with bronze or babbitt and mounted in housings which may be removed without separating the motor frame. Cast brass bearings are standard on all sides up to and including the No. 4; on all frames above No. 4 babbitt bearings are used. Grease lubrication is employed in all except the larger sizes—Nos. 9 and 10—the bearings of which are designed for lubrication by oil and waste. Drip cups are provided under the bearings for all motors. The bearing housings may be turned and bolted in several positions without modification of design or the addition of special parts.

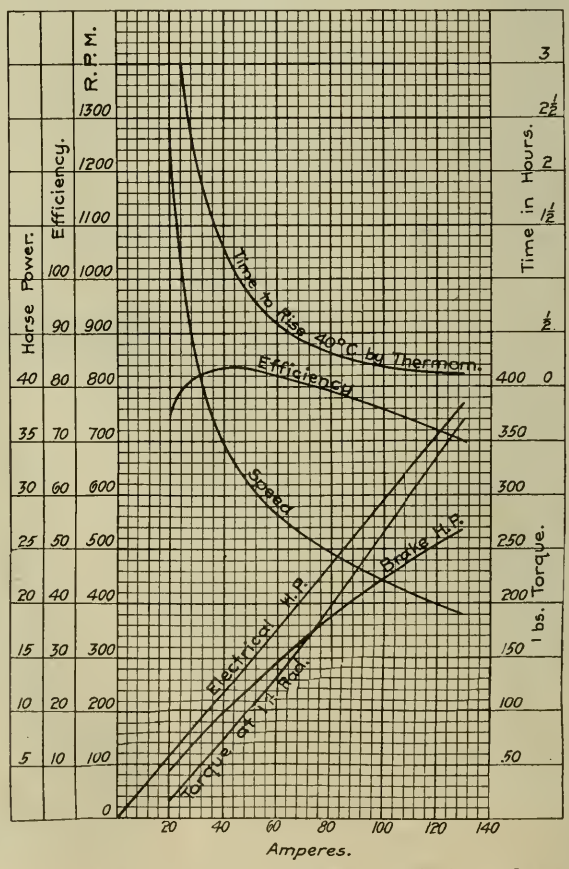
The armature core is built up of soft steel punchings of high permeability. These



The Westinghouse Type K Crane Motor.



The Westinghouse Type K Crane Motor, Showing Upper Field Raised.



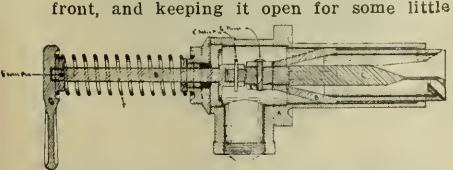

Characteristic Curves No. 6 Type K Westinghouse Crane Motor.

punchings are, in all except the smallest sizes, assembled on a spider and held from turning by steel key. The pinion end is provided with a bell shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections. The coils are placed in slots and retained by hands laid in grooves below the surface of the core, except in the case of armatures for the Nos. 9 and 10 motors, which have fish paper wedges forced in between V shaped grooves near the top of the slots. Covers of oiled duck protect the ends of the winding. Wiper rings or oil guards are provided at each end of the armature to protect the winding from oil. The shafts may be extended at either end to accommodate pulleys, pinions or brake discs. The commutator is built up of bars of hard drawn copper, insulated by mica, and mounted on the armature spider.

The brush holders are of the sliding type and the individual holders may be independently adjusted. Tension is provided by means of a coiled spring which acts through a short brass strip, so that the spring responds immediately to any movement of the brush, and close contact is maintained at all times. The brush holder arms are secured by stud bolts to surfaces which are machined on the ribs of the frame, parallel to tangents at the points of contact with the brushes. Adjustment to compensate for wear of the commutator can be made by removing the iron washers which are placed under the insulating washers on the stud bolts. With all but the two smaller sizes a shunt is connected to the tip of the spring, extended back over the spring and fastened to the brush holder, thus relieving the spring of the duty of carrying current, insuring good contact, low operating temperature and a permanent and even tension. With every carbon brush ⅝ in. or more in thickness an additional sheet is provided connecting the carbon to the carbon holder, improving the contact between carbon and holder and preventing the pitting of the brush, besides offering a further protection to the temper of the spring. Flexible leads are brought out through insulating bushings in the upper frame and are either connected to terminal blocks mounted on the top of the motor, or are arranged for direct connection to the controller lines.

### The "Diamond" Steam Flue Blower.

The illustration shows a sectional view of the "Diamond" steam flue blower, which is designed to overcome the disadvantages of the old method of a steam or air pipe blowing one flue at a time from the front end of the boiler, against the draft. This latter method, of course, necessitates opening the front, and keeping it open for some little



Sectional View of "Diamond" Blower.

time, cooling the boiler and reducing the steam pressure. Also the soot is blown into the smoke-box and must be removed. The "Diamond" blower is placed at the rear end of the boiler and blows the soot with the draft, and out of the chimney. About five minutes is all that is required to clean a set of flues as it cleans at each operation a cluster 4 ft. 6 in. in diameter.

The steam is admitted through the inlet, H, at the bottom, the pressure forcing out nozzle tube B, and with it nozzle C. Revolving nozzle C by handle G causes the steam to spray through all of the tubes within an area 4 ft. 6 in. in diameter at one time.

Prominent users of these blowers are: The Western Transit Company, Northern Steamship Company and The Mutual Transit Company, all of Buffalo, N. Y., and the Chicago Shipbuilding Company, Chicago. The maker, the Power Specialty Company, Detroit, Mich., will send blowers on trial.

### Signal Department of New York Central.

It is announced that beginning with January 1 the signal department of the New York Central will be placed under the supervision of the operating department instead of the maintenance of way department, as heretofore. The signal engineer becomes a signal superintendent and will report to the General Superintendent instead of to the Engineer of Maintenance of Way in all matters pertaining to maintenance and care of signals. The signal supervisors will report to the Division Superintendent in these matters and to the Engineer of Maintenance of Way in all questions involving plans, layouts and new installations. In changes of standards and in new plans the Signal Engineer will concur with the Engineer of Maintenance of Way. The Signal Engineer may call on the Signal Supervisors for reports of performance of signals, but has no direct supervision over them.

### Manufacturing and Business.

The Cleveland Punch & Shear Works Co., Cleveland, Ohio, recently shipped one of its automatic spacing tables to the Middletown Car Works, Middletown, Pa.

C. F. Ernst's Sons, of Buffalo, has been incorporated in New York with a capital of $100,000 to make iron and steel by C. K. Ernst and others, of Buffalo.

J. P. Neff, formerly foreman of shops for the Chicago & North Western at Boone, Iowa, took a position in the mechanical department of the American Locomotive Equipment Co., Chicago, on Dec. 1.

The Erie City Iron Works, of Erie, Pa., recently increased its capital stock from $1,000,000 to $2,000,000, and, it is reported, is planning to make large additions to its works now under construction.

The International Machine & Screw Co., of Portland, has been incorporated in Maine with a capital of $500,000 with E. W. Freeman, President, of Portland, and G. T. Warwick, Treasurer, of Springfield, Mass.

F. W. Bird & Son, East Walpole, Mass., maker of the Neponset insulating paper, have received the order for paper to be used in 1,000 refrigerator cars being built by The American Car & Foundry Co. of Chicago.

The National Steel Foundries Co., of New Haven, Conn., according to local reports, has been given a contract to furnish all the steel castings to be used in the London underground railway. The works will be run on full time to fill this contract.

Bankers of New York, Boston and Philadelphia, it is reported, have arranged to build the power canal of the Great Northern Power Co. at Duluth, Minn., and have arranged for a bond issue of $3,600,000 to provide funds for the work.

The Maryland Car Wheel Manufacturing Co., of Cumberland, Md., has been incorporated with a capital of $25,000 to make a self-lubricating car wheel; also various kinds of car and mining supplies, by John Duroth, C. G. Smith and others.

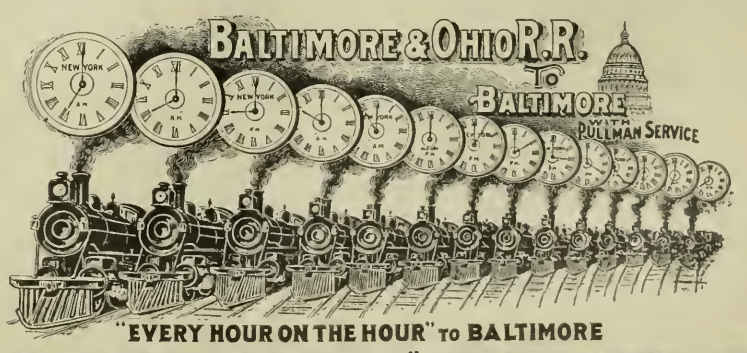
The Canada Foundry Co., of Toronto, it is reported, has bought from the Bucyrus Co., of Cleveland, Ohio, the sole right for Canada to make that company's steam shovels, wrecking cranes and pile drivers, and will enlarge its works to take up this work.

The Pressed Steel Car Company has opened its office in the south, and Mr. L. O. Cameron has been appointed General Sales Agent, Southern District, with headquarters at Atlanta. Mr. Cameron will have charge of all matters pertaining to the sales department in connection with railroads and manufacturing concerns located in the southern territory.

The American Steel Foundries, New York, announces that on Jan. 1, 1905, its engineering department will be placed in charge of Mr. C. M. Mendenhall, with the title of Chief Engineer, and that the following officers will report direct to Mr. Mendenhall: Geo. G. Floyd, Mechanical Engineer; J. V. McAdam, Traveling Engineer; W. Mac Gregor, Construction Engineer.

Mr. C. W. Whitney has resigned his position as Pacific Coast representative of the McGraw Publishing Company, New York, and has become identified with the Abner Doble Company, of San Francisco, engineers and manufacturers of tangential water wheels and needle regulating nozzles. Mr. Whitney will have charge of the Abner Doble Company's publicity department.

The Independent Railroad Supply Co., Chicago, was awarded a silver medal by the Louisiana Purchase Exposition for the Wolhaupter rail joint. Under the rules laid down for the jurors, governing the granting of awards, this was the highest award possible to obtain. The company has just re-




The Latest Fashion in Timetables.
*(Poster used in Washington, D. C.)*

ceived orders for these rail joints from the Cincinnati, Hamilton & Dayton and Chicago & Western Indiana, and recently shipped an order to the Michigan Central.

Contracts for the new boiler and machinery of the electric light station of the Holyoke (Mass.) municipal plant were let recently. The contract for the 500 k.w. generator has been given to the General Electric Co. for $18,000, which includes a steam turbine to operate it. The contract for three 250 h.p. Manning steam boilers was given to Coghlan's Holyoke Steam Boiler Works for $6,600. It is expected that the works will be in operation about May 1.

Walter Macleod & Co., Cincinnati, send notice of their removal to their new factory and offices at 213 East Pearl street. They own this new plant, which has over 20,000 sq. ft. of floor space in the factory. The notice is in the form of a handsome calendar for 1905. Accompanying it is a pamphlet describing Macleod's labor-saving specialties, including oil burners for light and heat, oil furnaces and forges, sand blast machines, white washing and painting machines and acetylene outfits.

The New Milford (Conn.) Power Co., which furnishes power for the electric railroads in Waterbury, New Britain, Plainville, Cheshire, Bridgeport, Greenwich, Milford, Southington, Norwalk and Naugatuck, it is reported, has been sold to New Haven capitalists. The company has an extensive plant in New Milford and auxiliary works are being built at Boardman's Bridge. The officers of the company are: President, Winthrop G. Bushnell; Vice-President, Louis E. Stoddard; Secretary and Treasurer, Samuel C. Morehouse. The headquarters of the company will be at New Haven.

Contracts aggregating $500,000, reports from Pittsburg state, have been given to the Westinghouse Companies for the complete equipment of the Rochester, Syracuse & Eastern Railroad, to be built by the Syracuse Construction Co. The contracts are divided between the Westinghouse Electric & Manufacturing Co. and the Westinghouse Machine Co. The former will furnish two 2,000 h.p. generators, two 750 h.p. and six 600 h.p. rotary converters and five 600 k.w. step-up transformers with 33,000 volts capacity. Equipment will also be furnished for 22 cars requiring 84 motors. There will be 12 quadruple equipments of 110 h.p. each, two 75 h.p., four 40 h.p., two 30 h.p., and two double 30 h.p. The Westinghouse Machine Co. will build two 2,000 h.p. steam turbines.

### Iron and Steel.

The Illinois Steel Co. will soon start its two largest mills and its entire steel plant, which have been idle for some months. The company proposes to resume work January 2 in its rail and steel mills.

Contracts aggregating several hundred thousand dollars, it is reported, have been given for building the new hoop mill of the Sharon Steel Hoop Co. at Sharon, Pa., which is to be in operation about June 1 of next year.

At a meeting in Pittsburg December 22 of steel sheet and tin plate makers, including the American Steel & Tin Plate Co., it was decided to raise the prices on these products $2 a ton, which makes the official quotation on black sheets of No. 28 gage $2.38 per hundred lbs. The demand for sheets and tin plates is increasing daily and is now greater than the mills can meet. The American Sheet & Tin Plate Co. has more than 90 per cent. of its capacity in active operation and expects very soon to have all its mills running on full time.

## MEETINGS AND ANNOUNCEMENTS.

*(For dates of conventions and regular meetings of railroad conventions and engineering societies see advertising page 24.)*

### Western Society of Engineers.

At an extra meeting held Dec. 21 the subject presented was "The Construction of Part of the Intercepting Sewers of Chicago from 39th Street to 63d Street." Two papers were read, the authors being Mr. W. A. Shaw and the late Mr. Guy Miltimore.

### Railway Club of Pittsburg.

At the regular meeting of this club December 23, an address was delivered by J. W. Wardrop on "The Merchants' and Manufacturers' Association and Its Relation to the Railroad and Business Interests of Pittsburg." The meeting was also addressed by Colonel J. N. Schoonmaker, J. F. Townsend, William Kirk, D. F. Hurd and others.

### The Railway Signal Association.

The next meeting of this Association will be held at the Grand Union Hotel, 42d street and Broadway, New York City, at 2 p.m., on Tuesday, January 10. Mr. Edward T. Reynolds will read a paper on storage batteries for block signals, and the committee report on Standard Specifications for Mechanical Interlocking and for Material for Construction Work will be discussed, beginning with paragraph 15. Paragraphs 1 to 14 inclusive were revised and adopted at the annual meeting in St. Louis, October 11.

## PERSONAL.

—Mr. A. S. Ostrander, formerly Superintendent of the Air Line Division of the New York, New Haven & Hartford, died at West Lynn, Mass., last week at the age of 56.

—Captain George H. Power, for more than half a century a prominent business man of Hudson, N. Y., died in that city on December 21, at the age of 87. Capt. Power's early business career was in boating on the Hudson River. He was the chief owner of the Hudson & Berkshire Railroad, which is now the Hudson branch of the Boston & Albany.

—Mr. William Howard Courtenay, the new Chief Engineer of the Louisville & Nashville, is a native southerner, having been born in Louisville in 1858. Mr. Courtenay is a graduate of Rensselaer Polytechnic Institute, class of 1879. Shortly after graduating he entered the service of the Louisville & Nashville as an Engineer and served in that capacity until 1891, when he was appointed to the position from which he is now promoted, that of Principal Assistant Engineer. He will assume his new duties on the first of the coming month.

—Announcement is made of the death of Sir Lowthian Bell, at the age of 88. Sir Lowthian, who was the third president of the Iron and Steel Institute, holding office from 1873 to 1875, and the first recipient of the Bessemer Gold Medal, in 1874, was a Fellow of the Royal Society, a member of the American Philosophical Institution, and an ex-Mayor of the City of Newcastle. He was well-known as a representative of the iron, steel and coal industries of Great Britain, and published books on the chemistry of the blast furnace and the principles of the manufacture of iron and steel. He was largely interested in the Clarence Iron Works, and was director of the North Eastern Railway. He was born in 1816; was created a baronet in 1885, and is succeeded in the title by his son, Thomas Hugh.

—Mr. J. C. Vining, the new General Superintendent of the Colorado Midland, was born in Richmond, Va., 39 years ago, and began work as a telegraph operator in 1879. For about a year he worked in Ohio and later went to St. Paul as operator on the North-

ern Pacific and worked for that company until 1884, during which time he was employed as operator, brakeman and conductor, running "the front" train laying track. Mr. Vining also served on the Southern Pacific, the Santa Fe and the Mineral Belt Railway in Arizona, which road was abandoned after 40 miles of rough work had been done. In April, 1891, he went to the Rio Grande as waybill clerk, subsequently being promoted to the position of local freight agent at Denver. In 1904 he went to the Colorado Midland as Trainmaster, and was later promoted to be Superintendent of Transportation, from which position he is now promoted to the new position just created, that of General Superintendent.

—Mr. C. W. Kinney, who recently succeeded Mr. Baxter as Superintendent of the Pennsylvania Division of the Lehigh Valley at Sayre, Pa., has been in the service of that company since 1886. He began as a tele-

graph operator on the New Jersey Division. In 1892 he was made train despatcher of that division at Perth Amboy and was transferred, with the office, to Easton in 1898. He was then promoted to be chief despatcher at that point and in the fall of 1904 was made Trainmaster, from which position he is now promoted to be Superintendent at Sayre.

—Mr. F. W. Hawks, Chief Engineer of the Evansville & Terre Haute and the Evansville & Indianapolis, was born at Decatur, Mich., 39 years ago. Mr. Hawks was graduated from the High School at that place and began work as a Deputy County Surveyor. His first railroad work was in 1889, when he began as a draftsman on the Chicago Great Western. In 1892 and 1893 he was on

the Chicago & Eastern Illinois, and in 1895 was appointed Assistant Engineer of Maintenance and Construction on the Chicago, Peoria & St. Louis. For the next six years he was Assistant Engineer on the Chicago & Eastern Illinois. In 1903 he had charge of the construction of 62 miles of line for this company. Mr. Hawks was appointed to his new position on the Evansville & Terre Haute in November last.

—Mr. Gustavo Navarro, Superintendent of Motive Power and Machinery of the Vera Cruz & Pacific, began work in 1883 as an apprentice on the Mexican Central. For a time he was in Panama as a locomotive engineer, and then went to the main shops of the National Railroad of Mexico at the City of Mexico. In 1889 he was employed by S. Pearson & Son on the great canal for the drainage of the Valley of Mexico, acting

as contractor and machinist until 1893. The next year he went to the Mexican Southern, and in 1895 went to the Tehuantepec National as Superintendent of Motive Power and Machinery. In 1897 Mr. Navarro was sent by the Mexican Government to the United States navy yard at Norfolk, and upon his return to Mexico again entered the service of the Tehuantepec National. For a time he engaged in mining. In 1902 he was given the contract to widen the locomotives of the National from narrow to standard gage, and was subsequently appointed Master Mechanic. In 1903 he went to Acambaro as Master Mechanic of the Pacific Division, from which position he resigned to go to the Vera Cruz & Pacific as Master Mechanic at Tierra Blanca; and about one month later was promoted to be Superintendent of Motive Power and Machinery.

—Colonel Alexander S. Johnson, who died in Dallas, Texas, last week at the age of 72, was for many years land commissioner of the Gulf, Colorado & Santa Fe.

## ELECTIONS AND APPOINTMENTS.

*Atchison, Topeka & Santa Fe (Coast Lines).*—J. B. Phillips, Machine Foreman of the San Bernardino Shops, has been appointed General Foreman, locomotive shops, succeeding W. L. Essex, resigned.

*Atlanta, Knoxville & Northern.*—See Louisville & Nashville.

*Atlantic Coast Line.*—W. B. Denham, hitherto General Superintendent at Savannah, Ga., has been transferred to Wilmington, N. C., as Chief Assistant to the Fourth Vice-President and General Manager. Mr. Denham has been succeeded at Savannah by Newton Riddell.

*Baltimore & Ohio.*—W. C. Loree, General Superintendent at Pittsburg, Pa., will on January 1 be transferred to Wheeling, W. Va., as General Superintendent of the Wheeling Division, to succeed T. J. Foley, resigned. Robert Finney, General Agent at Pittsburg, has been appointed to succeed Mr. Loree.

*Chicago, Burlington & Quincy.*—W. F. Hayes, hitherto Acting Superintendent of Bridges and Buildings at Creston, Iowa, has been transferred to be Superintendent of Bridges and Buildings of the Burlington Division at Burlington, J. G. Woodworth, Assistant to the First Vice-President, has resigned. W. E. Crane, Coal Traffic Manager, has resigned. (See Northern Pacific and the Ft. Smith & Western.)

*Chicago, Rock Island & Pacific.*—G. W. Duback, General Baggage Agent, has resigned.

*Fort Smith & Western.*—W. E. Crane, hitherto Coal Traffic Manager of the Chicago, Burlington & Quincy at Chicago, has been appointed General Manager of the Ft. S. & W., with headquarters at Ft. Smith, Ark., succeeding the late J. J. Mahoney.

*Grand Trunk.*—U. E. Gillen has been appointed Assistant Superintendent at London, Ont., succeeding J. W. Higgins, resigned. The office held by Mr. Gillen. Assistant Superintendent of the 5th, 6th and 7th Districts, has been abolished. H F. Coyle, Trainmaster at Belleville, will have charge of matters pertaining to transportation.

*Iowa Central.*—See Minneapolis & St. Louis.

*Lehigh Valley.*—J. H. Jacoby, Superintendent of Telegraph, has resigned, and the office has been abolished.

*Louisville & Nashville.*—R. Montfort has been appointed Consulting Engineer, with office at Louisville, Ky. W. H. Courtenay, hitherto Principal Assistant Engineer, has been appointed Chief Engineer, succeeding Mr. Montfort. T. E. Brooks has been appointed Superintendent of the South & North Alabama R. R. and the Birmingham Mineral Division of the L. & N., with office at Birmingham, Ala. J. R. Wheeler, hitherto Assistant Superintendent at Birmingham, Ala., has been appointed Superintendent of the Nashville Division, with headquarters at Nashville, Tenn., succeeding Mr. Brooks.

The Knoxville, LaFollette & Jellico Railroad, extending from Saxton, Ky., to Knoxville, Tenn., and the Atlanta, Knoxville & Northern Railway, extending from Knoxville, Tenn., to Marietta, Ga., with branches will after January 1 be operated as a part of the L. & N. Until further notice, E. E. Snyder, Superintendent of the Louisville Division, will be in charge of the line from Saxton to the north end of Dossett tunnel. C. W. Bradshaw has been appointed Superintendent in charge of the line from the south end of Dossett tunnel to Marietta, including branches, with headquarters at Blue Ridge, Ga.

*Minneapolis & St. Louis.*—J. N. Tittemore, Traffic Manager of the Iowa Central, has been appointed Traffic Manager of the M. & St. L., succeeding W. H. Hopkins, General Freight Agent, resigned. Mr. Tittemore will continue as Traffic Manager of the Iowa Central.

*Missouri Pacific.*—J. W. Higgins, hitherto Assistant Superintendent of the Grand Trunk at London, Ont., has been appointed Inspector of Transportation of the M. P., with headquarters at St. Louis.

*Morgan's Louisiana & Texas.*—F. E. Batturs, hitherto Assistant General Passenger Agent, has been appointed General Passenger Agent, in charge of Southern Pacific lines in Louisiana.

*New York Central & Hudson River.*—P. E. Crowley, hitherto Superintendent of the Pennsylvania Division at Corning, N. Y., has been appointed Assistant General Superintendent, with headquarters at Syracuse.

*New York, New Haven & Hartford.*—A. R. Whaley, hitherto Superintendent at Providence, R. I., has been appointed Superintendent of the New York Division, succeeding T. H. Fennell, who, on account of ill health, has been relieved of the Superintendency of that division. C. F. Kennedy has been appointed to succeed Mr. Whaley as Superintendent of the Worcester Division.

*Northern Pacific.*—J. G. Woodworth, hitherto Assistant to the First Vice-President of the Chicago, Burlington & Quincy, has been appointed Traffic Manager of the N. P.

*Philadelphia & Reading.*—George Ziegler, hitherto Assistant Comptroller, has been appointed Comptroller of the Reading and controlled lines, succeeding Daniel Jones, resigned.

*South & North Alabama.*—See Louisville & Nashville.

*Suffolk & Carolina.*—C. L. Hutchins, hitherto Auditor, has been appointed General Manager, succeeding G. L. Barton, resigned.

*Tennessee Central.*—L. F. Lonnbladh, hitherto Acting Engineer of Construction, has been appointed Chief Engineer, succeeding W. N. McDonald, Engineer of Maintenance of Way, resigned. O. M. Laing, hitherto General Storekeeper, has been appointed Purchasing Agent.

## LOCOMOTIVE BUILDING.

*The Detroit & Mackinac* will order two locomotives.

*The Toledo, Peoria & Western* has ordered five 10-wheel (4-6-0) locomotives from the Baldwin Locomotive Works.

*The Canadian Pacific* is reported to have ordered 30 (4-6-0) locomotives from the Locomotive & Machine Co. of Montreal, Ltd.

*The Canadian Pacific* has ordered 10 Mogul (2-6-0) locomotives from the Canadian Locomotive Co., Kingston, Ont. These locomotives are for delivery within 10 months.

*The Queen & Crescent*, as reported in our issue of December 9, has ordered 13 consolidation (2-8-0) locomotives from the American Locomotive Co. Eight of these are for the Alabama Great Southern and five for the Cincinnati, New Orleans & Texas Pacific. The locomotives will weigh 200,000 lbs., with 180,000 lbs. on drivers; cylinders, 22 in. x 30 in.; diameter of drivers, 56 in.; straight boil-

er, with a working steam pressure of 200 lbs.; heating surface, 3,517 sq. ft.; 437 charcoal iron tubes, 2 in. in diameter and 14 ft. 6½ in. long; carbon steel fire-box 108 in. long and 72½ in. wide, grate area, 53 sq. ft.; tank capacity, 6,000 gallons of water, and coal capacity, 12½ tons. Special equipment includes: Westinghouse brakes, Gollmar bell ringers, Keasbey & Mattison magnesia boiler lagging, Simplex brake-beams, Tower couplers, Dressel headlights, Monitor injectors, Ajax journal bearings, U. S. piston rod and valve rod packings, Coale safety valves, Nathan sight-feed lubricators, Railway Steel-Spring Co.'s springs, Ashton steam gages and Latrobe driving, truck and tender-wheel tires.

*The Michigan Central*, as reported in our issue of December 23, has ordered 14 compound Consolidation (2-8-0) locomotives, three simple Pacific type (4-6-2) locomotives, and 17 simple 10-wheel (4-6-0) engines from the American Locomotive Co. The (2-8-0) locomotives will weigh 198,500 lbs. with 174,000 lbs. on drivers; cylinders 23 and 35 x 32 in.; diameter of drivers, 63 in.; straight boiler with a working steam pressure of 210 lbs.; heating surface, 3,091 sq. ft.; 359 tubes, 2 in. in diameter and 15 ft. 7 in. long; wide steel fire-box, 96⅛ in. long and 75⅛ in. wide; grate area, 50 sq. ft.; tank capacity, 6,000 gallons, and coal capacity, 12 tons. The (4-6-2) locomotives will weigh 221,000 lbs., with 140,500 lbs. on drivers; cylinders, 22 in. x 26 in.; diameter of drivers, 75 in.; straight boiler with a working steam pressure of 200 lbs.; heating surface, 3,897 sq. ft.; 354 tubes, 2 in. in diameter and 20 ft. long; wide steel fire-box, 96⅛ in. long and 75¼ in. wide; grate area, 50 sq. ft.; tank capacity, 6,000 gallons of water, and coal capacity, 12 tons. The (4-6-0) locomotives will weigh 154,200 lbs.; cylinders, 19½ in. x 26 in.; diameter of drivers, 64 in.; extended wagon-top boiler with a working steam pressure of 200 lbs.; heating surface, 2,612 sq. ft.; 314 tubes, 2 in. in diameter and 14 ft. 8 in. long; fire-box, 108 13/16 in. long, and 41½ in. wide; grate area, 31 sq. ft.; tank capacity, 5,100 gallons of water, and coal capacity, 12 tons. Special equipment includes: Westinghouse air-brakes, Chicago Railway Equipment Co.'s brake-beams, National-Fulton journal bearings, U. S. metallic piston rod and valve rod packings, Leach sanding devices and Detroit sight feed lubricators.

## CAR BUILDING.

*The American Car & Foundry Company* has miscellaneous orders for 181 cars.

*The Long Island* has ordered 122 passenger coaches from the American Car & Foundry Co.

*The Denver, Northwestern & Pacific* denies being in the market for three passenger coaches, as reported in our issue of December 16.

*The Underground Electric Railways* (London) have ordered 36 motor car bodies and 72 trailers from the American Car & Foundry Co.

*The National Coal Dump Car Company* has ordered 450 dump cars from the American Car & Foundry Co. These dump cars are for the Illinois Central.

*The Chicago, Rock Island & Pacific* has ordered 25 combination stock cars from the National Coal Dump Car Co., to be built by the American Car & Foundry Co.

*The American Car & Foundry Company* has received an order for 50 ballast cars. These cars will be used for work on the Flatbush Avenue Terminal of the Long Island.

*The San Pedro, Los Angeles & Salt Lake* has ordered 200 steel flat cars of 100,000 lbs. capacity from the Pressed Steel Car Co. These cars will weigh 34,500 lbs., and will be 41 ft. 10 in. long and 9 ft. 4½ in. wide.

*The Minneapolis, St. Paul & Sault Ste. Marie* has ordered 15 cabooses from the American Car & Foundry Co. These cars will be 21 ft. 2 in. long and 8 ft. 9 in. wide, over sills; and 15 ft. 7½ in. high from top of cupola.

*The Grand Trunk Pacific* is reported to have made a contract with the Canada Car Co. The contract specifies the delivery of 15 cars a day for five years as soon as the plant of the Canada Car Co. at Montreal is completed.

*The Howland Improvement Company*, Goldsboro, N. C., has ordered 90 ventilated freight cars of 60,000 lbs. capacity from the South Baltimore Steel Car & Foundry Co. for January, 1905, delivery. The cars will weigh 24,000 lbs., and will be 36 ft. long, 8 ft. 6 in. wide and 7 ft. 6 in. high.

*The Michigan Central* has ordered 1,500 box cars of 80,000 lbs. capacity, 500 40 ft. refrigerator cars of 60,000 lbs. capacity, and 300 stock cars of 60,000 lbs. capacity from the American Car & Foundry Co. The box cars will weigh 36,000 lbs. and will be 36 ft. long, 8 ft. 6 in. wide, and 8 ft. high, inside measurement. The stock cars will be 40 ft. long, 8 ft. 5 in. wide and 7 ft. 6 in. high. Special equipment for all includes: Simplex bolsters, Westinghouse brakes, Smith doors for box cars, Miner draft rigging, Harrison dust guards, arch-bar trucks and Hutchins inside metal roofs for box cars.

*The Pittsburg Coal Company*, as reported in our issue of December 23, has ordered 2,000 twin hopper gondolas of 80,000 lbs. capacity from the American Car & Foundry Co., date of delivery commencing March, 1905. These cars will weigh 37,000 lbs., and will be 36 ft. 6 in. long, 9 ft. 7 in. wide and 4 ft. 2 in. high, inside measurement, with steel frames and underframes. Special equipment includes: Bettendorf and Simplex bolsters, Westinghouse air-brakes, Climax couplers, Simplex brake-beams, McCord journal boxes and journal box lids, Miner draft rigging, Union Steel and Railway Steel-Spring Co.'s springs, National-Fulton and Damascus brasses with Climax bearing keys and Diamond arch-bar trucks.

## BRIDGE BUILDING.

Dallas, Tex.—According to reports, the Missouri, Kansas & Texas is planning to put in about 10 new steel bridges on its Dallas division.

Eau Claire, Wis.—The City Council, it is reported, has given a contract to George Nelson at $34,167 for building a concrete and steel arch at Barstow street.

Fredericton, N. B.—C. H. LaBillois, Commissioner of Public Works, is asking for bids for the Forest City bridge and the Five Mile Brook bridge, both in York County.

Germantown, Ind.—The bridge of the Pittsburg, Cincinnati, Chicago & St. Louis over Martindale creek, which is 100 ft. long, has been wrecked. It was pushed from its abutments and fell a distance of 20 ft. into the stream below, by the wrecking of two flat cars loaded with heavy iron piping which struck the upright pieces of the bridge broadside. Damage about $25,000.

Harrisburg, Pa.—Nelson & Buchanan, of Chambersburg, has been given the state contract to build a bridge over Nescopeck Creek, in Luzerne County, for $10,844. The Penn Bridge Co., of Beaver Falls, was given the contract for the bridge at Swelyville over the Lackawaxen River, in Wayne County, at its bid of $16,100. There were 32 bids.

Bids are wanted January 10 by J. H. Shumaker, Superintendent of Grounds and Buildings, for rebuilding the substructure and superstructure of the highway bridge over Penn's Creek in Hartley township, Union County.

Minneapolis, Minn.—The bridge of the Minneapolis, St. Paul & Sault Ste. Marie, recently destroyed by fire, will be replaced by a steel bridge.

Norfolk, Va.—The steel bridge over Mahone's Canal, which is a combined highway and street car bridge, has been damaged by rust and corrosion to such an extent that it may have to be replaced by an entirely new structure.

Oshkosh, Wis.—Bids are wanted January 14 by the Board of Public Works for building the superstructure of the bridge over Fox river connecting Main and South streets. M. Coffey is a member of the board, and Karl L. Lehman, Consulting Engineer, 910 Operahouse building, Chicago, Ill., will furnish forms for proposals.

Pueblo, Colo.—The Pueblo Bridge Co., it is reported, has been given a contract at $97,460 to build the viaduct at Main street. It will be 700 ft. long with a roadway of 56 ft. and two sidewalks.

Sacramento, Cal.—The Board of Supervisors of Sacramento County is reported having given a contract to Clark & Henry for building a drawbridge with a draw of 117 ft. over the Sacramento River at Grand Island for $59,763. Objections were made to the bridge unless the draw-opening was widened to 148 ft., which has been consented to, at an increased cost of $4,000.

St. Louis, Mo.—The Board of Public Improvements has decided to let contracts at once for building a concrete arch with a 24-ft. roadway and foot paths on each side over the River des Peres in Forest Park, to replace the present wooden structure

St. Paul, Minn.—According to reports, the high bridge across the Mississippi recently partly destroyed by wind will be rebuilt at a cost of about $60,000. L. W. Rundlett is City Engineer.

Springfield, Mass.—The special commission appointed by the Mayor to consider the problem of building a new bridge across Connecticut river has reported that to avoid building at a high level it is desirable to remove the main tracks and the yards of the New York, New Haven & Hartford to the west side of the river. This would reduce by $350,000 the cost of the highway bridge, but would necessitate the expenditure of a million to change the location of the railroad for 2½ miles. This bold project is favored by the railroad company; and, for the million expenditure, the city would in return have the present right of way of the railroad for a great river front park. If the railroad were to be changed, it would cross from the east to the west side of the river three miles below the city and would return to the east side at the point where now the Boston & Albany crosses. This plan would necessitate two bridges over Agewam river and the construction by the Boston & Albany of a four-track bridge to make room for the New Haven. The Boston & Albany would also have to widen its road for some distance east of the river. The plan contemplates the establishment of new freight yards for the New Haven road east of the union passenger station and south of the Boston & Albany.

Bids are wanted by the County Commissioners January 11 for the removal and rebuilding of the stone piers and abutments for the new bridge to be built over the Connecticut River between West Springfield and Chicopee. The upper portions of the six existing piers and two abutments will be removed and rebuilt, and approximately 1,150 cu. yds. of masonry is to be removed and replaced. Robert O. Morris is Clerk.

Toronto, Ont.—The Canada Foundry Co., Ltd., of this place, it is reported, has been given a contract by the Canadian Northern to build the steel superstructure of a bridge 1,870 ft. long over the North Saskatchewan river.

Waynesboro, Pa.—Petition has been made to the court for a bridge to be built over the Antietam Creek.

### Other Structures.

Alexandria, Va.—The Washington Southern, reports state, is asking bids January 2 for putting up a brick passenger station 33 x 96 ft. and a baggage room 33 x 41 ft.

Buffalo, N. Y.—The Union Station Com-

mission, according to reports, has got the approval of the railroads of its plans for a new union passenger station.

CHICAGO, ILL.—According to newspaper reports from Chicago, the Pennsylvania is making elaborate plans for a new passenger station to be built on the site of the present union station.

DALLAS, TEX.—A contract is reported having been given to J. C. McCord for putting up a brick car barn for the Dallas Consolidated Electric Street Railway Co. 94 x 305 ft.. to cost about $15,000.

GREENSBORO, N. C.—The Southern Railway, according to local reports, will make improvements to cost $45,000, to include an addition to the present freight house, which is one story high and extending 250 ft. towards Davie street, and the building of a transfer shed 15 ft. wide and 750 ft. long.

GULFPORT, MISS.—The Gulf & Ship Island, it is reported, will begin work early in January on a new pier as large as the one already constructed, which is about one mile long.

KNOXVILLE, TENN.—The Knoxville Construction Co. has given the contract and work on the substructure has been commenced for its new brick car barns 250 x 300 ft. at Park avenue. Contracts for the brick work will soon be let.

LANCASTER, PA.—The Pennsylvania Railroad has notified the city authorities that it will build a tunnel at Prince and Walnut streets.

LOUISVILLE, KY.—According to local reports, a contract has been given by the Louisville & Nashville to the American Bridge Co. at $200,000 for the steel skeleton of its proposed nine-story office building.

MEMPHIS, TENN.—Plans are being made and bids will soon be asked for building a large elevator on the river front for the Lee line to cost about $100,000.

RENOVO, PA.—The Pennsylvania, it is reported, is planning to build an extension to its erecting shop 160 ft. long and to put up a new machine shop 80 x 280 ft. The foundation work is reported under way, but the company is not yet ready to receive bids for the buildings.

SCHENECTADY, N. Y.—Plans, it is reported, are under way for the building by the New York Central of a passenger station for the use of that company and the Schenectady Railway Co.; and it is also proposed to build a viaduct at the State street crossing.

## RAILROAD CONSTRUCTION.

### New Incorporations, Surveys, Etc.

ATLANTA, KNOXVILLE & NORTHERN.—This company is rebuilding 60 miles of its line from Knoxville south to Etowah, Tenn.. and there will be practically a new roadbed for the entire distance. W. J. Oliver & Co., of Knoxville, are the contractors. It is expected to begin track laying about March 1, and to have the line ready for operation by July 1. Grading is also in progress on an extension from Etowah, Tenn., to Cartersville, Ga., 90 miles. The contractors for this portion of the line are Wright, Williams & Wadley, of Birmingham, Ala. This extension will probably be finished before the end of 1905.

CHICAGO, ROCK ISLAND & PACIFIC.—It is reported that this company is preparing to build an extension from Knoxville, the present terminus of the Washington divison, to Indianola, Iowa, 28 miles. Surveys have been finished and estimates of the probable cost have been made. It is stated that a spur line will also be built from Knoxville to coal regions in Marion County, Iowa.

COLORADO, NEW MEXICO & GULF.—Articles of incorporation have been filed by this company in Colorado. It is proposed to build a railroad in the state of Colorado and New Mexico. W. S. Hopkins, of Hillsboro, N. Mex., is named as an incorporator.

DURANGO, ALBUQUERQUE & GULF.—This company, which was recently incorporated in New Mexico, proposes to build a railroad from San Felipe through Bernalillo, McKinley and San Juan counties, New Mexico, to a point in La Plata County, Colo., 220 miles. W. H. Andrews and W. S. Hopewell, both of Santa Fe, N. M., are said to be interested. (December 16, p. 197.)

DYERSBURG NORTHERN.—This company has been incorporated in Tennessee to build a railroad from Dyersburg north to Tiptonville, in Lake County, 3 miles. Connection will be made with the Illinois Central at Dyersburg. George T. Weakley, J. C. Doyle and W. H. Kupe, all of Dyersburg, Tenn., are incorporators.

EASTERN NEW YORK (ELECTRIC).—This company has been incorporated in New York to build an electric railroad from Ballston to Middle Grove, in Saratoga, ten miles. The authorized capital is $100,000. F. H. Beach, George D. Cunningham and B. L. Cole, all of Ballston, N. Y., are incorporators.

FLORIDA EAST COAST.—This company is about to build an extension of its line from its southern terminus at Miami to Key West, 136 miles. This extension will be both unique in its conception and novel in its proposed construction. The Florida East Coast Railroad, as is well-known, is the personal property of Henry M. Flagler, and is located on the eastern rim of the state of Florida, where it is for the greater part of its length in sight of the waters of the Atlantic Ocean. Mr. Flagler has for some time been anxious to reach a nearer point to Havana with his railroad and to this end had a survey made from Miami across the unexplored portion of Florida to Cape Sable. After this survey was made, he decided that this line was not feasible, and he therefore made a survey along the coast and the keys to Key West. He now proposes to build an extension south from Miami across to Key Largo on the neck of land separating Baines Sound from Blackwater Sound, and running thence along Key Largo, Long Key, Upper and Lower Mattecumbe and other keys to Key West. These Florida keys are coral ridges, most of them containing a lake in the center and covered with a thin soil and luxuriant vegetation. Some are scarcely above high water and are only a mangrove thicket. Others are inhabited and cultivated and some contain wells or springs of fresh water. Outside these keys runs the Florida reef, another coral reef that does not reach the surface of the water. Between them is the Hawk channel, which is used by medium-sized vessels. Most of the channels connecting the inside passage with the Hawk channel are small and shallow. As these keys are exposed to the full fury of the tropical storms, the work will involve a large amount of filling on the coral rock foundations. Approximately 35 miles of the line will be over water and the balance over keys partly rock and partly submerged. Most of the keys are destitute of soil, and the only material available nearby for filling is that found in the bars and shoals of pulverized set shell formed near the keys. An examination of the coast charts shows that the building of a road with grade 8 ft. above mean low tide would require about 40,000 cu. yds. of material per mile. At present there are three parties in the field locating this line. They are in charge of J. C. Meredith, Engineer of Construction, whose headquarters are at Miami, Fla. From the terminus at Key West it is proposed to run boats to Havana, 85 miles. It is proposed to build these "ferry" boats large enough to carry freight trains.

GEORGIA, FLORIDA & ALABAMA.—Press reports state that location surveys are in progress for an extension of this road north from Cuthbert, Ga., to Columbus, 50 miles. It is stated that work will be begun on this line as soon as the surveys are completed. (See Construction Supplement.)

GREENVILLE & KNOXVILLE.—Press reports state that work is progressing rapidly on this road between Greenville, S. C., and Riverview, 21 miles, and that 18 miles have already been graded out of Greenville in a northerly direction. E. E. McCollough, Greenville, S. C., is Chief Engineer, and H. M. Prince is President. (December 2, p. 177.)

LOUISVILLE & NASHVILLE.—According to newspaper reports, this company will soon begin rebuilding its Knoxville branch between Lexington, Ky., and Jellico, 65 miles. This branch runs through a mountainous country and a number of steep grades and sharp curves are to be eliminated.

NEWHOUSE, COPPER GULCH & SEVIER LAKE.—Articles of incorporation have been filed by this company in Utah. The proposed route of the railroad is from Newhouse, Beaver County, Utah, to Sevier Lake, in Millard County, 20 miles. Work is reported already in progress. Samuel Newhouse is interested.

NORFOLK & WESTERN.—An officer writes that track has been laid during the past year on the following lines: From Naugatuck, W. Va., to Kenova, 59 miles; North Carolina extension from Blair to Galax, three miles; Widemouth branch from Montcalm, W. Va., down the Bluestone river, 19 miles; Roanoke Belt Line from the main line west of Roanoke to the Winston-Salem district, 2½ miles; Tug Fork branch extension above Gary, W. Va., to reach coal fields, five miles; Radford branch extension from present terminus to Little and New rivers in Montgomery county, Va., four miles; Zenith branch to coal fields of the Zenith Coal & Coke Co. in McDowell County, W. Va., 1½ miles. Work is now in progress on the Iaeger & Southern branch from Iaeger, W. Va., up the Dry Fork branch of the Tug river to reach the coal and coke fields of the Berwind-White Coal Mining Co., 29½ miles, and on the Big Creek branch to a point in Tazewell County, Va., six miles. This work will be completed during the year 1905.

OKLAHOMA CITY, HENRIETTA & ST. LOUIS.—This company has been incorporated in Oklahoma Territory, with headquarters at Oklahoma City. It is proposed to build a railroad from Woodward, Okla. T., to Oklahoma City, and thence to Checotah, Ind. T., a distance of 280 miles. The authorized capital is $3,000,000. J. A. Dibble, J. H. Wheeler, J. W. Shortwell and others, of Oklahoma City, are directors.

PARKERSBURG, POMEROY & WESTERN.—Incorporation has been granted this company in Ohio. It is proposed to build a steam railroad from a point on the Ohio River opposite Parkersburg, W. Va., to Toledo, Ohio. C. F. Evans, J. K. Brandon, C. E. Bryan and F. L. Cooperider are named as incorporators.

PENDLETON SOUTHERN.—A charter has been granted this company in Oregon to build a railroad from Pendleton, in Umatilla County, southwest to Heppner, in Morrow County, 45 miles. C. J. Smith, C. H. Carter, T. C. Taylor and J. R. Raley, of Pendleton, Ore., are named as incorporators.

PENNSYLVANIA COMPANY (NORTHWEST SYSTEM).—This company now has a double-track line through from Pittsburg to Chicago. In the double-tracking of this line (the Pittsburg, Fort Wayne & Chicago) grades and curves have been reduced and many grade crossings abolished, making it practically a new road for much of the way.

PLANT CITY, ARCADIA & GULF.—Articles of incorporation have been filed by this company in Florida. The company proposes to buy 12 miles of railroad already built out of Plant City, belonging to the Warnell Lumber & Veneer Co., and to extend it 75 miles to the Gulf. C. A. Root, D. C. Thompson and William Schneider, of Plant City, Fla., are incorporators.

RED LAKE, MINNESOTA & MANITOBA.—Grading is reported completed on this road from Nebish, Minn., to Bemidji, five miles. It is stated that this portion of the line will be finished before the end of the year. C. M Amsden, C. A. Smith, C. J. Johnson and others, of Minncapolis, are interested. (July 8, p. 30.)

St. Louis, Brownsville & Mexico.—An officer writes that the branch line from Harlingen Junction to Fordyce, Tex., 55 miles, has been finished and was opened for traffic on December 19. Work is now in progress on an extension between Brownsville and Robstown. W. P. Homan, Corpus Christi, Tex., is Chief Engineer.

Southern.—This company is reported to be receiving bids for building passing tracks between Selma, Ala., and Meridian, Miss., and for grading a spur line 2½ miles long from Mobile Junction, Ala., to a point west of Bessemer.

Virginia Roads.—The Virginia Iron, Coal & Coke Co. is reported to have begun work on a line from Norton, Va., to Stonega, 20 miles. Connection will be made at the latter point with a branch line of the Virginia & Southeastern now building.

Western Maryland.—This company has opened that portion of its Cumberland extension between Big Pool and Hancock, Md., nine miles. This is part of the line which is being built between Big Pool and Cherry Run, 65 miles. (June 17, p. 8.)

## RAILROAD CORPORATION NEWS.

Boston Elevated Railroad.—The new tunnel under Boston Harbor from the mainland to East Boston has been leased by the city of Boston to the Boston Elevated Railroad Co. for a term of 25 years dating from 1897. The company is to pay an annual rental of three-eighths of 1 per cent. of the gross receipts each year on all its lines. In addition, the railroad company is to collect from each person passing through the tunnel a toll of one cent which is to revert to the city. The tunnel will be opened December 30.

Canadian Northern.—J. P. Morgan & Co. have bought $5,000,000 bonds of this company. These bonds bear 4 per cent. interest and the proceeds from the sale are to be used in building an extension west from the present terminus in the Saskatchewan valley through the Rocky Mountains to the Pacific. The bonds are guaranteed by the Manitoba Government and are a part of an authorized issue of $9,000,000.

Connecticut Railway & Lighting Company.—Redmond & Co., New York, are offering $500,000 first and refunding mortgage 4½ per cent. gold bonds at 98 and interest. The interest on these bonds is guaranteed by the United Gas Improvement Co., of Philadelphia. The total amount of bonds outstanding under the mortgage is $10,268,600. The net earnings of the Connecticut Railway & Lighting Co. for the three months ending September 30, 1904, were $104,428 after the payment of all interest and taxes.

Dominion Atlantic.—This company, which operates a line from Windsor Junction, N. S., to Yarmouth, 203 miles, with branch lines aggregating 17 miles, has bought the Midland Railway extending from Windsor to Truro, 58 miles.

Grand Trunk.—At a meeting of the stockholders of this company on December 21, the resolution of the directors guaranteeing $7,500,000 4 per cent. bonds of the Grand Trunk Pacific was approved. These bonds have been bought by Speyer & Co., New York, and Speyer Bros., London, and will soon be offered to investors.

Indiana, Illinois & Iowa.—The directors of this company have voted to resume the payment of dividends which were suspended last summer and have declared a dividend of 2 per cent. payable on February 1 to holders of record stock January 21.

Midland Railway.—See Dominion Atlantic above.

New England Railroad (N. Y., N. H. & H.).—The $10,000,000 6 per cent. and 7 per cent. first-mortgage bonds will be paid at maturity on January 1 at the office of the company in Boston, or by J. P. Morgan & Co., New York, who offer to the holders of the bonds the privilege of exchanging their holdings for the consolidated mortgage 4 per cent. bonds on a basis of par and accrued interest for the old bonds and 110 and accrued interest for the new.

New York & Ottawa.—At the foreclosure sale of this company on December 22, the road was bid in for the bondholders, who, it is understood, are acting for the New York Central interests. The price paid was $1,000,000.

New York, New Haven & Hartford.—The Supreme Court of Connecticut has decided unanimously in favor of the corporation in the case of the New York, New Haven & Hartford Railroad Company vs. C. K. Offield, of Chicago. The defendant holds the two remainder shares of the New Haven & Derby Railroad, a subsidiary line leased at 4 per cent. These shares the New Haven Company brought proceedings to condemn under a new and somewhat unique Connecticut statute. Offield asked $2,000 a share for his holding and testified that he had been offered $700 a share. The case may be appealed to the federal courts.

Reading Company.—At a meeting of the directors on December 21, a semi-annual dividend of 1½ per cent. was declared on the $70,000,000 outstanding common stock, payable February 1 to holders of record January 14. The regular semi-annual dividend of 2 per cent. on the second preferred stock was also declared. The surplus over fixed charges and taxes for the fiscal year ending June 30 was $7,283,631. Dividends at the full rate of 4 per cent. on both classes of preferred stock call for $2,800,000, leaving $4,483,631 available for dividends on the common stock, or equal to about 6 per cent.

Richmond, Fredericksburg & Potomac.—An extra dividend of ½ per cent. has been declared, payable January 1, to the holders of the common stock of this company. The usual semi-annual dividend has been 4 per cent.

St. Louis & San Francisco.—J. S. Bache & Co., New York, are offering at 98⅝ the remaining $1,500,000 of this company's total issue of $5,000,000 2½-year 5 per cent. coupon gold notes of $1,000 denomination each due Dec. 1, 1906. These notes are secured by the entire capital stock of the St. Louis & Gulf, and by about 95 per cent. of the $4,000,000 collateral trust 40-year 4 per cent. notes.

This road announces through freight service from Chicago and Kansas City to New Orleans, by way of Tupelo, and Meridian, Miss.

Western Maryland.—At a recent meeting of the State Board of Public Works, it was voted to accept the bid of this company of $155,000 for the state's interest in the Chesapeake & Ohio canal. This interest comprises a majority of the canal stock. With regard to the purchase, Vice-President Landstreet says that the Western Maryland does not intend to use the waterway, but it needs the right of way for its new line now building between Big Pool, Md., and Cherry Run, W. Va., which crosses the canal at eight different points.

Worcester & Southbridge (Electric).—The State Railroad Commission of Massachusetts has authorized the consolidation of the Worcester & Southbridge, the Southbridge & Sturbridge and the Worcester, Rochdale & Charlton Depot Street Railroad Companies. The controlling interest in all of these electric roads is now owned by the New York, New Haven & Hartford. The new company will be known as the Worcester & Southbridge Street Railway Co., and has received permission to increase its capital stock by $100,000. The proceeds from the sale of this stock will be used to purchase the outstanding stock of the Southbridge & Sturbridge and the Charlton Depot lines.

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## EDITORIAL ANNOUNCEMENTS:

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*CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.*

*ADVERTISEMENTS.—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* except in the advertising columns our own *opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.*

FRIDAY, DECEMBER 30, 1904.

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